In this article we describe a new method for investing in commodities. This method combines a macro approach designed for generating long-term returns to hedge expected inflation with a fundamental view on how commodities should perform on a relative basis. The macro based allocation strategically weights commodities by their risk contribution and targets optimal diversification, and these weights vary depending upon the changing risk environment and the business cycle at the macro level. In the near-term, fundamental views based upon the long accepted “Theory of Storage” increase positions in commodities that are expected to outperform and reduce weight in those expected to lag. In addition, the very structure of the futures markets influences the way we need to trade. We make a compelling case for this Commodities Total Return (CTR) method as a far more investor appropriate construct than other commodity portfolios because it approaches commodity investing from all levels and from a market perspective.

CTR seeks a total return that improves upon the long-term expected inflation hedging goal rather than accepting an arbitrarily developed index, and can add value from nearer-term inefficiencies in the commodity futures markets themselves. CTR is designed with the goal of offering these risk and return characteristics while still providing the same, if not better, expected inflation hedging and diversification with stocks and bonds than more conventional approaches to commodity management.

The Issues with Commodity Investing
There is a strong consensus that commodities should be a part of any well diversified portfolio both to hedge bonds against the risk of expected inflation as well as participate in inflationary growth. While equities offer exposure to economic growth, inflation can substantially erode earnings. Commodities are able to provide an excellent counterpoint, as they hedge against the expected inflationary erosion of bond principal and equity earnings. Commodities can also significantly increase risk-adjusted returns when added to portfolios of stocks and bonds. However, traditional commodity investing can be problematic for many reasons.

First, it is impractical for most investors to buy physical commodities, so the only alternatives are derivatives such as futures or swaps, or exchange-traded products such as ETFs and ETNs. Of these, futures offer the widest variety of possible investments, since swap and ETF exposure is limited to the most liquid commodities. ETFs and related instruments are cash intensive and are also a more expensive and less flexible way to gain exposure to commodities than either swaps or futures. The primary benefit they offer is that they are exchange-traded (like futures) instead of being traded over-the-counter (like swaps). Swaps, and those ETNs that are implemented via swaps, also have embedded credit exposure. In the end, futures offer the most flexibility and liquidity on the most continuous basis for the least cost, with no hidden credit exposure and low cash usage.
Second, commodities, unlike financial futures, are quite dissimilar from one another and developing a uniform approach to investing in commodities is difficult. For instance, some commodities, like agricultural commodities, are renewable while others, like gold, will always be in limited supply. Some are tied directly to the economy, such as energy and industrial metals, while others, such as livestock, have only a tenuous relationship to the broader economy. Some are difficult to store and are perishable, while others are inexpensive to store and last for decades, or in the case of gold, forever. So a common approach to investing in commodities based upon valuation, for instance, is a challenge.

Third, due to these dissimilarities, there has not been consensus on how to create long-term strategic weights for a commodity investment. The most popular indices use “production” weighting which puts an undue weight on industrial commodities like energy rather than agriculture and precious metals. This makes the indices less likely to hedge against food inflation or economic uncertainty. Yet strategic weights are critical if inflation hedging and participating in economic growth are goals of the commodity investment. Unfortunately, active managers use these admittedly flawed commodity indices as the long-term strategic component of their returns. In addition, most commodity managers do not use a fundamental approach to commodities and instead depend upon momentum and various technical measures. While these approaches can work some of the time, they cannot deliver the confidence investors receive from an investment philosophy tied to fundamental aspects of the asset class.

The Inefficiency of Conventional Commodity Indices
It is common to look at the diversification of a portfolio or index through the number of assets and the capital weight of those assets. Two indices, the Goldman Sachs Commodity Index (GSCI) and the Dow Jones UBS Commodity Index (DJ UBSCI), are the most popular commodity indices used as benchmarks. The GSCI is frequently used because it has a liquid cash settled futures contract, so it offers an easy way to passively invest in commodities. The GSCI weights commodities according to their worldwide production which gives it a 71% capital weight to energy. This raises questions about the diversification of the index, so the DJ UBSCI modifies the weighting scheme by placing maximums on sectors and individual commodity as well as taking into consideration the liquidity of commodities markets. As a result, the DJ UBSCI has a 33% weight in energy and so looks on the surface to be more diversified. Both indices have a large number of commodities in them. The GSCI has 24, while the DJ UBSCI has 19.

However, if we look at the risk budgets of each index, neither looks diversified at all. There are five primary commodity sectors: agriculture, energy, industrial metals, precious metals, and livestock. The capital weights for both GSCI and DJ UBSCI are determined once a year. Exhibit 1 shows the capital weights of the GSCI and DJ UBSCI on the left while the right shows the risk budget weights.

The GSCI is almost entirely an energy index. Not only is 71% of its capital invested in energy, over 90% of its risk budget is in energy. The other sectors make a small contribution to the index. Precious metals, for instance, are virtually non-existent, so those who consider gold an important investment receive virtually no exposure through the GSCI. The DJ UBSCI is better, but still 61% of its risk budget is given to energy with the balance primarily in agriculture and industrial metals. Precious metals and livestock again receive virtually no weight.

Exhibit 2 shows the return contribution of the different sectors from 1/88 – 12/11, and we can see that the return contribution of each sector is very similar to their risk weights. This is no coincidence. Research has shown that there is a strong relationship between risk and return contribution in a portfolio.

From this analysis we can see that the most common commodity indices do not really give true diversification, but are energy heavy both in their returns and risk contribution. As such, they are inadequate as the long-term strategic weights for a commodity strategy.
Most commodity managers use one of the above two indices as a benchmark for investment. That is, they believe that their job is to add value to a passive investment in the index. We take a different view. Instead of trying to enhance something that is fundamentally flawed, we created a strategy that is driven in all respects by the inner workings of the commodity markets. A common approach to investing outside of commodities is to first study all aspects of the relevant assets and then use this knowledge to combine the assets into a portfolio. But this is, in fact, a relatively new idea in commodities at an institutional scale for the following reasons.

First, commodities as an institutional investment are a relatively new phenomenon. Twenty years ago, most institutional funds were not invested in commodity markets, whereas today it is commonplace. Flows into the asset class have been extraordinary. In the past decade alone the cumulative investment has increased by almost 10 times. Due to this explosive growth, the race among investment managers has been one of building assets and capacity rather than creating strategies to best capture the unique aspects of the asset class.

Second, the existing standard indices described above originally came at the market from the perspective of an aggregate descriptive index and not from the perspective of an optimal investment. Although indices often become investment benchmarks, they do not necessarily attempt to combine assets in a way that might be considered optimal for an investor. For example, the common equity index methodology of market capitalization weighting or issue weighting in bond indices is identical to the production weighting tenet used by most commodity indices. In all cases, assets receive a weight proportional to the weight of the total available amount of that asset. Other critical investment features, such as risk, correlation, predictability, or expectation of return, are not considered. Indices offer a shortcut for describing an asset class as a whole, while offering limited guidance as to what an investor should be doing to capture the returns inside that asset class.

Third, commodity markets have been evolving rapidly in the past decade. Until recently, there was not enough liquidity to make a market driven approach feasible. But the recent growth of the asset class itself has increased the number of potential strategies that can be applied to the asset class. The almost 10 fold growth of flows turns into an almost 10 fold growth of strategy capacity. For managers that run a more blunt, index style strategy, this is good news, but it is even better news for investors. It means investors now have access to a new set of diversified and uncorrelated strategies which could not previously exist in any meaningful way. Investors can now choose strategies that better suit their investment needs and more optimally achieve their goals.

Due to the complacency which has led to the dominance of traditional commodity indexing, commodity markets have not been studied as an investment as thoroughly as other more traditional asset classes. When we take the time to understand this asset class, we find that there are many unique features of commodities that don’t exist in other asset classes. We gain different insights, for example, by focusing on the characteristics of commodity markets over different investment horizons. Once these features are recognized and understood, we have the tools necessary to create a strategy for investment.

The Supply/Demand Horizon: Fundamental Effects

First, we examine a near-term horizon on the order of six to eighteen months. While commodities are diverse and uncorrelated as a group, they respond broadly to macroeconomic risks (a topic we will discuss below), but at a nearer-term horizon, commodities respond to their own bottom up fundamentals of supply and demand. Within this time-scale, we find that the features most relevant to investors are ones that drive commodities relative to each other. In other words, from a bottom up stand point, it is most effective to analyze how particular commodities respond relative to other commodities, rather than how they respond in an absolute context. It is at this investment horizon that the major published academic theories of commodities apply.
The primary centerpiece of academic commodity theory is The Theory of Storage. This almost century old theory describes several fundamental features of commodity markets. Aspects of the theory have been developed and tested by a veritable army of researchers over the decades up to the present from Keynes (1930), through Kaldor (1939), Working (1948 and 1950), Brennan (1958), and Fama and French (1988). It has become an enduring and consistent underpinning of our understanding of the inner-workings of commodity markets. The three main conclusions of the theory relevant to this discussion are:

1) Commodity prices rise as supply falls relative to demand,
2) The volatility of commodity prices rises as supply falls relative to demand, and
3) The basis of commodity prices rises as supply falls relative to demand. (The "basis" of a commodity is the difference between its current and future values.)

This theory gives us tools to make statements about expected commodity prices as they relate to the current or future supply/demand balance. Putting this together in a relative context, suppose we had information about the supply/demand balance for wheat, and we knew that as a whole it was in under-supply relative to corn. We can now make a statement about the relative behavior of wheat and corn. In this case, we would expect wheat to out-perform corn. We would not necessarily know the absolute direction of wheat and corn prices (that would depend on a host of other macroeconomic factors as well), but we could say with some degree of certainty that wheat should relatively out-perform corn until the fundamentals changed.

**The Strategic Horizon: Macro Effects**

Commodities also respond to macro-economic effects at longer horizons, varying broadly with the major portions of market cycles and also display top-down structure across market cycles. At first thought, we might not expect to find useful information over a full market cycle other than a general trend, but in fact, there are two important features of commodities that jump out. At this longer-term horizon, first, commodities have a weak asset class identity. Commodities are an exceptionally diverse group of assets that have a lot less self-similarity than other assets such as equities. For example, from October 1989 - December 2011, the average pair-wise correlation between equity sectors is near 0.5, but the average pair-wise correlation between commodity sectors is near 0.1. Looking at this over time in rolling three-year windows, the minimum pair-wise correlation between equity sectors is about 0.3 whereas the maximum pair-wise correlation between commodity sectors is about 0.4. So while equity sectors are decent proxies for each other, commodity sectors are not. This means an investor must take more care when determining appropriate weightings for a commodity portfolio.

A second important observation is that while commodity returns are difficult to forecast over the business cycle, commodity risks are surprisingly stable from period to period. For example, if we rank the commodity sectors each year by their returns and separately by their risks, we find that from 1988-2011, the correlation of the year-to-year ranked returns is 1%, whereas the correlation of the ranked risks is 67%. In other words, although we cannot count on the stability of returns, we can count on the stability of risks.

We also find that commodities respond to the same global macroeconomic risks as equities. Commodities are often classified as “risk assets” (as are equities and certain currencies), which means that they suffer during times of heightened market risk. Risk here can be defined in a variety of ways, but our research has concentrated on four primary measures:

1) The VIX index,
2) Corporate credit spreads,
3) Global PMI (Purchasing Managers Index), and
4) Global monetary policy.

Roughly, if the VIX or credit spreads are high or global PMI is low and global monetary policy is tight, we define that as a high macroeconomic risk environment, and in those high risk environments, we find that risk assets, including commodities, do poorly. Conversely, if the VIX or credit spreads are low, or global PMI is high and global monetary policy is loose, we find that risk assets, including commodities, do well. The effects are more subtle inside the commodity asset class as well. Sectors like the energies and industrial metals respond more to the business cycle than sectors like agriculture and livestock. In a hierarchy of needs, a person must eat before they must buy a new car or build a new house. We have previously documented this effect in “Using Volatility Regimes” and we combine these measures into an indicator we call the “FQ Market Risk Index (MRI)”. It has five levels of risk.

In another paper, Peters (2011), we show that from December 1934 to February 2010 the DJ AIG Spot Index (a commodity index) volatility was influenced by equity volatility regimes ranging from an average volatility of 9.39% in low volatility regimes to an average volatility of 15.84% in high volatility regimes with an average volatility of 13.01% over the entire
First, prices of nearer-term futures may be higher or lower than prices of further out futures. These effects are described as a commodity being in backwardation (near > far) or contango (near < far). If one expects the shape of this price term structure to hold, and say is taking a long position, it is advantageous to have a backwardated market since we could expect the futures price to naturally “roll up” the curve as a future gets nearer to expiration. This is called a “positive roll yield”. Contrarily, contangoed markets offer a negative roll yield, so if we would like to take a long position, we can expect to lose the value of the roll yield. That would be the case at the end of the story if backwardation and contango were linear, but they are generally non-linear with price curves generally getting steeper as we approach expiration. This means that if we took a long position in a contangoed market, we would rather be farther from maturity where we would suffer the least from negative roll yield.

Second, liquidity of commodity futures exists out many months and even years in certain cases, but generally decays as we get further from maturity, and we must also take this into consideration when deciding which contract to trade. For example, if we would like to hold a long position in a contangoed market, we would prefer a future that is farther from maturity. However, we have to take into account the lower liquidity of the more distant contracts which may generate excessive transaction costs or concentration in a single commodity. There are nuances in this liquidity term structure as well. For example, in the northern hemisphere mid-summer, a future on wheat or corn may have more liquidity than a late spring maturity due to common crop cycle effects. Additionally, an end of the year future in crude may have more liquidity than a mid-fall future due to behavioral effects of market participants. A deep understanding of this dimension is clearly important.

Finally, the risk of different commodity contracts also has a term structure. This risk term structure is famously known as the “Samuelson effect” after Paul Samuelson (1965), the MIT and Nobel prize winning economist who first described it. Samuelson showed that for purely stochastic reasons, the volatility of a contract farther from maturity is lower than the volatility of a contract nearer to maturity. This effect is straightforward to measure. Across a wide set of commodities, the average volatility of a future 12 months from maturity is about 20% less than a future one month to maturity. In other words, if the annualized volatility of a one month to maturity future is 15%, the annualized volatility of a 12 month to maturity future would be roughly 12% on average. Understanding this effect is critical to properly

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**EXHIBIT 3: SHARPE RATIO FOR INDICES**

<table>
<thead>
<tr>
<th></th>
<th>Sharpe Ratio</th>
<th>Annualized Risk (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;P GSCI</td>
<td>0.1</td>
<td>21.1</td>
</tr>
<tr>
<td>DJ UBSCI</td>
<td>0.1</td>
<td>15.6</td>
</tr>
<tr>
<td>Overall</td>
<td>0.5</td>
<td>14.3</td>
</tr>
<tr>
<td>High Volatility Regime</td>
<td>0.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Low Volatility Regime</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

Sources: First Quadrant, LP, StyleAdvisor, Bloomberg LP

The Trading Horizon: Futures Market Micro-structure

Finally, at a “trading horizon” of zero to six months, commodity markets are a bit more complex than other asset classes due to the structure of the commodity futures markets themselves. Whereas futures markets for assets such as equities, bonds, or currencies have liquidity concentrated in the nearest contract to maturity, commodities have liquidity spread out over many maturities. This makes sense from a fundamental stand point since a producer of finished goods may have enough of a raw input to last through a time period like the next six months, but may also want to lock in the price of that raw input after that. Another producer may carry only one month of inventory of raw input, and so may want to lock in the price just one month out. This spreading out of liquidity allows some interesting features to develop in the markets involving the term structures of price, liquidity, and risk.
construct a commodity portfolio in a risk managed context. Following on our previous example, a long position farther out into the future may require a larger notional position to achieve the same risk. Tying the price, liquidity, and risk term structures together is a complex balancing act, and as such is a critical element to creating a Commodity Total Return portfolio.

**Constructing the CTR**

The Commodity Total Return (CTR) strategy takes the above three primary dimensions of commodity markets into account to create a market driven approach to commodity investing:

1) The Strategic Horizon: Allocations dynamically adapt to changes in the risk environment and macro effects over the business cycle,

2) The Supply/Demand Horizon: Near-term views based on the laws of supply and demand as incorporated in The Theory of Storage further adjust positioning, and

3) The Trading Horizon: Implementation management that considers the liquidity, risk, and price term structures when purchasing or selling individual commodity futures is applied.

We believe each dimension improves the performance of the portfolio.

The methodology is straightforward. First, an overall risk target is set for the portfolio. One of the issues with a commodity portfolio is that the low correlation among the commodities limits the amount of risk that a portfolio can achieve if we limit the weights to a total of 100%. A true risk balanced commodity portfolio without leverage would produce a risk of 8% or less. That could, in fact, be a reason that other less diversified weighting schemes are commonly reported by industry groups or aggregated by data providers. Taking these different perspectives into account adds diversity to our market assessment and ultimately leads to more accurate market measurements.

Finally, when trading we look at the attractiveness across the various maturities to determine the best contracts to buy and sell to take advantage of the various term structure opportunities.

**Simulation**

The Commodity Total Return was simulated using data from January 1988 to December 2011 targeting a total risk level of 12%. What follows is a discussion based on the observations made from the Commodity Total Return simulation (henceforth “CTR”).

Exhibit 4 updates Exhibit 1 to include the return attribution of the CTR’s Macro Effects along with the GSCI and DJ UBSSCI and shows the benefits of diversification that comes with long-term risk balanced allocation as opposed to the production weight focus of the two indices.
Commodities Total Return

The CTR has a much more even return attribution by sector reflecting its more diversified risk composition.

Exhibit 5 shows the stabilizing effect of using volatility regimes to manage risk. The blue bars show the average annualized risk over the period, the yellow bars show the average annualized risk in the high volatility regime, while the green bars show the average annualized risk in the low volatility regime. In the case of the GSCI and DJ UBSCI, we can see that realized risk follows the regimes, while the CTR shows more stable risk across the two regimes.

Exhibit 6 shows the Sharpe ratios across regimes and illustrates that whatever excess return the GSCI and DJ UBSCI earn, it comes during the low volatility regime but tends to give it up in the high volatility regime. CTR has positive Sharpe ratios in both regimes, though it is still higher in the low volatility regime.

Finally, Exhibit 7 shows how the fundamental and macro portions of CTR each improves the Sharpe ratio of the portfolio.

We can see that the CTR has more favorable risk/return potential than the GSCI and the DJ UBSCI, but does it still have the diversifying effects that investors expect of commodities?

Exhibit 8 shows the correlations with stocks and bonds for all 3 strategies and we can see that the CTR has a similar small positive correlation with stocks and negative correlation with bonds that the other two indices have. So from a correlation standpoint, the CTR can offer similar diversifying characteristics.

Aside from diversification to stocks and bonds, does CTR preserve other benefits of an allocation to commodities, namely inflation hedging? We can measure inflation in multiple ways, but the Consumer Price Index (CPI) is a...
as a beneficial feature of commodities, if the correlation is coming dominantly from the downside, it is not actually all that beneficial. CTR enhances the way in which a commodity allocation can be more beneficially correlated to growth. As we see from Exhibit 10, CTR drastically decreases the
correlation to global growth on the downside at the expense of giving up only a small amount of correlation to growth on the upside. The amount of downside protection received is approximately 6 times the amount of upside benefit given up, and so the tradeoff is clearly beneficial.

When would the Commodities Total Return underperform the GSCI and the DJ UBSCI? Whenever energy far outstrips the other sectors, then portfolios more concentrated in energy, like the GSCI and the DJ UBSCI, will likely outperform depending upon the performance of Commodities Total Return’s near-term opportunity signals. At other times, we can expect that diversification and an approach that considers the market’s unique characteristics will win out.

Summary
Commodities are accepted as important components of a diversified asset allocation portfolio. Most commodity managers offer an index beta coupled with an “alpha” based upon over and underweighting individual commodities relative to that index, and this is often driven by technical signals like momentum. The index still generally accounts for a substantial amount of the total return. A more rational approach is to construct a better long-run portfolio, take into account changes in risk over the business cycle, and then adjust these weights based upon nearer-term
opportunities driven by fundamentals. Commodities Total Return does just that. A strategic portfolio is constructed that is designed to be well diversified across all sectors of the commodity markets. These weights take into account changes in macro market conditions relating to the business cycle and volatility. Positions are modified for near-term opportunities that come from fundamental supply/demand considerations. Finally, a multi-factor assessment of the term structures of commodity futures markets is undertaken in order to implement these strategies in an efficient manner. Combined together, as demonstrated earlier in the paper, the Commodities Total Return is designed to achieve strong risk-adjusted returns combined with significant diversification of traditional stock and bond holdings and superior hedging characteristics.

Endnotes
1 Simulation is supplemental information. Please see Commodities Total Return – Simulated Performance (Gross of Fees) and Commodities Total Return Strategy Composite Information and Commodities Total Return Strategy disclosures found at the end of this document for information concerning the simulation, the live composite, and the effect of fees on the performance.

² US GDP was used due to the historical data availability at a quarterly granularity. US inflation data was used for consistency with the GDP data.

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Commodities Total Return – Simulated Performance

Unless otherwise noted, performance figures do not reflect the deduction of investment advisory fees. These fees are described below. The returns shown will be reduced by the advisory fee and any other expenses the advisor may incur in the management of an investment advisory account. Simulated performance is no guarantee of the future results in a live portfolio using the strategy. Potential for profit is accompanied by possibility of loss. General Disclosures: Hypothetical or simulated performance results have certain inherent limitations. Unlike an actual performance record, simulated results do not represent actual trading. Also, since the trades have not actually been executed, the results may under or over-estimate the impact, if any, of certain market factors, such as lack of liquidity or security positions that need to be rounded based upon contract size where live futures trades are executed. Simulated trading programs in general are also subject to the fact that they are designed with the benefit of hindsight.

Further, backtesting allows the security selection methodology to be adjusted until returns are maximized. No representation is made that any account will or is likely to achieve profits similar to those shown. Unless otherwise noted, prior year returns for periods of less than one year or one year are annualized for the period.

The results are derived from the hypothetical or simulated results presented. The views expressed are those of First Quadrant, LP only through the period December 31, 2011. No information is subject to change based on market and other conditions.

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