The Nature of Commodity Index Returns

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Given recent volatility in stock and bond markets, as well as the possible resurgence in inflation, long-only passive unleveraged commodity indexes increasingly are being considered by institutional investment managers. Commodity indexes offer a means of accessing natural sources of commodity return and inflation protection. While previous studies (Halpern et al. [1998]) have measured commodity returns during high and low inflation periods, the real benefits of commodity investment may lie in periods of unexpected rises in inflation. Anticipated inflation, which results in high bond yields and high equity earnings growth, may result in positive real returns for stocks and bonds. It is the unexpected inflation that should cause concern to every serious investor. Unexpected inflation may result in negative returns to stock and equity markets while often being favorable to increasing commodity prices. In addition to providing exposure to unexpected changes in inflation, commodity indexes may provide exposure to long-term growth in world demand that may also result in an increasing demand and prices for certain commodity products.

One of the most attractive aspects of commodity investment today is that there are now a number of passive indexes that are fully investable. Most alternative assets do not have a passive, investable index, requiring the investor to select and monitor active managers. In addition to providing a simple method to access these returns, commodity indexes have a number of other uses. Commodity indexes are a source of information on cash commodity and futures commodity market trends, are used as performance benchmarks for evaluation of commodity trading advisers, and provide a historical track record useful in developing asset allocation strategies.

Historically, direct commodity investment has been a small part of investors' asset allocation decision. Indirect commodity investment through ownership of equity in commodity producers has been the preferred strategy of obtaining claims on commodity investment. In recent years, a variety of passive investable commodity indexes or commodity-linked products have been created that provide direct access to commodity investment. These include exchange-traded commodity indexes such as the GSCI and CRB-Bridge and other commodity-linked investments such as the Chase Physical Commodity Index, J.P. Morgan Commodity Index and the Dow Jones-AIG Commodity Index, as well as more exotic, futures-based products such as the MLM index and LME metals index.

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

This article explores those fundamental reasons as well as other factors that form the basis of commodity investing. In this article we explore the following:

- Is there an inherent return to an unleveraged commodity index?
- Can the return be expected to be uncorrelated — or, better yet, negatively correlated — with stock and bond returns? This would provide the diversification benefits that portfolio managers seek. (This does not mean that commodity indexes will go down in value when stocks go up — only that they perform worse than their long-term average when stocks show better-than-average performance.)
- Can the return be expected to correlate positively with the rate of inflation? Even better, might there be a stronger correlation with changes in the rate of inflation?
- Last, can the inherent return from an unleveraged commodity index be expected to exceed the return on cash sufficiently to justify an allocation from the portfolio?

WHAT IS AN UNLEVERAGED COMMODITY INDEX?

An unleveraged commodity index represents the returns that would be earned by holding only passive long positions in commodity futures contracts. Financial futures are not included. To be unleveraged, the position must be fully collateralized with T-bills. To purchase a ten-ton cocoa futures contract, for instance, at $1,800 per ton, the investor would allocate $18,000 from his portfolio to support that futures position. This $18,000, in the form of a risk-free asset (T-bills), would provide a current return, while the futures contract would provide unleveraged exposure to *the expected future price* of cocoa. These positions would be held in a variety of commodity markets and allocated to those markets in a passive manner so that ongoing judgment of a trader and his trading system would not be required. While futures positions would have to be rolled over into more distant contracts as the nearby contracts approached maturity, this would be done mechanically. Defined in this manner, the investor would receive only the inherent returns that might be available to this asset class.

It is important to note that investment in a long-only unleveraged passive commodity index is not like a managed futures program. The typical managed futures account is active in that the manager has discretion over the actual trading positions taken. Moreover, these positions can be either long or short. If there is no consistent economic exposure to an economic event, then the investor does not have exposure to inherent returns of an underlying asset class.

MODEL OF THE FUTURES MARKETS

A brief description of the function of commodity futures markets (Keynes [1930]) will help provide a framework for answering the fundamental economic questions posed in this paper. Assume that you are a cattleman and want to hedge the value of your production. It is February, and you have cattle that will go to market in September. Since we assume an efficient market in futures, you and the rest of the market share the expectation that cattle will sell for $0.72 per pound in September. However, you also know you could be wrong. A variety of events could occur (fear of mad cow disease, heavy barbecuing season, etc.) that might make the September price as low as $0.60 or as high as $0.90. The final factor you know is that, if the price in September is below $0.65, you will be selling below your cost of production, and you will go out of business.

To stay in business, you go to the futures market, asking investors to purchase your cattle for September delivery at $0.72. You have no takers, since you are asking them to assume your price risk for an expected return of zero. However, at a lower price, say $0.70, investors will take that long position, expecting to earn an "insurance premium" of $0.02 in return for insuring that you stay in business. This $0.70 becomes the observable futures price. Why can't you go instead to the natural buyer of cattle, the meatpacker? The answer is simple. That buyer of your product doesn't need price insurance the same way you do. In fact, if he fixed his cost of raw material by entering into a futures contract, he might actually increase his business risk, since he doesn't control the cost of his final output. He's content instead to buy low-priced cattle and sell low-priced hamburger or buy high-priced cattle and sell high-priced hamburger. Either way, he earns his processor's margin. You, on the other hand, have a high component of fixed costs and have large inventory relative to annual production. You need that price insurance and so must provide an expected return to those who furnish the insurance that enables you to stay in business. Your alternative is to be "self-insured," setting aside equity capital to protect against the unexpected. The futures markets allow you to use your capital more efficiently, which justifies the insurance premium.

A similar model applies to the range of commodities that are in a typical index. But cattle were specifically chosen to demonstrate that the concept of carrying charges (which are part of the basis for the classical economic concept of backwardation) does not necessarily play a role. The term structure of futures prices for a commodity is not a function of carrying costs if, as in the case of cattle, carrying costs are not relevant. When cattle come out of the feedlot and are ready for market, they will be sold. Except for a short period of time, withholding them from market and paying a storage, or carrying, cost is not an option. So it is the expected supply of cattle, and the expected demand for hamburger, that determine the September futures price. The amount of cattle already in feedlots in February, when the futures transaction is entered into, has little relevance. Those cattle can't be stored and carried until September. This rationale applies whether the February price is above or below $0.72. This principle — that these markets are used for insurance by producers — of course, applies to a greater or lesser degree in different markets at different times.

Exhibit 1 illustrates the concepts just discussed. One thing is almost certain: the price of cattle will not be $0.72 in September. Actual supply and demand factors are likely to be different from those expected back in February. This difference between expectations and ultimate reality, referred to as "expectational variance,"[1] is shown in Exhibit 2. If the markets are truly efficient, then one should expect positive and negative expectational variance to even out over time. However, even if this economic factor is not a *source* of long-term return, it is a definite factor in the *pattern* of returns.

One might expect several small negative deviations and a few large positive deviations. Why? Because the "surprises" that create expectational variance are more likely to be surprises that unexpectedly shrink supply rather than the reverse. Events like cartel action, drought, freeze, and war all would be more likely to drive prices up unexpectedly. This pattern would tend to give a commodity index some positive skew. Yet even if there is no unexpected reduction in supply, the small negative deviations might be offset by other components of return, so that the total return of the unleveraged index could still be positive a majority of the time.

This model of commodity futures markets shows that the futures

EXHIBIT 1
Commodity Futures Pricing Model

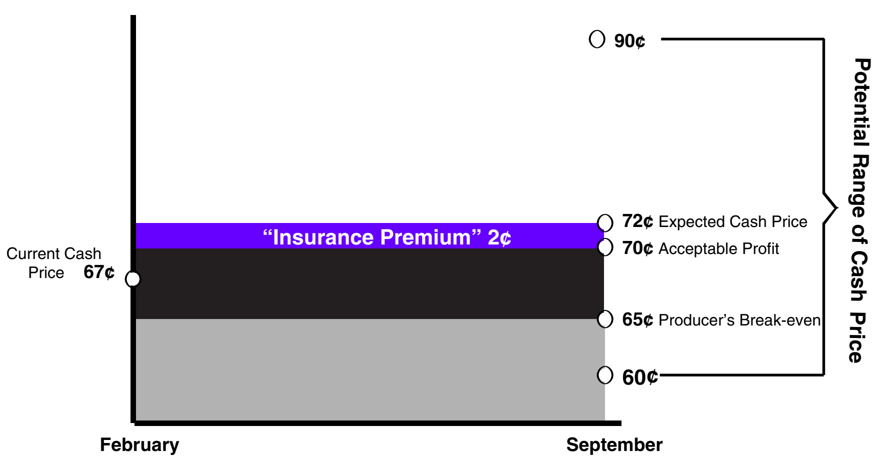
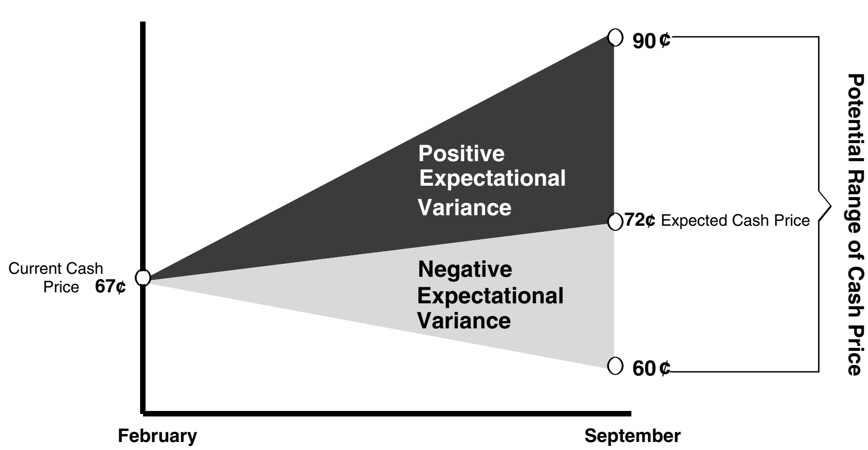


EXHIBIT 2
Expectational Variance



price is a function of participants' (hedgers, investors, speculators) expectations regarding the commodity's actual future price. This, in turn, is driven by expected supply/demand characteristics of each individual market. Those supply/demand factors that ultimately determine the price of each commodity are very different for different commodities and often unrelated. The primary factors driving the expected future price of cattle are different from those driving the expected future price of crude oil. And the primary supply/demand factors of these two commodities are different from the primary factors driving the prices of cotton, gold, or coffee. This should cause the price movements of individual commodities to have little correlation with each other.[2] The importance of this economic expectation is shown below.

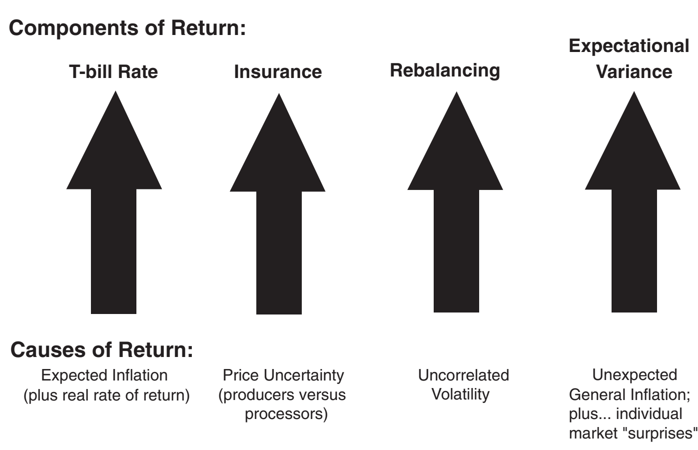
WHERE DOES THE INHERENT RETURN COME FROM?

The total return from an unleveraged commodity index comes from several sources, as shown in Exhibit 3. First and most obvious is the T-bill (riskless) return that accrues to the collateral component. This T-bill return traditionally reflects *expected* inflation plus a real rate of return. The second component of return reflects the insurance component previously discussed. This component cannot be isolated, since all we can observe is the price in February of the September cattle contract and where the actual price of live cattle settles in September. We can't know, for any given contract, how much of that difference is due to the "insurance premium" negotiated in the marketplace and how much is due to the expectational variance that occurs for that specific commodity in that specific time period. The best we can say is that, if the combination of these two components is positive over a sample of many commodities and many time periods, then there is an argument that such an insurance premium exists.

The third component of return relates not to the futures model for a single commodity but to the expectation that commodity futures prices are not highly correlated with each other. If these prices move randomly (or, better yet, if they are mean-reverting), then construction of a value-weighted commodity index (as contrasted to a quantity-weighted or cap-weighted construction) can capture "excess growth" from the asset class.[3] This value-weighted construction simply means that each commodity will be given a *fixed percentage of the value* of the portfolio. As prices fluctuate, the index reflects the idea of selling the futures that go up and buying those that go down to maintain this constant balance. Unless there is an economic reason to expect futures prices to trend indefinitely up or down, then this construction should provide incremental return to the extent that the various futures in the index are uncorrelated. It will also reduce the volatility of returns.[4] This approach is standard procedure in constructing a portfolio of diverse assets. Certainly, if futures prices are mean-reverting, then such a construction will provide incremental return.[5]

Last, we have to look again at the concept of expectational variance. It also creates the argument for diversification, since a specific market could be responding to economic factors that don't affect overall price levels of stocks and bonds. But now consider a broader economic event, one that might affect expected prices in many markets, including commodity markets and capital markets. Imagine that investors one morning decide that future inflation would be higher than they thought when they went to bed the night before. You could expect bond values to drop when the markets opened that morning for trading. (Higher expected inflation causes higher interest rates causes lower bond prices.) Most people would expect stock prices to drop as well on the expectation of higher inflation. Not so the unleveraged commodity index. If the market suddenly expects higher prices in the future, then an index that has consistent positive exposure to futures prices can be expected to go up in value. So, to the extent

EXHIBIT 3
Basis for Returns



that market movements are affected by unexpected inflation, you could expect negative correlation between a commodity index and the more traditional capital assets. This is especially important since *changes* in the expected rate of inflation can affect stock and bond values more than the absolute rate of inflation.

So is there a fundamental rationale for expecting positive returns from an unleveraged commodity index? Yes, and that rationale also supports the idea that these returns should be somewhat negatively correlated to stocks and bonds and positively correlated to inflation. That return is made up of:

- real rate of return;
- plus expected inflation;
- plus or minus unexpected inflation;
- plus a producers' insurance premium;
- plus a rebalancing yield.

DOES HISTORY SUPPORT THE THEORY?

Exhibit 4 demonstrates that the return comes from more than just increases in commodity prices. The weighted average price of commodities in the Chase Physical Commodity Index^{SM} (CPCI)[6] declined by 4.5% from December 1993 to September 1998, while the total return of the CPCI was 45% — an annualized 8% per year. (This is about 3% per year above the T-bill rate embedded in the index.[7]) Also, from 1970 to the present, returns from this asset class have been negatively correlated with stocks and bonds and positively correlated with the rate of inflation. Data also shows that commodity indexes are even more positively correlated with unexpected inflation.[8]

Exhibit 5 shows these major asset class correlations for annual data. The commodity index used is the total return CPCI. Unexpected inflation is defined as the amount by which inflation in the current year exceeds

EXHIBIT 4
Commodity Price Changes versus Commodity Index Returns

Commodity	Contract: The Upcoming Month of:	Price($) 12/30/93	Contract: The Upcoming Month of:	Price($) 9/30/98	Percent Change	1998 CPCI Weights	Weighted Percent Change
Corn	March	3.0600	December	2.0900	–31.70%	4.94%	–1.57%
Soybeans	March	7.1250	November	5.2075	–26.91%	3.61%	–0.97%
Wheat	March	3.7825	December	2.6925	–28.82%	6.16%	–1.78%
Oats	March	1.3675	December	1.1200	–18.10%	2.07%	–0.37%
Feeder Cattle	January	0.82950	October	0.67725	–18.35%	2.26%	–0.41%
Live Cattle	February	0.73300	October	0.59075	–19.41%	8.71%	–1.69%
Lean Hogs	February	0.64643	October	0.42625	–34.06%	9.58%	–3.26%
Cocoa	March	1144.00	December	1512.00	32.17%	2.03%	0.65%
Coffee	March	0.7155	December	1.0515	46.96%	2.59%	1.22%
Sugar	March	0.1077	October	0.0713	–33.80%	3.30%	–1.12%
Cotton	March	0.6788	October	0.7140	5.19%	3.58%	0.19%
Copper	March	0.8330	October	0.7330	–12.00%	3.00%	–0.36%
Gold	February	391.90	October	296.40	–24.37%	3.29%	–0.80%
Silver	March	5.1170	October	5.3200	3.97%	1.98%	0.08%
Crude Oil	February	14.17	November	16.14	13.90%	19.40%	2.70%
Heating Oil	February	0.4452	November	0.4340	–2.52%	8.02%	–0.20%
Gasoline	February	0.4000	November	0.4718	17.95%	5.24%	0.94%
Nat'l Gas	February	1.9970	November	2.4330	21.83%	10.24%	2.24%
						100.00%	**–4.53%**
CPCI (total return)		1296.09		1881.59			**45.17%**

Note: Live/lean hog contract price adjusted for change in contract specification.

EXHIBIT 5
Asset Class Returns (1970-1999)

Correlations	Commodities*	Stocks**	Bonds***	Inflation****	Changes in Inflation
Commodities	1.00	–0.14	–0.32	0.23	0.59
Stocks		1.00	0.43	–0.39	–0.51
Bonds			1.00	–0.43	–0.53
Average Annual Return	12.2%	14.9%	9.6%		
Average Annual Volatility	19.6%	16.0%	12.1%		
Skew	0.57	–0.67	0.76		

*Chase Physical Commodity Index ("CPCI")
**Standard & Poor's 500 total return
***Lehman long T-bond
****Consumer price index(CPI-U)

inflation in the previous year. This exhibit supports the theory regarding the pattern of index returns, which is important in considering commodity indexes as a separate asset class for a portfolio. The commodity index was slightly negatively correlated with stock and bond returns. It also had positive correlation (0.23) with the *rate* of inflation and much higher positive correlation (0.59) with *changes* in the rate of inflation. Meanwhile, stocks and bonds, as expected, are negatively correlated to the rate of inflation and to changes in the rate of inflation. Exhibit 5 also supports the idea that "surprises" tend to drive commodity prices unexpectedly upward, since it shows that the commodity index has a positive skew, while the S&P 500 total return is negatively skewed. Meanwhile, the overall return of the commodity index is comparable to equities in magnitude and volatility.

Exhibit 6 shows the components of the annual CPCI returns. The T-bill component is simply the average thirteen-week T-bill rate reported by the Fed. The rebalancing yield is calculated using the Fernholz and Shay formula, applied to the daily returns of the weighted components of the CPCI each year. Finally, the return component labeled "Insurance/Variance" is the remaining component of return, such that (1 + T-bill)(1 + Rebalancing)(1 + Insurance/Variance) = (1 + Total Return). Also shown in Exhibit 6 is the average cross-correlation of the individual commodities in the index and the number of commodities involved. As the range of commodities available for investment has increased, the average correlation has declined. This supports the notion that factors driving these asset prices differ from one commodity to the next.

CONCLUSION

The data from 1970 to the present indeed support the risk and return benefits of commodity index investing:

- Total return from an unleveraged commodity index is positive, on average, and comparable in magnitude and volatility to equity returns.
- Commodity index returns are negatively correlated with stocks and bonds.
- Commodity index returns are positively correlated with inflation.
- Commodity index returns are more positively correlated with changes in the rate of inflation.
- Commodity prices are not highly correlated with each other.

ENDNOTES

[1]Thanks to Grant Gardner of the Frank Russell Company for coining this term.

[2]This idea of a unique supply/demand model also argues that commodity prices don't respond to a traditional CAPM, a supplemental argument for non-correlation with stocks and bonds.

Exhibit 6

Chase Physical Commodity Index Return Characteristics

Year	T-bill	Rebalancing	Insurance/ Variance	Total Return	Average Cross-Correlation	Number of Commodities in Index
1970	6.47%	0.56%	4.29%	11.65%	0.37	5
1971	4.37%	1.03%	6.19%	11.98%	0.18	6
1972	4.05%	1.01%	32.66%	39.43%	0.28	6
1973	7.01%	2.82%	53.73%	69.14%	0.43	6
1974	7.89%	4.22%	–6.76%	4.84%	0.29	10
1975	5.85%	2.99%	–2.90%	5.85%	0.28	10
1976	5.01%	2.26%	–11.36%	–4.81%	0.28	10
1977	5.24%	1.73%	–3.06%	3.79%	0.19	10
1978	7.17%	2.49%	15.72%	27.11%	0.16	15
1979	10.01%	2.49%	19.73%	35.00%	0.17	15
1980	11.48%	3.78%	–7.64%	6.86%	0.20	16
1981	14.09%	2.73%	–33.26%	–21.78%	0.23	17
1982	10.76%	2.43%	–7.82%	4.58%	0.21	18
1983	8.61%	2.11%	1.88%	12.98%	0.17	18
1984	9.59%	1.43%	–12.53%	–2.77%	0.15	16
1985	7.49%	2.08%	3.69%	13.77%	0.14	16
1986	5.99%	6.25%	–16.04%	–5.45%	0.15	16
1987	5.82%	2.04%	9.89%	18.65%	0.13	16
1988	6.64%	2.91%	8.66%	19.24%	0.14	18
1989	8.12%	1.97%	16.52%	28.46%	0.08	18
1990	7.53%	3.26%	13.36%	25.87%	0.10	18
1991	5.45%	3.19%	–11.47%	–3.67%	0.07	18
1992	3.46%	1.43%	–0.85%	4.05%	0.09	17
1993	3.02%	1.98%	–6.10%	–1.35%	0.07	18
1994	4.21%	2.09%	2.65%	9.21%	0.12	18
1995	5.52%	1.67%	9.14%	17.09%	0.08	18
1996	5.02%	2.62%	30.18%	40.29%	0.07	18
1997	5.07%	2.51%	–10.01%	–3.07%	0.06	19
1998	4.82%	3.06%	–34.69%	–29.45%	0.12	18
1999	4.65%	3.25%	19.97%	29.63%	0.11	18

[3]This concept is described in Fernholz and Shay [1982]. The "excess growth" is quantified as:

$$\frac{1}{2}\left(\sum_{i}\pi_i\sigma_i^2 - \sum_{i,j}\pi_i\pi_j\sigma_{i,j}\right)$$

where

π = weight given to asset i ($\Sigma\pi = 1.00$)
σ^2 = variance of asset i
$\sigma_{i,j}$ = covariance of i and j

[4]An alternative would be to assign fixed relative quantities to the various commodities in an index.

[5]Bessembinder [1995] shows that investors seem to expect actual commodity prices, except those of precious metals, to mean-revert, though this does not address whether futures prices themselves are mean-reverting.

[6]The CPCI is a direct continuation of the Daiwa physical commodity index.

[7]As an example, in January 1996, the market expected wheat in July to be worth $4.47 per bushel (the price of the July 1996 contract on January 31, 1996). By May 31, that contract had increased to $5.29, an 18% increase in the market's expectations for wheat in July. Yet, as the market looked further out

to July 1997, the price of this new crop contract was $4.40 per bushel on that same May 31. So in January an investor might have bought a July 1996 wheat contract, held it until May for an 18% gain, and then sold the July 1996 contract and bought a July 1997 contract. After this transaction his return would then be a function of changing market expectations for wheat prices in 1997, compared to his new basis of $4.40 — less than the price he originally paid in January for 1996 wheat!

[8]It's hard to measure investors' expectations of future inflation directly, especially without a long history of results from Treasury Inflation Protected Securities (TIPS) auctions. So we assume that investors expect the future to be like the past, i.e., they expect future inflation to be equal to past inflation. To the extent that future inflation is different, this reflects unexpected inflation.

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continuous long-only investment in commodity futures positions. Weights of the DJAGICI are adjusted once a year. The Goldman Sachs Commodity Index (GSCI) is a composite index of commodity sector returns, representing an unleveraged, long-only investment in commodity futures that is broadly diversified across the spectrum of commodities. The Commodity Research Bureau Index (CRB Index) measures the overall direction of commodity sectors. The CRB Index was designed to isolate and reveal the directional movement of prices in overall commodity trades. The Standard & Poor's 500 Index (S&P 500) is an unmanaged index of U.S. companies with market capitalizations in excess of $4 billion and is generally representative of the U.S. stock market. The Consumer Price Index ("CPI") is an unmanaged index representing the rate of inflation of the U.S. consumer prices as determined by the US Department of Labor Statistics. There can be no guarantee that the CPI or other indexes will reflect the exact level of inflation at any given time.