A Liquid Alternative Commodity Index for All Weather Portfolio Diversification

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Abstract

The recent lackluster performance of the "All Weather" methodology of investing, popularized by Bridgewater Associates, has many investors looking more closely at the core tenets of the program The strategy, intended to generate stable investment returns with acceptable levels of volatility, has not addressed major paradigm shifts in the commodity markets including backwardation-contango oscillation, factor crowding, massive flow of funds populating long only strategies, and significant slippage due to periodic rolls. In this paper we develop an all-weather methodology utilizing a more sophisticated commodity component with a newly created program called the Liquid Alternative Commodity Index (LACI©). The index uses a long/short/flat monthly positioning strategy for the commodity markets. It also incorporates a simple proprietary trend/counter-trend algorithm to determine the following month's position. Risk adjusted performance shows that LACI is able to generate superior performance compared to a large number of brand name CTA's and hedge funds as well as commodity based listed ETFs, ETNs, and mutual funds.

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I. Introduction

Investors have been investing in commodities for decades but the concept gained widespread traction with the introduction in 1991 of the GSCI[1] by Goldman Sachs. This marked a turning point as it provided a widely recognized and investable benchmark for the commodity asset class[2]. From 1991-2004, it was primarily sophisticated institutional investors who took advantage of this new environment of commodity investment. Since 2004, there have been numerous new innovative products providing easier access to commodities for a broader group of investors.

Long-short commodity strategies have attracted interests from both practitioner and academic communities for their performance in terms of risk-returns, hedging benefits, and for portfolio asset allocation. The traditional role of commodities in a well balanced portfolio has been to serve as a counter-weight to traditional equity and bond holdings. Numerous academic papers have been written on the subject and advocate the use of passive long-only commodity exposures as a beneficial addition to a portfolio (see Miffre (2015) for a review). These studies rely heavily on the non-correlated aspects of the more popular commodity index benchmarks versus equities and bonds. These non-correlated characteristics have eroded over time and has weakened the passive long-only commodity argument. We believe that many of these long-short commodity strategies may be tweaked to offer much better performance in terms of profitability than what has been reported in the press.

Until recently many investors seeking access to alternative commodity strategies were relegated to the managed futures[3] universe of hedge funds and CTA's who provided specialized strategies in the commodity asset class versus standard long only exposures. While traditionally these strategies, as measured by numerous

[1] In 2002 Standard & Poor's became the calculation agent for the Goldman Sachs Commodity Index. The GSCI index became S&PGSCI or SPGSCI in 2007.

[2] See Murphy (1999) for the development of the CRB index which facilitated development of commodities based investment strategies.

[3] The benefits of a broad managed futures exposure have been widely reported. During a recent interview, Andrew Lo (MIT and Chairman of AlphaSimplex Group), states that managed futures can provide a highly liquid, counter-cyclic, low counter-party risk exposure to the equity market. It is these characteristics of futures based investing that make it a reasonable allocation for many investors seeking important diversification for their portfolios. See Barron's (May 27, 2016) issue.

managed futures indices, provided value-added diversification benefits, they did so with significant obstacles. Some of these have to do with issues of transparency, strategy style drift, volatility, manager selection, and high fee structures.

Commodity specific offerings have been plentiful but have mostly been concentrated on providing non-futures based exposures to the retail investor class in the form of exchange listed ETF's, ETN's, and mutual funds. Many of these are single commodity focused investments, such as Gold or Crude Oil, and are provided in different structures such as 2x leveraged, inverse, or even 3x inverse leveraged. There are also several index based commodity products. These involve standard index tracking vehicles which mimic a popular commodity index as well as more innovative structures. The alternative structures include strategic methodologies that provide a long only exposure but try to increase returns by using an alternative roll methodology versus those used by the index providers. Other strategic "smart beta" products utilize a variety of different strategies including long/short positioning, inter-market spread trading, contango/backwardation based analysis, and trend following.

Investors are now being offered a wider array of these types of strategies with emerging smart beta indices being introduced by a variety of firms. While the vast majority of these products have been concentrated in equity products there have been a few in the managed futures space and, to a lesser degree, the commodity arena. According to a recently published paper by FTSE-Russell[4], investors are significantly increasing their smart beta allocations as these investments provide the diversifying attributes they require from alternative investments. The managed futures smart beta products attempt to provide index type vehicles that give investors the returns from a broad array of managers in a variety of futures- based investment strategies but with more transparency, higher liquidity, and more competitive fee structures. These strategies cover all four basic asset classes (equities, fixed income, currencies, and commodities). The largest of these to date, form an asset under management (AUM) measurement, is the AQR Managed Futures Strategy Fund (AQMIX") with $11 billion AUM. This fund was introduced in January of 2010 and has so far produced mediocre results (.71% compounded return since inception through May 31, 2016).

[4] Smart Beta: 2016 Global Survey of Asset Owners Findings, FTSE/Russell.

Addressing all of these issues in a single investment strategy is a challenging task. In this paper, we develop an alternative way to gain exposure to the commodity asset class. The trend following Liquid Alternative Commodity Index (LACI©) provides investors access to a strategy which uses a set of proprietary algorithms and incorporates a long/short/flat positioning methodology. The index is fully transparent, highly liquid, and provides stable returns. The index incorporates a proprietary trend/counter-trend algorithm to determine its positions. Risk adjusted performance shows that LACI generates superior performance compared to a large number of brand name CTAs, hedge funds, alternative mutual funds, and ETFs.

In Section II, we review the literature on long-short commodity programs to motivate the development of our new strategy. Section III presents the performance data with critical comparisons between the LACI and its competitors. The final section concludes the paper.

II. All Weather Investment Models

Any improvement over the existing long-short, trend following strategies, for example, must be rationalized on the uniqueness of the proposed methodology. The proposed investment strategy needs to deal with volatility of the spread during rebalancing, systemic exposure of the commodity contracts to the equity market, and extracting high quality signals that are robust to stylized features of the commodity markets when futures contracts oscillate between contango and backwardation. The significance of regime switching from backwardation to contango has not been fully explored in terms of innovative trading strategies that are also capable of dealing with roll-yields, inventory levels, and hedging pressures in the marketplace.

The introduction of the "all weather" methodology of investing, popularized by Bridgewater Associates, has been warmly received by the investing public as a prudent way to achieve stable investment returns with acceptable levels of volatility. The recent lackluster performance has many investors looking more closely at the details of the methodology.

The development of these new innovative products reflects a number of major changes that have impacted the way the commodity markets have traditionally functioned. In particular, this new paradigm is largely responsible for shaping the way traders now design profitable trading strategies and diversified

portfolios that can perform well in tranquil or turbulent markets. First, the growing influx of passive funds (Figure 1) from a wide array of investors significantly grew the amount of money in the space. These new passive funds, in addition to the rapidly increasing assets being placed with hedge funds and managed futures (Figure 2), fundamentally altered the way commodity markets functioned. The changes primarily affected the way forward markets in many key commodity futures were priced. This is critically important as the returns associated with rolling futures forward in the SPGSCI have accounted for more than half of the overall returns historically (Erb and Harvey (2005)).

Second, there has been a steady increase in correlation[5] between SPGSCI and the broad based equity market index like the S&P500. We suspect that this is a consequence of factor crowding where investors use the same systemic factors to trade the same basket of stocks or commodities. Factor crowding increases herding among investors and also correlation between popular stocks and the index[6]. For commodity markets, an increasing correlation with the S&P500 index has eroded diversification benefits.

Period	SPGSCI / S&P 500 Correlation
1990 – May-16	*.24*
1990 – 2004	.00
2005 – 2015	.45
2010 –May-16	.60

The table clearly shows that the argument for including a long-only commodity exposure in a well- diversified portfolio has been steadily eroding. This is counter to what the majority of academic work prior to 2005 indicated should be the case. These papers have argued that "high real commodity prices can be a signal that monetary policy is loose" (Frankel, 2006).[5] That has not been the case recently during this extended period of accommodative Fed policy. In past periods this has normally resolved itself as the business cycle would play itself out and the traditional correlation relationships would re-establish themselves. But has the commodity market permanently changed? And, if so, what part can be attributed to the considerable amount of passive investor funds contributing to the diminished return expectations from a long-only exposure to commodities?

[5] The correlation between S&P500 and SPGSCI is as follows:

[6] Factor crowding refers to hedge funds following similar systemic factors to forecast equity risk premium. As a result, the hedge funds strategies are becoming too crowded and are becoming more correlated, leading their risk premiums to be arbitraged away. See Cahan (2013) for more.

Since 2004, open interest has more than doubled for the average commodity. The table on the prior page suggests that an investor's ability to utilize commodities as a useful diversifying investment now requires a more active approach similar to those utilized by hedge funds, alternative fund of funds, and CTAs. Historically, managed futures particularly have proven to be an excellent diversifier to a traditional equity/bond portfolio; however, their lack of transparency, high fee structure, manager selection, and issues relating to style drift has kept some investors from utilizing these strategies. Overall, however, investors search for yield has continued to siphon AUM towards alternatives (see Figures 1-2).

Third, most commodity allocations and commodity index benchmarks have WTI Crude Oil as their largest exposure. Through 2004, Crude Oil futures were backwardated, a pricing structure that allowed a passive investor to maintain a long position by rolling from a higher priced futures contract into a lower priced one, thus capturing a "roll yield"[7]. The Crude Oil market went from a pricing structure dominated by a backwardated curve structure to one now dominated by contango. This pricing anomaly was a primary driver of returns for not only Crude Oil but commodities in general (Erb and Harvey (2005)). This new forward structure has resulted in changing what was a "roll yield" into a "roll cost" (Bhardwaj, Gorton, Gary, and Rouwenhorst (2015)). Figures 3 and 4 demonstrate the futures curve for WTI Crude Oil on 10/1/1997 and 11/30/2015. As can be seen (Figure 5), the WTI crude oil market has historically oscillated between contango and backwardation. Between 1988 and 2004, the WTI traded in backwardation 69% of the time. Since 2004, the WTI has traded in contango 76% of the time.

Fourth, there has been noticeable increases in large order flows ahead of periodic rolls by major commodity hedge funds and index providers. Trading ahead of the major rolls is primarily devoted to avoiding the negative effect on spreads when index providers roll from front month to next nearby contracts. In Figure 6, the changing dynamics of the WTI Crude Oil roll period associated with the SPGSCI can be observed. Each index component commodity, when required, is rolled forward during the 5th through 9th business day (shaded area) of the month. Other long-only commodity index benchmarks also roll early in the

[7] In a backwardated market, the inventory is low and the benefits of owning the commodity for selling in future exceeds the cost of storage. So, the futures price rolls up to the expected spot, generating a positive roll-yield for those going long. In a contangoed market, storage costs exceed the roll yield as the futures price gravitates downward to the spot market. In a contangoed market, short positions capture the negative roll-yield.

month on varying time frames but are similar to the SPGSCI methodology. As can be seen, the early part of the month through 2004 had marginal roll costs compared to the significant slippage associated with the roll functon since 2004. Although the roll of month 1 to month 3 is shown, similar analysis demonstrates this degrading roll yield function across the active 12 month forward curve. Fama and French (1987) cite the level of interest rates and convenience yield to affect the roll yield or the basis. The paper by Gorton, Hayashi, and Rouwenhorst (2012) claim, among others, inventory as the principal driver of the basis.

The practitioner and the academic communities have implemented these structural changes in designing trading strategies. In particular, studies have incorporated roll-yield, inventory, and the hedging pressure hypothesis in long-short or passive long trading strategies (see Mifre, 2015 for a review of the literature). In this section, we briefly highlight the major issues in applying these concepts in developing futures trading strategies.

The roll-yield has been used as a signal in trading strategies (see Erb and Harvey (2006), Dewally, Ederington, and Fernando (2013), and Gorton, et. al (2012). In general, in a bakwardated market (downward sloping futures curve), high roll-yield suggests going long and in a contango market (upward sloping futures curve), high negative roll-cost suggests going short would be profitable. To implement the strategy, one can obvserve the difference between front month and second nearest contract to guide asset allocation. The authors also suggest that the long-short portfolios trading the roll-yield generate returns similar to long-only passive commodity indexes like the SPGSCI. In contrast, developing trading strategies on the basis of standardized inventory (inventory divided by 12-month moving average of inventory) is profitable[8]. According to Gorton, et al (2012), profit from inventory based trading strategies have higher returns for commodities with bakwardated futures curves. In addition, inventory based long-short strategies have a Sharpe ratio of .46, in comparison to long-only portfolios rebalanced at the monthly frequencies.

Hedging pressure theory derives its root from the normal backwardation theory (Keynes, 1930) which states that hedgers, who are net short face a risk of falling prices, offer a risk premium to speculators

[8] The ratio is lower in a backwardated market.

who are net long. As futures price is expected to rise, speculators who are long earn a positive risk premium[9]. It follows then that backwardated and contangoed markets are driven by hedging pressure in the market. Empirically, the theory has been supported by several authors (see Bessembinder (1992) and Basu and Miffre (2013) and references therein). In particular, Basu and Miffre (2013) developed a long-short strategy based on 27 commodity futures and generated an average Sharpe ratio of 0.51 for the period 1992-2011. This is in contrast to a Sharpe ratio of 0.08 from a long-only equally-weighted portfolio that includes all commodities for the same period. Finally, during the same period the SPGSCI generates a Sharpe ratio of 0.19. These findings have been challenged in an another study by Daskalaki, Kostakis, and Skiadopoulos (2014). The authors show that returns to net short hedgers in a backwardated market are statistically insignificant from the returns earned by net long hedgers in a contagoed market.[10]

Long-short trend following strategies (see Erb and Harvey (2006), and Blitz and De Groot (2014), to name a few) applied to the commodity futures markets are quite popular and have done well in the past. The trend following momentum studies are two types: cross-sectional and time series momentum. Both strategies have done well (see Miffre (2015) for a summary of performance). In general, the cross-sectional momentum strategy that buys the winners and sells the losers have Sharpe ratio of 0.5, in contrast to -0.24 Sharpe for long-only equally-weighted portfolio (see Miffre and Rallis (2007)). While the cross-sectional momentum strategy is the most popular, time-series momentum strategy has also performed well. According to a recent study by Szakmary, Shen, and Sharma (2010), this strategy has a Sharpe ratio of 0.52. In another study by Hurst, Oci, and Pedersen (2014) of AQR Capital Management, the strategy offers a Sharpe ratio of 0.77, net of all fees, for the period January 1983 – December 2013. The authors attribute several factors contributing to the success of this strategy including investors' behavioral biases, market frictions, hedging demands, and market interventions by regulatory bodies such as the central banks and governments.

Trend following long-short strategies based on various measures of risk such as beta, total risk, and idiosyncratic volatility (see Frazini and Pedersen (2014), Gorton, Hayashi, and Rouwenhorst (2012), and

[9] Similarly, the futures price needs to be set at a high level for net short speculators to accommodate hedgers who are net long.

[10] See Miffre (2015) for an analysis of the differences between these studies that may explain different results.

Szymanowska, De Roon, Nijman, and Van Den Goorbergh (2014)) have also been reported. The beta based strategy (Frazzini and Pedersen (2014)) which involves buying low beta assets and shorting high beta assets has a Sharpe ratio of only 0.11. Gorton, Hayashi, and Rouwenhorst (2012) note that a high volatility portfolio statistically outperforms a low volatility portfolio by 5.41% annually. In terms of Sharpe ratio, the long-short portfolio compares favorably compared to a long only portfolio. Fernandez-Perez, Fuertes and Miffre (2015) use residuals from a model that includes roll-yields, hedging pressure, and past performance to form quantile portfolios of commodities futures. The strategy (long contracts with high previous performance, high roll-yields, and low idiosyncratic volatility and short contracts with low previous performance, low roll-yields, and high idiosyncratic volatility) has a Sharpe ratio of 0.38 which is higher than 0.02 Sharpe ratio of the SPGSCI.

Finally, there are other strategies including cheapness/dearness, liquidity, inflation beta, dollar beta, open interest, skewness (long contracts with most negative skewness and short contracts with most positive skewness), and term structure of the commodity contracts (for example, shorting nearby contracts and buying distant contracts). Some of these strategies have produced attractive returns, compared to their chosen benchmarks. See Miffre (2015) for a review of these strategies.

Overall, trend following long-short strategies using commodity contracts are based on popular stock investing models like, for example, the four factor model. To the extent that investment psychology differs between the markets, it is not clear that some of these factor models are capable of dealing with contango and backwardation features in the commodity markets. In addition, the stock market's exposure to the world geopolitical environment certainly is different than the exposure of the commodity markets. Finally, as noted earlier, flow of AUM into passive long only portfolios have exacerbated the correlation between commodity and stock indices. The models have performed well in the past but their recent performance brings into question whether improvements can made by tweaking these models.

III. All Weather Liquid Alternative Commodity Index (LACI)

We introduce a new index (Liquid Alternative Commodity Index (LACI) in the commodity space that stands out quite well among a large number of competing indices. As discussed below, the innovative design of the LACI allows it to be truly an all-weather index in terms of high Sharpe ratio and robustness. The proprietary construction of the index takes into consideration the disparate signals that have been identified in the literature such as backwardation, contango, roll-yields, momentums, cheapness/dearness, idiosyncratic volatility, beta, hedging pressure, and term structure of commodity contracts. By combining all these signals into an investible index, LACI has the potential to offer superior returns, in comparison to the competing brand name CTAs, hedge funds, mutual funds, and ETF/ETN products.

The data for the construction of the long/short/flat LACI Index is based on daily data on 27 commodity futures contracts representing the commodities included in the SPGSCI and DJ-UBS Commodity Indices. The data covers the period January 1990 to May 2016 and competing indices for comparison are available at irregular intervals. The LACI provides investors access to an innovative trading strategy which is based upon simple trend and counter-trend following algorithms and incorporates a long/short/flat positioning methodology. The fully transparent index is highly liquid and provides stable returns. The investment strategy deals with the volatility of the spread during rebalancing and offers significant improvements in the way signals are generated that are robust to stylized features of the commodity markets when futures contracts oscillate between contango and backwardation. The significance of regime switching from backwardation to contango has not been fully explored in terms of innovative trading strategies that are capable of dealing with roll-yields, inventory levels, and hedging pressures in the marketplace. We also construct two other versions of LACI – LACI-TLO (long only) and LACI-TSO (short only). These investible indices can also offer targeted diversification benefits when combined with traditional portfolios.

In Figure 8, we plot LACI against several benchmarks including the SPY (ETF) and the SPGSCI. The LACI is able to generate superior performance compared to the benchmarks. It has a Sharpe ratio of 1.02 for the entire sample[11], which compares quite favorably against the benchmarks. In Table 1, we report

[11] We adjust the Sharpe ratio for serial correlation. See Rulle (2015) for more.

several measures of performance of LACI against the benchmarks and several competing alternative products. As noticed, the Sharpe ratio indicates that LACI beats all its competitors. For the full sample, LACI again beats all its competitors.

Over the past several years there have been a variety of so-called "liquid alternatives" trying to fill this void but very few have been able to provide a consistently viable alternative for a dedicated commodity strategy. Many of these commodity related liquid alternatives were long-only strategies attempting to devise ways of minimizing the negative effects associated with rolling positions forward along the curve. Some of these strategies worked for a short period of time but were quickly arbitraged away. The LACI is intended to provide a more palatable exposure to the commodity asset class by capturing large trends in commodities in both up and down commodity cycles. In this manner it provides meaningful diversification when it is most needed. The table below shows the correlations between the SPGSCI and LACI to the S&P 500 over different periods.

Period	SPGSCI|S&P 500 Correlation	LACI|S&P 500 Correlation
1990 to 2004	.00	-.09
2005 to 2015	.45	-.30
2010 to May-16	.60	-.20

The LACI has consistently kept its diversifying characteristics while the SPGSCI has become a less effective diversifier. By replacing the passive long only commodity exposure with a more active commodity allocation, the overall Sharpe Ratios and drawdowns improve significantly. In Table 2, we present salient statistics of adding LACI to construct a series of simplified all weather type portfolios starting in May 1996. We use this point in time as it corresponds to the introduction of the Bridgewater All Weather fund, an evolutionary product that has gained a broad following among sophisticated investors. The value added monthly index (VAMI) for the selected portfolios are shown in Figure 9. The results indicate the addition of LACI improves the risk-return performance of the portfolios. We believe LACI truly becomes the all weather diversifier that is prudent for any investor utilizing the commodity markets. By focusing on the 30% Equity, 50% Bonds, and 20% LACI portfolio, we can then see how this mix compares to the actual performance of other widely held investments.

Finally, Table 4 displays the performance of LACI versus 139 ETFs, ETNs, and mutual funds. These competing products represent a broad cross section of commodity and alternative investment strategies without any bias with respect to assets under management (AUM). Performance data for the competing products of LACI are collected from publicly available databases. In Table 4, we see that LACI has the best Sharpe ratio (.96) for the most recent 10 year period shown.

Robustness Check

How unique is LACI? One way to test this would be to determine if LACI type returns can be harvested by replacing the performance of LACI by investing in close substitutes. One way to demonstrate this involves testing whether LACI is cointegrated with any of its competitors. Cointegration between two time series is consistent with the presence of short-run deviations of these assets from one another. However, in the long-run, their prices must track each other as successful arbitrage can push their prices to return to a long-run equilibrium. In other words, if two related variables move together in the long run, then there exists an error correction representation of the common relationship. This implies that today's relationship between these two variables depends upon the amount of disequilibrium in the previous period. For related financial assets, cointegration is consistent with the notion of the no-arbitrage condition. This is consistent with Fama (1991) where he defines efficiency as a lack of arbitrage opportunities. For instance, Hogan, Kroner and Sultan (1993) show that cointegration between the S&P500 cash price and the S&P500 futures price is due to index arbitrage.

Tests for cointegration is carried out in two stages. In the first stage, we use the Carrion-i-Silvestre et al. (2009) (CKP). The CKP method to see if level prices are non-stationary in the level, a requirement for two series to be cointegrated. The CKP method allows up to 5 structural breaks in both the level and slope of the trend function. There are three test statistics estimated, namely $MZ_a^{GLS}(\lambda)$, $MZB^{GLS}(\lambda)$, and $MZ_t^{GLS}(\lambda)$ which are robust to all the shortcomings of well-known conventional tests widely employed in the literature[12]. In the second stage, we use Maki's (2012) cointegration test (MB*k*) to check whether the log of LACI price

[12] See Carrion-i-Silvestre et al. (2009) for detailed technical explanations for the procedures of the tests.

and its close competitors have a long-run relationship. MB*k* with unknown number of structural breaks tests the null hypothesis of no cointegration against the alternative hypothesis of cointegration with *i* breaks (*i*≤*k* where k is the maximum number of breaks). This test performs even better than previously developed cointegration tests with structural breaks when the cointegration relationship has more than three breaks or persistent Markov switching shifts (Maki, 2012: 2011) [13]. To check for robustness, we further test our hypotheses using a robust least squares algorithm to deal with outliers. This is accomplished by using Huber's (1973) *M*-estimation method which is robust to outliers.

In Table 3, we report cointegration results for LACI and 27 of its publicly traded competitors. The competitors are chosen on the basis of publicly available data on the Morningstar and Yahoo Finance web sites and that resemble LACI's investible universe. Recall that for a cointegration test, both the LACI and a particular asset must be non-stationary in the levels. As can be seen, LACI is not cointegrated with any of the assets examined, which implies that the LACI and these assets do not share a common trend; and that each may be responding to a different set of economic forces. Hence, it would be very difficult to use any of these alternative assets to replicate the performance of LACI.

Herding and LACI Performance

The final robustness test conducted involves estimating sensitivity of LACI returns to factor crowding. Factor crowding increases the exposure of an investment strategy to systemic risk when investors use the same factors to trade the same basket of stocks or commodities. If everyone knows the factors that generate these risk premia, it is possible that they will be arbitraged away[14]. As noted earlier, factor crowding increases herding among investors and also correlation between popular stocks and the index. There is a vast literature on herding. See McAleer and Randalj (2013) for a survey of the literature. Herding is analogous to mimicking others when making investment decisions, even when such correlated actions so would contract

[13] See also Maki (2012) for detailed explanations of the estimation steps for the test statistic, MB*k*.

[14] Cliff Asness of AQR suggests that factor strategies continue to work despite factor crowding. He cites two reasons. First, risk premium is for the investor for taking risk. So, the risk premium is a rational return that will not be arbitraged. Second, since investors are prone to making errors, it leads to mispricing, over valuation, over/under reaction in assets returns. Over time as the market returns to normalcy, risk premiums are generated, even if everyone knows about these factors. See https://www.aqr.com/cliffs-perspective/how-can-a-strategy-still-work-if-everyone-knows-about-it

the investors' own private information or rationale (Banerjee (1992)). Correlated behavior is linked to investors using the same information and interpreting it in a similar manners (Hirshleifer, Subrahmanyam, and Titman (1994)). Bikhchandani et al. (1992) claim that sequential decision making among investors is responsible for herding. Their explanation suggests that cascading buying and selling decisions from following the leader (s) places more importance to the actions by the leaders than on private information. Empirically, several authors have constructed measures of herding to understand investor psychology and its effects on the market. The LSV measure developed by Lakonishok, Shleifer, and Vishny (1992) uses observed percentages of buyers and sellers in a market to study herding among institutional traders. Christie and Huang (1995) define herding using the cross-section absolute deviation of returns (CSAD). A similar measure developed by Chang et al.(2000) looks at the squared dispersion of equity returns and the overall market return (CSSD). These authors find ample evidence of herding in commodities, currencies, equities, and financial futures, for example.

We estimate individual commodities-specific herding using both the cross sectional standard deviations (CSSD) and cross-sectional absolute standard deviations (CSAD) methods. We assume that the SPGSCI is the appropriate market index of commodities considered in this paper. The CSSD measure is then calculated as follows:

$$CSSD_t = \sqrt{\frac{\sum_{i=1}^{N}\left(r_{i,t} - r_{m,t}\right)^2}{N-1}} \qquad (1)$$

where $r_{i,t}$ are the daily returns from a particular commodity and the $r_{m,t}$ is the daily return from the market index (SPSCI). We then calculated a weighted aggregate measure of herding for all commodities by their respective weights in the LACI strategy. Because LACI returns distribution is not normal, we estimated a generalized autoregressive conditional heteroskedasticity (GARCH) model, which assumes changing distributions of the second moments of the returns. The model is:

$$LACI_t = \delta_0 + \delta_1 CSSD_t + \varepsilon_t \qquad (2)$$

$$\varepsilon_t \,|\, \psi_{t-1} \sim N(0, \sigma_t^2) \qquad (3)$$

$$\sigma_t^2 = \Omega + \sum_{i=1}^{q} \alpha_i \varepsilon^2{}_{t-i} + \sum_{j=1}^{p} \beta_i \sigma_{t-j} \qquad (4)$$

where $LACI_t$ in the mean equation (equation 2) are the daily LACI returns from our proprietary long-short-flat investment strategy and $CSSD_t$ is the aggregate measure of herding. Equation (3) describes the returns distribution given time varying conditional variances (Ψ_{t-1} is the information set). The variance equation (4) models the conditional variances as a GARCH(p,q) process where p and q denote the lag length. Ω is the intercept term, α_i are ARCH terms and β_j are GARCH terms. We would expect α and β terms to be positive and significant determinants of the conditional variance of returns. The model is estimated assuming t-distribution for the error term. For the second regression, we simply replace CSSD with CSAD, which is defined as:

$$CSAD_t = \frac{1}{N} \sum_{i=1}^{N} | r_{i,t} - r_{m,t} | \qquad (5)$$

where CSAD in equation (5) is the aggregate weighted measure of herding for all the commodities considered in this study, with weights representing the proportion of each commodity in constructing LACI. An increase in CSSD (or CSAD) indicates a decline in herding. So, a positive sign for the coefficient of herding should be interpreted as a decrease in herding leading to an increase in the LACI returns. To avoid contemporaneous relationship between LACI and measures of herding, CSSD and CSAD are lagged by one day. Regression[15] results are reported below (with robust t-statistics in parentheses).

[15] We report only the results using CSSD as a measure of herding. Results using CASD are also similar and therefore are not reported to conserve space.

Mean Equation

$LACI_t$	=	.000007 +	0.261 $CSSD_{t-1}$	-0.0038 AR1	
		(1.36)	(0.51)	(-0.28)	

Variance Equation

σ^2_t	=	0.000007 +	0.29 ε^2_{t-1}	+0.76 σ_{t-1}	+0.23 TDF[16]
		(6.61)	(13.05)	(61.74)	(16.81)

The results suggest that LACI returns are insensitive to the level of herding. The coefficient δ_1 is positive but statistically insignificant. We consider this to be a strong evidence of the effectiveness of our investment strategy and it reinforces our prior assumption that as cascading investment decisions in the market lead to herding, the profitability of implementing a long-short-flat investment strategy as outlined in this paper remains robust. What this also implies is that herding is common in the commodities that we considered and yet it fails to affect LACI and LACI-like investment strategies.

V. Conclusions

The realization that falling commodity prices can be just as detrimental to equity and bond markets as rapidly rising prices requires a more active exposure to this asset class. Rising correlation between the commodity asset class and equities diminishes the utility of a plain passive long-only commodity exposure. Additionally, the structural changes in the commodity futures forward markets indicate that the cost of maintaining plain long-only exposures may continue to diminish the overall effectiveness of this passive type of allocation. What is shocking is that the popular commodity based ETFs, ETN's, and listed managed futures strategies, expected to offer stable investment returns with acceptable levels of volatility, has not addressed major paradigm shifts in the commodity markets including backwardation-contango oscillation, factor crowding, massive flow of funds populating long only strategies, and significant slippage due to periodic rolls. What is equally puzzling is that investors continue to pour money into these strategies despite the poor Sharpe ratios for an overwhelming number of these commodity specific alternative products.

[16] TDF is the inverse of degrees of freedom parameter. The results indicate normality assumption is not valid as the degrees of freedom is 4.35 (=1/.23). The assumption of t-distribution corrects for the low degrees of freedom.

The proposed alternative investment strategy aims to fill the void. Our alternative methodology utilizes a more sophisticated commodity component with a newly created program called the Liquid Alternative Commodity Index (LACI©). The strategy is based on long/short/flat monthly positions for the commodity markets. The series of statistical tests on robustness of the strategy confirms our belief that LACI is a unique product which is difficult to replicate and capable of delivering attractive returns with high Sharpe ratios. In addition, we also find that two variants of LACI, namely LACI Tactical Long Only and LACI tactical Short Only, can be excellent additions to all-weather portfolios for superior diversification without sacrificing returns. Finally, the LACI provides a critical exposure in a highly liquid, fully transparent structure.

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Figure 1

Figure 2

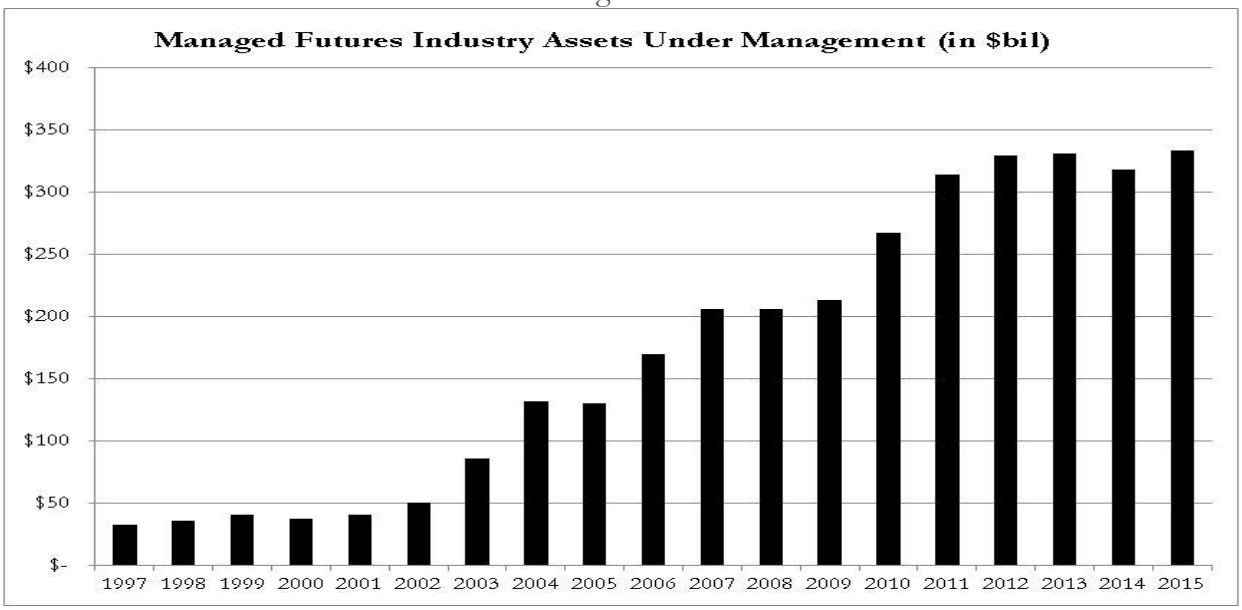

Figure 3
Futures Curve Showing Backwardation in WTI Crude Oil
(10/1/1997)

Figure 4
Futures Curve Showing Contango in WTI Crude Oil
(11/30/2015)

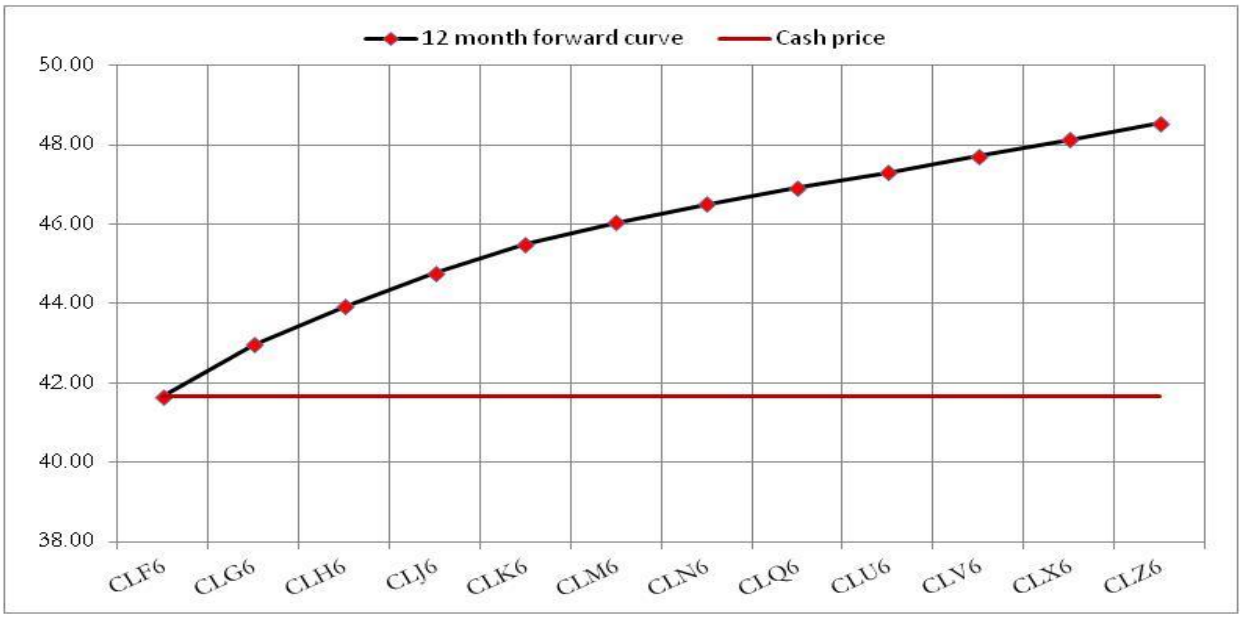

Figure 5

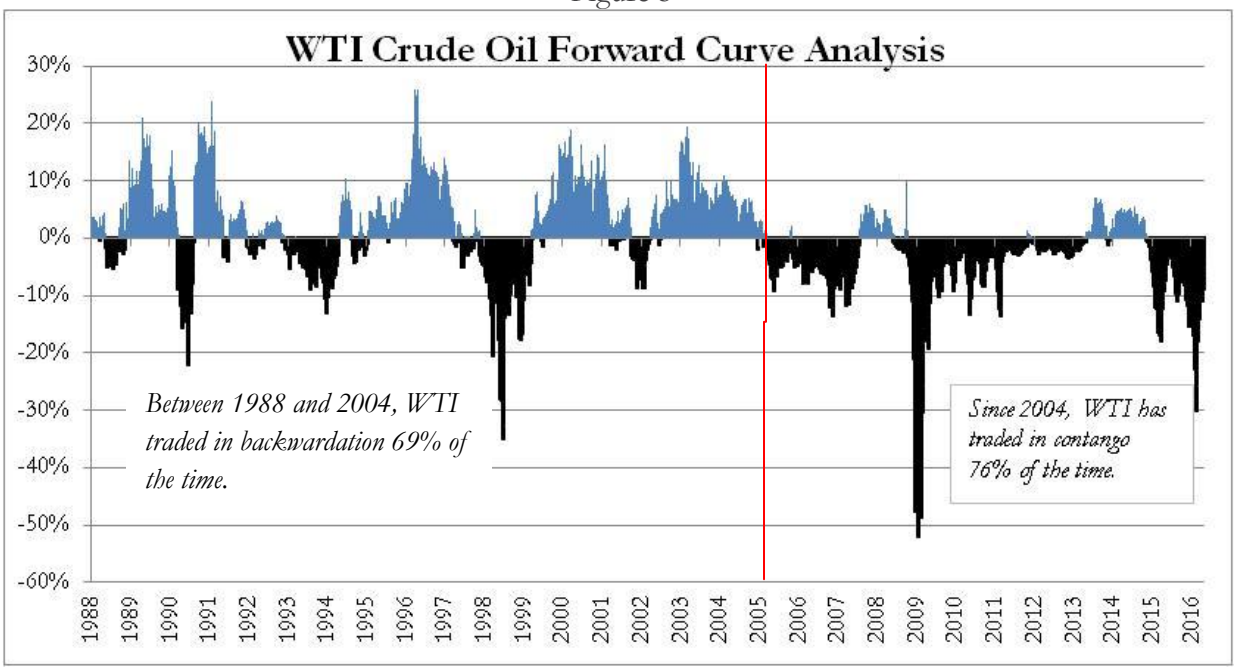

Figure 6
WTI Crude Oil Month 1-3 Spread Cumulative % Change

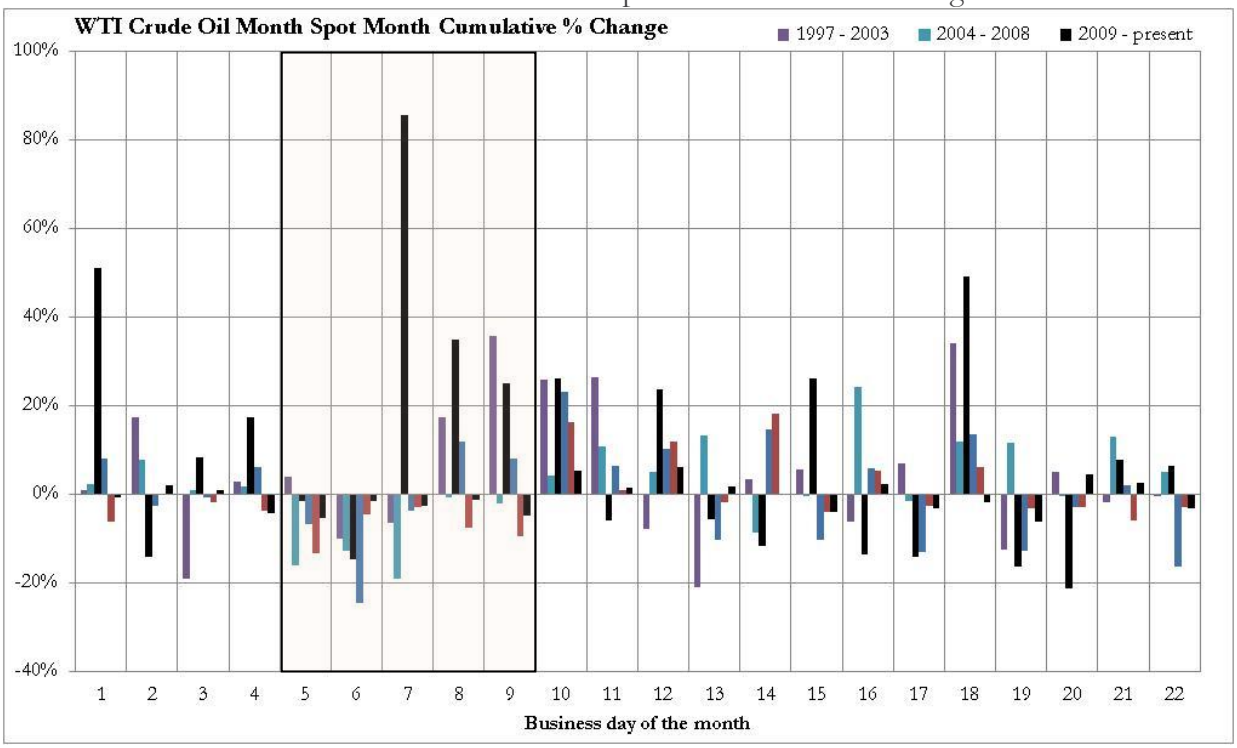

Figure 7

WTI Crude Oil NYMEX Open Interest average for the first 12 listed futures contract months

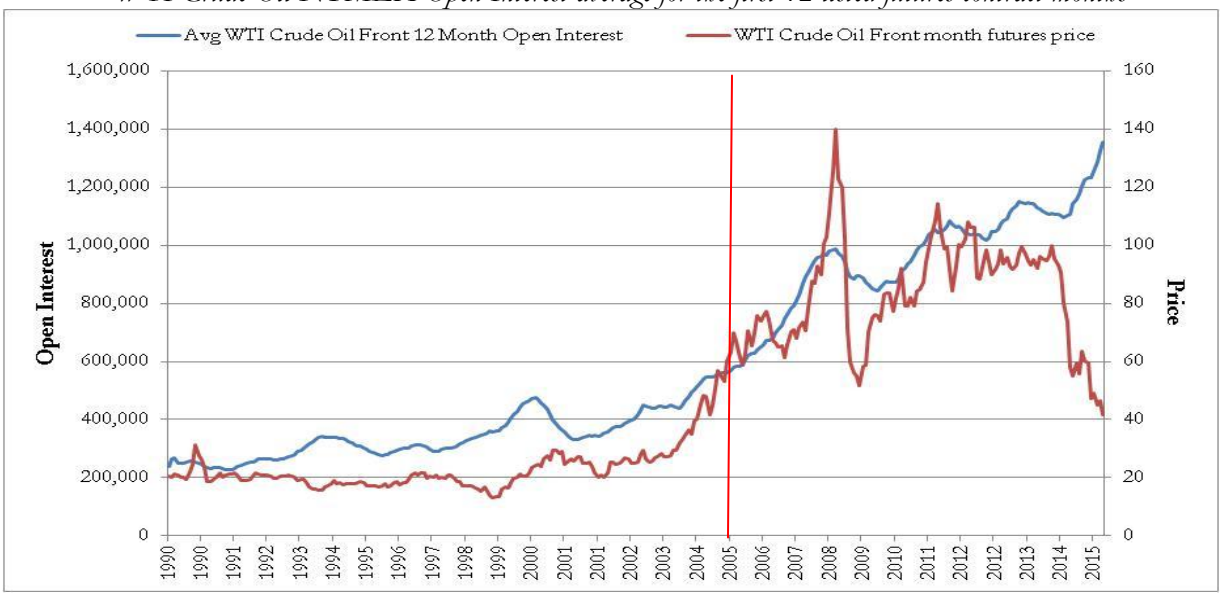

Figure 8

Value Added Monthly Index of LACI vs. Competing Benchmarks

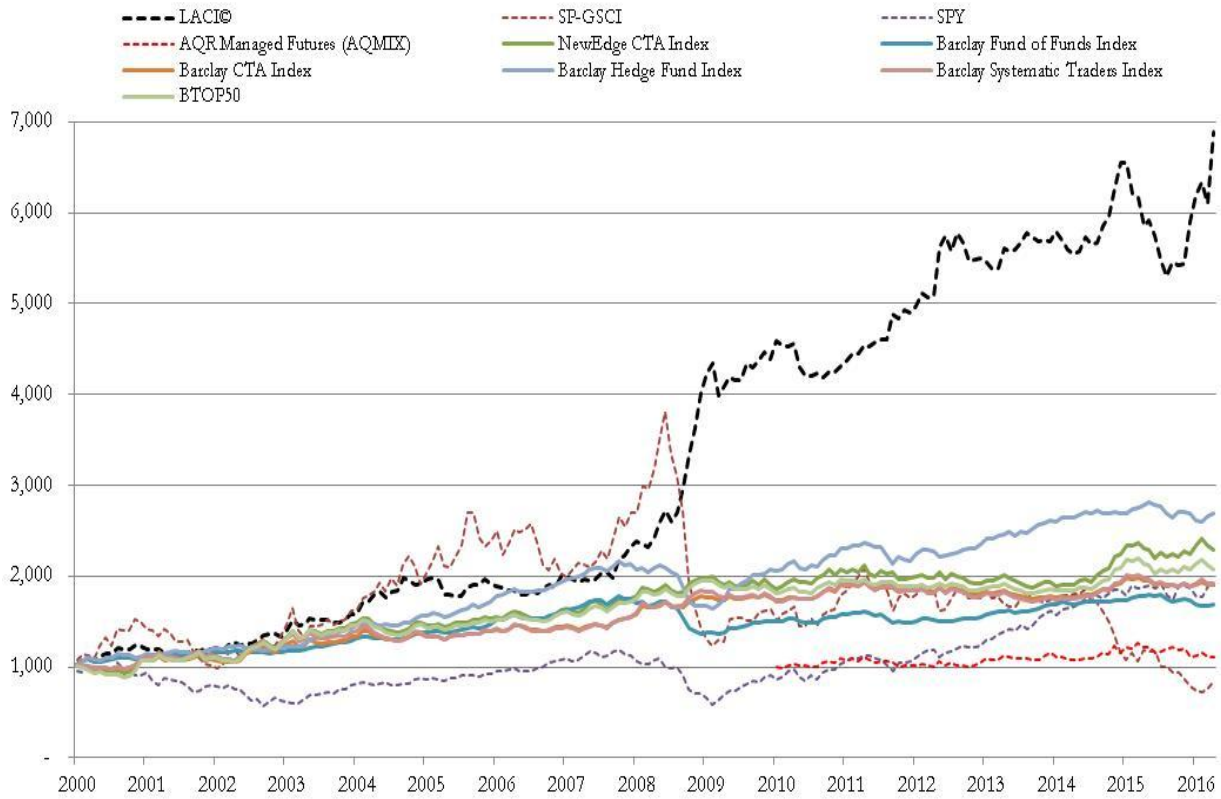

Figure 9

Portfolio Diversification with LACI

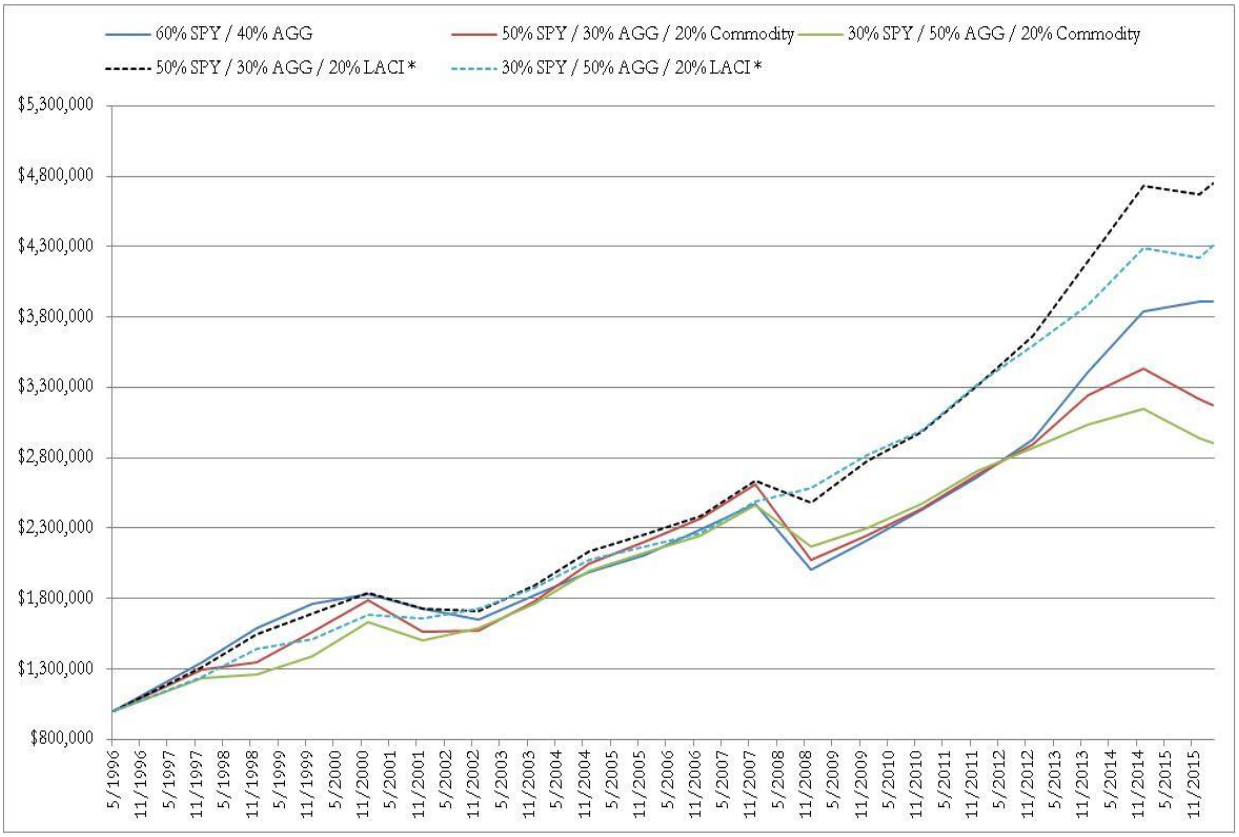

Table 1

Liquid Alternative Commodity Index (LACI©) and Alternative ETF's, ETN's, and Mutual Funds

Ticker	Fund Name	Expense Ratio	Later of Inception Date or 12/30/2005	1 Year	3 Year (Annualized)	5 Year (Annualized)	SHARPE ratio *
LACI	**Liquid Alternative Commodity Index**	**1.00%**	**12/30/2005**	**+15.97%**	**+7.19%**	**+8.66%**	**0.96**
MIP-BP	**Marblehead IP Balanced Portfolio**	**1.00%**	**12/30/2005**	**+5.06%**	**+6.23%**	**+6.96%**	**1.27**
AQMIX	AQR Managed Futures Strategy Fuutures	1.26%	1/5/2010	-11.13%	-0.60%	+0.00%	0.06
BCSAX	BlackRock Commodity Strategies Portfolio	1.50%	10/3/2011	-12.37%	-10.21%		(0.53)
BRCAX	Invesco Balanced-Risk Commodity	1.57%	11/29/2010	-5.06%	-9.83%	-9.31%	(0.46)
CCXE	WisdomTree Commodity Country Equity	0.58%	10/12/2006	-8.72%	-6.29%	-4.63%	0.03
CMCAX	Van Eck CM Commodity Index Fund	0.95%	12/30/2010	-15.07%	-13.97%	-11.62%	(0.73)
CRSAX	Credit Suisse Commodity Return	1.03%	12/30/2005	-15.47%	-13.76%	-12.77%	(0.38)
CSFFX	Arrow Commodity Strategy Fund	2.07%	12/30/2010	-12.56%	-12.34%	-11.54%	(0.68)
CTF	Nuveen Long/Short Commodity TR Common	1.73%	10/25/2012	-7.76%	-0.13%		(0.42)
DDP	DB Commodity Short ETN	0.75%	5/21/2008	+16.33%	+19.54%	+11.43%	0.23
DPU	DB Commodity Long ETN	0.75%	5/21/2008	-18.52%	-16.49%	-14.25%	(0.31)
DXCTX	Direxion Indexed Commodity Strategy	1.26%	6/9/2008	-5.31%	-8.17%	-12.34%	(0.60)
EACSX	Eaton Vance Commodity Strategy	1.50%	4/8/2010	-14.97%	-14.69%	-13.32%	(0.19)
EIPCX	Parametric Commodity Strategy Fund	0.70%	5/25/2011	-13.10%	-11.77%	-10.94%	(0.86)
GSCAX	Goldman Sachs Commodity Strategy	0.98%	3/30/2007	-24.76%	-19.04%	-14.82%	(0.40)
HDG	Hedge Replication ETF	0.95%	7/13/2011	-3.06%	+1.10%		0.15
IMUAX	Transamerica Multi-Manager Alternative Portfolio	2.28%	1/3/2007	-6.54%	-0.20%	+0.69%	0.11
JCRAX	ALPS|Core Commodity Management Commodities Strategy Fund	1.45%	6/30/2010	-13.08%	-11.16%	-10.62%	(0.21)
LCSAX	LoCorr Long/Short Commodities S	2.20%	1/17/2012	+23.40%	+14.45%		0.48
LSC	S&P Commodity Trend Index ETN	0.75%	6/10/2008	+2.94%	+2.91%	-7.28%	(0.32)
MCRO	IQ Hedge Macro Tracker ETF	0.75%	6/8/2009	-3.32%	-1.48%	-1.39%	0.10
MCSAX	MFS Commodity Strategy Fund Cl	1.07%	6/1/2010	-13.33%	-12.88%	-12.03%	(0.38)
NGSAX	Nuveen Gresham Long/Short Commodity TR Common	1.71%	7/27/2012	+2.98%	+0.41%		(0.22)
NGVAX	Nuveen Gresham Diversified Commodity	1.32%	7/27/2012	-18.11%	-13.89%		(1.05)
NRBAX	Neuberger Berman Risk Commodity	1.46%	8/24/2012	-15.44%	-13.33%		(1.06)
PCLAX	PIMCO CommoditiesPLUS Strategy	1.24%	5/31/2010	-21.36%	-15.80%	-11.88%	(0.25)
PCRAX	PIMCO Commodity Real Return Strategy	1.19%	10/1/2009	-18.43%	-15.94%	-13.02%	(0.28)
QAI	IQ Hedge Multi-Strategy Tracker ETF	0.75%	3/24/2009	-3.03%	+1.85%	+2.02%	0.46
QGMIX	AQR Global Macro Fund	1.51%	7/20/2011	-0.67%	+3.69%		0.43
QRAAX	Oppenheimer Commodity Strategy	1.46%	12/30/2005	-25.46%	-19.71%	-15.05%	(0.53)
RCSAX	Russell Commodity Strategies Futures	1.56%	6/30/2010	-16.64%	-14.84%	-13.53%	(0.53)
RTSRX	State Street/Ramius Managed Futures	3.35%	10/27/2011	-9.07%	+1.86%		0.09
RYMEX	Rydex Series Fds Commodities Strategy	1.59%	12/30/2005	-28.40%	-21.71%	-16.52%	(0.51)
SKNRX	Deutsche Enhanced Commodity Strategy	1.48%	3/11/2009	-7.04%	-6.53%	-7.85%	0.13
TGGWX	TCW Enhanced Commmodity Strategy	0.70%	3/31/2011	-15.45%	-12.55%	-10.82%	(0.77)
VWELX	Vanguard Wellington Income Fund	0.26%	12/30/2005	+1.29%	+7.32%	+8.37%	0.50
VWINX	Vanguard Wellesley Income Fund	0.23%	12/30/2005	+4.31%	+5.97%	+7.28%	0.91
WDTI	Managed Futures Strategy Fund	0.95%	1/4/2011	-3.44%	+1.57%	-3.77%	(0.46)

** data shown is through 5/31/2016*

*** SHARPE ratios are from the inception date shown*

Table 2
LACI and Portfolio Asset Allocation

	60% SPY / 40% AGG	50% SPY / 30% AGG / 20% Commodity	30% SPY / 50% AGG / 20% Commodity	50% SPY / 30% AGG / 20% LACI *	30% SPY / 50% AGG / 20% LACI *
Annualized average return	+7.15%	+6.11%	+5.63%	+8.34%	+7.79%
Average annual vol	9.34%	9.87%	7.40%	7.58%	5.03%
Sharpe	0.52	0.39	0.45	0.79	1.09
Serial Correlation	0.05	0.06	0.05	0.01	-0.03
Adjusted Sharpe	0.49	0.36	0.43	0.79	1.12
Max drawdown	-32.32%	-37.07%	-28.15%	-18.29%	-6.22%

NOTE: Data represented is from 6/1/1996 through 05/31/2016 (20.0 years)

** LACI, LACI-TLO, and LACI-TSO returns are NET of all expected transaction costs and management fees.*

*** Adjusted Sharpe uses the Van Belle volatility adjustment methodology to account for serial correlation in a return series.*
*The formula for the adjustment is: SQRT ((1-serial corr) / (1 + serial corr)) * Sharpe Ratio*

SPY = SPDR S&P 500 ETF

VWELX = Vanguard Wellington Income Fund

AGG = from 5/1/1996 through 8/31/2003 the returns from the Lehman Aggregate Bond Index is used. Starting 9/1/2003 the iShares Core U.S. Aggregate Bond ETF is used.

Commodity = The Goldman Sachs Comodity Index - Total Return is used from 5/1/1996 through 7/31/2006 Starting 8/1/2006 an average of the PowerShares DB Commodity Index ETF (DBC) and the S&P GSCI Commodity Indexed Trust ETF (GSG) are used. Each allocation is rebalanced at the beginning of each month.

LACI = Liquid Alternative Commodity Index

TABLE 3

Cointegration between LACI and Brand Name CTAs, Mutual Funds, Hedge Funds, and ETFs

			Maki (2012)	Break Points Observations				
Ticker	Name	Cointegrated?	Test Statistics	B1	B2	B3	B4	B5
SPY	SPDR S&P 500	Not Cointegrated	-5.29	754	-	-	-	-
AGG	iShares Core U.S. Aggregate Bon	Not Cointegrated	-5.793	725	-	-	-	-
DBC	PowerShares DB Commodity Index	Not Cointegrated	-6.62	628	793	1026	-	-
GSG	iShares GSCI Commodity-Indexed	Not Cointegrated	-6.492	509	704	1243	1530	1795
CTF	Nuveen Long/Short Commodity Total	Not Cointegrated	-4.038	272	354	435	800	857
GSC	Goldman Sachs Connect S&P Enhan	Not Cointegrated	-5.37	330	870	1156	1416	
DXCTX	Direxion Indexed Commodity Stra	Not Cointegrated	-5.698	128	415	786	1038	1945
QRAAX	Oppenheimer Commodity Strategy	Not Cointegrated	-5.32	352	655	849	1389	1675
NGSAX	Nuveen Gresham Long/Short Commodity	Not Cointegrated	-5.492	754	857	921	-	-
AQMIX	AQR Managed Futures Strategy Fu	Not Cointegrated	-4.788	108	536	950	1550	-
ARCIX	AQR Risk-Balanced Commodities F	Not Cointegrated	-4.382	86	137	296	433	860
BCSAX	BlackRock Commodity Strategies	Not Cointegrated	-5.488	173	315	451	539	1075
CMCAX	Van Eck CM Commodity Index Fd C	Not Cointegrated	-6.53	71	252	370	496	1313
LCSAX	LoCorr Long/Short Commodities S	Not Cointegrated	-6.375	91	316	386	883	940
WDTI	WisdomTree Managed Futures Stra	Not Cointegrated	-6.078	380	939	1017	1143	1305
DJP	iPath Bloomberg Commodity Index	Not Cointegrated	-6.283	438	633	1173	1325	1459
VWELX	Vanguard Wellington Income Fund	Not Cointegrated	-5.691	478	622	831	1494	-
VWINX	Vanguard Wellesley Income Fund	Not Cointegrated	-5.532	610	833	-	-	-
BRCAX	Invesco Balanced-Risk Commodity	Not Cointegrated	-4.688	109	198	407	564	1334
NRBAX	Neuberger Berman Risk Commodity	Not Cointegrated						
PCLAX	PIMCO CommoditiesPLUS Strategy	Not Cointegrated	-6.131	49	102	249	305	852
RCSAX	Russell Commodity Strategies Fu	Not Cointegrated	-4.927	977	1058	1240	1329	1436

Table 4

Comparison of Performance: LACI vs commodity related ETF's, ETN's, and Mutual Funds

Ticker	Fund Name	Expense Ratio	Inception Date	AUM	Segment	1 Year	3 Year (Annualized)	5 Year (Annualized)	SHARPE ratio **
LACI	**RTMLiquid Alternative Commodity Index**	**1.00%**	**12/30/2005**	**N/A**	**Broad Liquid Alternative**	**+15.97%**	**+7.19%**	**+8.66%**	**0.96**
MIP-BP	**Marblehead IP Balanced Portfolio**	**1.00%**	**12/30/2005**	**N/A**	**All Weather**	**+5.06%**	**+6.23%**	**+6.96%**	**1.27**
CMD	ProShares UltraShort Bloomberg Commodity	0.91%	11/28/2008	$6.96M	Inverse Broad Market	+29.21%	+26.65%	+22.16%	(0.02)
DEE	DB Commodity Double Short ETN	0.75%	4/30/2008	$1.63M	Inverse Broad Market	+52.38%	+35.99%	+22.94%	0.32
DDP	DB Commodity Short ETN	0.75%	5/30/2008	$1.17M	Inverse Broad Market	+16.33%	+18.99%	+11.43%	0.28
UCIB	ETRACS CMCI Total Return ETN Series B	0.55%	10/30/2015	$19.64M	Broad Market	+0.00%	+0.00%	+0.00%	(0.47)
MLM	Mount Lucas Long/Short Commodity Strategy	1.00%	12/30/2005	$345.00M	Broad Market	+4.62%	+7.37%	-0.71%	0.07
PDBC	PowerShares DB Optimum Yield Diversified Commodity Strategy Portfolio	0.60%	11/28/2014	$372.24M	Broad Market	-16.14%	+0.00%	+0.00%	(1.02)
CSCR	Credit Suisse X-Links Commodity Rotation ETN	0.85%	6/28/2013	$1.04M	Broad Market	-13.35%	+0.00%	+0.00%	(0.81)
FTGC	First Trust Global Tactical Commodity Strategy Fund	0.95%	10/31/2013	$306.82M	Broad Market	-14.37%	+0.00%	+0.00%	(0.93)
CMDT	iShares Commodity Optimized Trust	0.48%	8/30/2013	$8.84M	Broad Market	-12.23%	+0.00%	+0.00%	(1.03)
BCM	iPath Pure Beta Broad Commodity ETN	0.85%	4/29/2011	$33.41M	Broad Market	-15.65%	-13.02%	-11.02%	(0.73)
DYY	DB Commodity Double Long ETN	0.75%	5/30/2008	$1.22M	Leveraged Broad Market	-60.00%	-34.34%	-28.83%	(0.59)
UCI	ETRACS UBS Bloomberg Constant Maturity Commodity Index TR ETN	0.55%	4/30/2008	$68.61M	Broad Market	-15.06%	-13.51%	-11.57%	(0.40)
USCI	United States Commodity Index Fund	0.92%	8/31/2010	$541.92M	Broad Market	-9.93%	-9.14%	-9.29%	(0.23)
GSC	GS Connect S&P GSCI Enhanced Commodity TR Strategy ETN	1.25%	12/31/2007	$114.83M	Broad Market	-23.71%	-20.23%	-15.86%	(0.47)
RJI	Elements Rogers International Commodity Index-Total Return ETN	0.75%	10/31/2007	$219.94M	Broad Market	-18.76%	-15.11%	-12.75%	(0.40)
GSP	iPath S&P GSCI Total Return Index ETN	0.75%	6/30/2006	$50.12M	Broad Market	-30.32%	-22.56%	-17.15%	(0.50)
GSG	iShares S&P GSCI Commodity Indexed Trust	0.48%	7/31/2006	$913.84M	Broad Market	-27.13%	-20.60%	-15.72%	(0.51)
DBC	PowerShares DB Commodity Index Tracking Fund	0.85%	2/28/2006	$2.34B	Broad Market	-16.94%	-17.14%	-13.43%	(0.24)
GCC	WisdomTree Continuous Commodity Index Fund	0.79%	1/31/2008	$221.21M	Broad Market	-9.05%	-9.90%	-10.90%	(0.33)
SBV	iPath Pure Beta S&P GSCI-Weighted ETN	0.85%	4/29/2011	$1.92M	Broad Market	-31.49%	-20.16%	-15.59%	(0.87)
DJCI	E-TRACS Bloomberg Commodity Index Total Return ETN	0.50%	10/30/2009	$134.69M	Broad Market	-16.40%	-14.00%	-13.22%	(0.45)
UCD	ProShares Ultra Bloomberg Commodity	0.93%	11/28/2008	$11.50M	Leveraged Broad Market	-30.54%	-26.80%	-26.14%	(0.42)
DJP	iPath Bloomberg Commodity Index Total Return ETN	0.70%	10/31/2006	$837.44M	Broad Market	-17.78%	-15.04%	-14.14%	(0.42)
DTO	DB Crude Oil Double Short ETN	0.75%	6/30/2008	$62.68M	Inverse Energy Crude Oil	+97.73%	+40.86%	+22.65%	0.35
BOM	DB Base Metals Double Short ETN	0.75%	6/30/2008	$3.67M	Inverse Industrial Metals	+39.17%	+13.88%	+14.27%	(0.02)
AGA	DB Agriculture Double Short ETN	0.75%	6/30/2008	$1.07M	Inverse Agriculture	-23.54%	+22.35%	+8.93%	0.06
DWTI	VelocityShares 3X Inverse Crude Oil ETN	1.35%	2/29/2012	$380.15M	Inverse Energy Crude Oil	+15.84%	+16.89%	+0.00%	0.17
DGLD	VelocityShares 3X Inverse Gold ETN	1.35%	10/31/2011	$22.97M	Inverse Precious Metals Gold	-19.19%	-3.95%	+0.00%	0.10
DSLV	VelocityShares 3X Inverse Silver ETN	1.65%	10/31/2011	$24.42M	Inverse Precious Metals Silver	-20.58%	-11.52%	+0.00%	0.00
DZZ	DB Gold Double Short ETN	0.75%	2/29/2008	$49.98M	Inverse Precious Metals Gold	-12.53%	+0.00%	-0.74%	(0.38)
DGAZ	VelocityShares 3X Inverse Natural Gas ETN	1.65%	2/29/2012	$58.83M	Inverse Energy Natural Gas	+98.62%	+9.28%	+0.00%	(0.19)
SZO	DB Crude Oil Short ETN	0.75%	6/30/2008	$10.01M	Inverse Energy Crude Oil	+41.62%	+22.85%	+14.27%	0.48
DNO	United States Short Oil Fund LP	0.70%	9/30/2009	$20.18M	Inverse Energy Crude Oil	+34.56%	+20.70%	+12.71%	0.16
KOLD	ProShares UltraShort Bloomberg Natural Gas	1.28%	10/31/2011	$13.75M	Inverse Energy Natural Gas	+84.74%	+31.02%	+0.00%	0.33
BOS	DB Base Metals Short ETN	0.75%	6/30/2008	$1.73M	Inverse Industrial Metals	+17.71%	+9.23%	+7.94%	0.05
ADZ	DB Agriculture Short ETN	0.75%	4/30/2008	$890.68K	Inverse Agriculture	-8.81%	+12.20%	+5.79%	0.06
SCO	ProShares UltraShort Bloomberg Crude Oil	0.86%	11/28/2008	$224.12M	Inverse Energy Crude Oil	+46.58%	+26.67%	+13.99%	(0.11)
DGZ	DB Gold Short ETN	0.75%	2/29/2008	$23.29M	Inverse Precious Metals Gold	-5.26%	+1.12%	+1.09%	(0.33)
ZSL	ProShares UltraShort Silver	0.91%	12/31/2008	$44.15M	Inverse Precious Metals Silver	-7.95%	+2.85%	+2.09%	(0.62)
GLL	ProShares UltraShort Gold	0.90%	12/31/2008	$69.73M	Inverse Precious Metals Gold	-13.19%	-0.91%	-1.96%	(0.51)
DGP	DB Gold Double Long ETN	0.75%	2/29/2008	$139.32M	Leveraged Precious Metals Gold	+3.29%	-11.39%	-13.11%	(0.03)
UGL	ProShares Ultra Gold	0.90%	12/31/2008	$89.63M	Leveraged Precious Metals Gold	-0.70%	-12.40%	-13.98%	0.07
UGLD	VelocityShares 3X Long Gold ETN	1.35%	10/31/2011	$73.91M	Leveraged Precious Metals Gold	-3.64%	-21.37%	+0.00%	(0.57)
DAG	DB Agriculture Double Long ETN	0.75%	4/30/2008	$9.99M	Leveraged Agriculture	-29.12%	-25.47%	-22.43%	(0.42)
USLV	VelocityShares 3X Long Silver ETN	1.65%	10/31/2011	$151.26M	Leveraged Precious Metals Silver	-31.66%	-45.93%	+0.00%	(0.65)
AGQ	ProShares Ultra Silver	0.88%	12/31/2008	$294.26M	Leveraged Precious Metals Silver	-16.28%	-26.74%	-39.08%	(0.11)
BDD	DB Base Metals Double Long ETN	0.75%	6/30/2008	$2.95M	Leveraged Industrial Metals	-30.43%	-18.08%	-23.69%	(0.42)
UGAZ	VelocityShares 3X Long Natural Gas ETN	1.65%	2/29/2012	$282.58M	Leveraged Energy Natural Gas	-89.65%	-80.49%	+0.00%	(0.79)
UWTI	VelocityShares 3x Long Crude Oil ETN	1.35%	2/29/2012	$1.05B	Leveraged Energy Crude Oil	-89.72%	-75.83%	+0.00%	(0.82)
UCO	ProShares Ultra Bloomberg Crude Oil	0.87%	11/28/2008	$930.28M	Leveraged Energy Crude Oil	-72.88%	-54.64%	-44.80%	(0.62)
BOIL	ProShares Ultra Bloomberg Natural Gas	1.24%	10/31/2011	$26.50M	Leveraged Energy Natural Gas	-71.30%	-59.95%	+0.00%	(0.94)
GEUR	AdvisorShares Gartman Gold/EURO ETF	0.65%	2/28/2014	$16.97M	Precious Metals Gold	+0.75%	+0.00%	+0.00%	0.27
GYEN	AdvisorShares Gartman Gold/Yen ETF	0.65%	2/28/2014	$25.91M	Precious Metals Gold	-9.63%	+0.00%	+0.00%	(0.08)
OUNZ	VanEck Merk Gold	0.40%	5/30/2014	$110.12M	Precious Metals Gold	+1.81%	+0.00%	+0.00%	(0.11)
CHOC	iPath Pure Beta Cocoa ETN	0.85%	4/29/2011	$8.14M	Agriculture Cocoa	-1.37%	+11.19%	-1.66%	(0.16)
NIB	iPath Bloomberg Cocoa Subindex Total Return ETN	0.70%	6/30/2008	$15.09M	Agriculture Cocoa	-4.71%	+9.49%	-1.96%	(0.13)
UBC	ETRACS UBS Bloomberg CMCI Livestock Total Return ETN	0.65%	4/30/2008	$4.48M	Agriculture Livestock	-13.73%	+1.66%	-1.04%	(0.27)
SOYB	Teucrium Soybean Fund	3.41%	9/30/2011	$12.72M	Agriculture Soybeans	+8.08%	-6.77%	+0.00%	(0.11)
USAG	United States Agriculture Index Fund	2.59%	5/31/2012	$2.05M	Agriculture	-0.50%	-5.91%	+0.00%	(0.17)
LSTK	iPath Pure Beta Livestock ETN	0.85%	4/29/2011	$3.17M	Agriculture Livestock	-15.52%	+2.41%	-1.29%	(0.24)
LD	iPath Bloomberg Lead Subindex Total Return ETN	0.70%	6/30/2008	$664.65K	Industrial Metals Lead	-7.16%	-9.97%	-9.74%	(0.07)
FUE	Elements MLCX Biofuels Index-Total Return ETN	0.75%	2/29/2008	$1.70M	Agriculture Grains	+9.62%	-6.62%	-6.08%	(0.12)
COW	iPath Bloomberg Livestock Subindex Total Return ETN	0.75%	11/30/2007	$11.56M	Agriculture Livestock	-15.24%	-2.94%	-3.14%	(0.60)
IAU	iShares Gold Trust	0.25%	12/30/2005	$7.87B	Precious Metals Gold	+1.82%	-4.51%	-4.80%	0.37
WEET	iPath Pure Beta Grains ETN	0.85%	4/29/2011	$875.33K	Agriculture Grains	+3.90%	-8.68%	-5.94%	(0.26)
GLD	SPDR Gold Trust	0.40%	12/30/2005	$34.29B	Precious Metals Gold	+1.72%	-4.66%	-4.96%	0.36
SGOL	ETFS Physical Swiss Gold Shares	0.39%	9/30/2009	$975.23M	Precious Metals Gold	+1.74%	-4.62%	-4.95%	0.13
PALL	ETFS Physical Palladium Shares	0.60%	1/29/2010	$164.86M	Precious Metals Palladium	-29.97%	-10.44%	-7.31%	0.13
TONS	WisdomTree Coal Fund	0.99%	2/27/2015	$888.79K	Energy Coal	-12.54%	+0.00%	+0.00%	(1.05)
UBG	ETRACS UBS Bloomberg CMCI Gold Total Return ETN	0.30%	4/30/2008	$12.37M	Precious Metals Gold	+1.63%	-5.11%	-5.45%	0.13
DGL	PowerShares DB Gold Fund DB Gold Inx Fund	0.62%	1/31/2007	$232.52M	Precious Metals Gold	+1.40%	-5.42%	-5.91%	0.23
BDG	DB Base Metals Long ETN	0.75%	6/30/2008	$566.60K	Industrial Metals	-13.64%	-1.61%	-10.91%	(0.23)

** data shown is through 5/31/2016*

*** SHARPE ratio time frame is from inception date or from 5/31/20011.*

Table 4 (contd.)

Comparison of Performance: LACI vs commodity related ETF's, ETN's, and Mutual Funds

Ticker	Fund Name	Expense Ratio	Inception Date	AUM	Segment	1 Year	3 Year (Annualized)	5 Year (Annualized)	SHARPE ratio **
JJG	iPath Bloomberg Grains Subindex Total Return ETN	0.75%	10/31/2007	$117.29M	Agriculture Grains	+4.15%	-13.34%	-8.98%	(0.33)
GRU	Elements MLCX Grains Index-Total Return ETN	0.75%	2/29/2008	$4.58M	Agriculture Grains	+3.64%	-13.50%	-9.58%	(0.35)
AGF	DB Agriculture Long ETN	0.75%	4/29/2011	$1.85M	Agriculture	+5.28%	-8.79%	-10.62%	(0.35)
DIRT	iPath Pure Beta Agriculture ETN	0.85%	4/29/2011	$1.59M	Agriculture	+5.32%	-9.40%	-7.18%	(0.36)
JJT	iPath Bloomberg Tin Subindex Total Return ETN	0.75%	6/30/2008	$2.12M	Industrial Metals Tin	+2.01%	-9.09%	-11.28%	(0.37)
LEDD	iPath Pure Beta Lead ETN	0.85%	4/29/2011	$3.18M	Industrial Metals Lead	-17.16%	-9.63%	-7.94%	(0.37)
BLNG	iPath Pure Beta Precious Metals ETN	0.85%	4/29/2011	$1.76M	Precious Metals	+5.94%	-5.05%	-7.03%	(0.37)
CUPM	iPath Pure Beta Copper ETN	0.85%	4/29/2011	$1.72M	Industrial Metals Copper	-23.94%	-13.41%	-12.95%	(0.38)
FUD	ETRACS UBS Bloomberg CMCI Food Total Return ETN	0.65%	4/30/2008	$19.26M	Agriculture	+7.59%	-7.45%	-6.44%	(0.38)
UAG	ETRACS UBS Bloomberg CMCI Agriculture Total Return ETN	0.65%	4/30/2008	$14.99M	Agriculture	+11.19%	-8.77%	-7.60%	(0.39)
SLVO	Credit Suisse X-Links Silver Shares Covered Call ETN	0.65%	4/30/2013	$32.95M	Precious Metals Silver	-6.40%	-9.89%	+0.00%	(0.39)
JJP	iPath Bloomberg Precious Metals Subindex Total Return ETN	0.75%	6/30/2008	$7.12M	Precious Metals	-1.11%	-7.30%	-9.14%	(0.41)
DBP	PowerShares DB Precious Metals Fund	0.62%	1/31/2007	$179.62M	Precious Metals	-0.27%	-6.82%	-8.44%	(0.43)
JJA	iPath Bloomberg Agriculture Subindex Total Return ETN	0.75%	10/31/2007	$20.05M	Agriculture	+8.30%	-9.75%	-9.36%	(0.43)
UGA	United States Gasoline Fund LP	0.68%	2/29/2008	$91.19M	Energy Gasoline	-31.13%	-20.06%	-11.18%	(0.43)
SGG	iPath Bloomberg Sugar Subindex Total Return ETN	0.75%	6/30/2008	$56.12M	Agriculture Sugar	+31.17%	-12.45%	-11.88%	(0.45)
GRN	iPath Global Carbon ETN	0.75%	6/30/2008	$1.56M	Energy Carbon Credits	-28.32%	+12.76%	-25.66%	(0.46)
GLTR	ETFS Physical Precious Metals Basket Shares	0.60%	10/29/2010	$176.59M	Precious Metals	-3.69%	-7.59%	-9.95%	(0.45)
SGAR	iPath Pure Beta Sugar ETN	0.85%	4/29/2011	$1.05M	Agriculture Sugar	+33.04%	-9.24%	-10.88%	(0.47)
GLDI	Credit Suisse X-Links Gold Shares Covered Call ETN	0.65%	1/31/2013	$39.75M	Precious Metals Gold	-1.14%	-5.17%	+0.00%	(0.47)
CORN	Teucrium Corn Fund	2.89%	6/30/2010	$65.15M	Agriculture Corn	-2.17%	-19.52%	-13.34%	(0.51)
PTM	ETRACS UBS Bloomberg CMCI Platinum Total Return ETN	0.65%	5/30/2008	$21.47M	Precious Metals Platinum	-14.00%	-14.12%	-13.44%	(0.52)
FOIL	iPath Pure Beta Aluminum ETN	0.85%	4/29/2011	$1.28M	Industrial Metals Aluminum	-12.05%	-9.95%	-13.93%	(0.52)
USV	ETRACS UBS Bloomberg CMCI Silver Total Return ETN	0.40%	4/30/2008	$8.80M	Precious Metals Silver	-5.47%	-11.86%	-17.27%	(0.53)
SIVR	ETFS Physical Silver Shares	0.30%	7/31/2009	$300.32M	Precious Metals Silver	-4.68%	-10.64%	-16.39%	(0.52)
SLV	iShares Silver Trust	0.50%	4/28/2006	$5.44B	Precious Metals Silver	-5.00%	-10.85%	-16.58%	(0.56)
TAGS	Teucrium Agricultural Fund	0.50%	3/30/2012	$1.40M	Agriculture	+3.45%	-12.20%	+0.00%	(0.55)
NINI	iPath Pure Beta Nickel ETN	0.85%	4/29/2011	$724.34K	Industrial Metals Nickel	-34.62%	-18.64%	-20.74%	(0.55)
DBS	PowerShares DB Silver Fund	0.44%	1/31/2007	$20.51M	Precious Metals Silver	-5.53%	-12.28%	-17.84%	(0.57)
UHN	United States Diesel-Heating Oil Fund LP	0.70%	4/30/2008	$3.96M	Energy Heating Oil	-32.61%	-18.96%	-14.39%	(0.55)
BAL	iPath Bloomberg Cotton Subindex Total Return ETN	0.75%	6/30/2008	$15.34M	Agriculture Cotton	-2.86%	-5.04%	-13.50%	(0.56)
PPLT	ETFS Physical Platinum Shares	0.60%	1/29/2010	$491.79M	Precious Metals Platinum	-12.60%	-12.92%	-12.33%	(0.56)
PGM	iPath Bloomberg Platinum Subindex Total Return ETN	0.75%	6/30/2008	$7.36M	Precious Metals Platinum	-13.45%	-14.49%	-13.73%	(0.57)
RJA	Elements Rogers International Commodity Index-Agriculture TR ETN	0.75%	10/31/2007	$108.57M	Agriculture	-0.76%	-8.88%	-9.56%	(0.59)
CTNN	iPath Pure Beta Cotton ETN	0.85%	4/29/2011	$1.26M	Agriculture Cotton	-5.42%	-6.76%	-13.01%	(0.59)
BNO	United States Brent Oil Fund LP	0.94%	6/30/2010	$131.69M	Energy Crude Oil	-36.14%	-26.61%	-17.26%	(0.59)
RJZ	Elements Rogers International Commodity Index-Metals Total Return ETN	0.75%	10/31/2007	$8.32M	Broad Market Metals	-10.30%	-9.23%	-11.17%	(0.62)
HEVY	iPath Pure Beta Industrial Metals ETN	0.85%	4/29/2011	$434.68K	Industrial Metals	-15.17%	-10.10%	-12.01%	(0.62)
DBA	PowerShares DB Agriculture Fund	0.75%	1/31/2007	$820.70M	Agriculture	-2.38%	-5.80%	-8.22%	(0.66)
USL	United States 12 Month Oil Fund LP	0.92%	12/31/2007	$120.64M	Energy Crude Oil	-28.88%	-20.84%	-16.26%	(0.65)
DBB	PowerShares DB Base Metals Fund	0.66%	1/31/2007	$130.17M	Industrial Metals	-17.93%	-10.04%	-12.23%	(0.68)
CPER	United States Copper Index Fund	3.24%	11/30/2011	$2.74M	Industrial Metals Copper	-24.76%	-15.03%	+0.00%	(0.65)
OLEM	iPath Pure Beta Crude Oil ETN	0.85%	4/29/2011	$29.26M	Energy Crude Oil	-28.83%	-22.95%	-17.61%	(0.66)
JJC	iPath Bloomberg Copper Subindex Total Return ETN	0.75%	10/31/2007	$33.70M	Industrial Metals Copper	-26.98%	-16.11%	-15.45%	(0.68)
WEAT	Teucrium Wheat Fund	3.35%	9/30/2011	$29.26M	Agriculture Wheat	-12.53%	-22.63%	+0.00%	(0.69)
JO	iPath Bloomberg Coffee Subindex Total Return ETN	0.75%	6/30/2008	$139.59M	Agriculture Coffee	-15.26%	-12.33%	-23.35%	(0.72)
RJN	Elements Rogers International Commodity Index-Energy TR ETN	0.75%	10/31/2007	$12.52M	Energy	-35.96%	-25.59%	-18.70%	(0.73)
CAFE	iPath Pure Beta Coffee ETN	0.85%	4/29/2011	$5.14M	Agriculture Coffee	-12.18%	-10.19%	-21.81%	(0.72)
JJN	iPath Bloomberg Nickel Subindex Total Return ETN	0.75%	10/31/2007	$8.08M	Industrial Metals Nickel	-38.96%	-20.76%	-22.02%	(0.73)
USO	United States Oil Fund LP	0.74%	4/28/2006	$3.54B	Energy Crude Oil	-41.56%	-28.60%	-21.77%	(0.75)
GRWN	iPath Pure Beta Softs ETN	0.85%	4/29/2011	$745.56K	Agriculture Softs	+3.31%	-9.73%	-13.58%	(0.72)
DBE	PowerShares DB Energy Fund	0.62%	1/31/2007	$105.01M	Energy	-30.06%	-23.36%	-16.87%	(0.75)
ONG	iPath Pure Beta Energy ETN	0.85%	4/29/2011	$1.07M	Energy	-44.40%	-27.56%	-20.00%	(0.73)
CANE	Teucrium Sugar Fund	1.79%	9/30/2011	$6.20M	Agriculture Sugar	+22.34%	-8.70%	+0.00%	(0.73)
UBN	ETRACS UBS Bloomberg CMCI Energy Total Return ETN	0.65%	4/30/2008	$3.11M	Energy	-28.35%	-22.27%	-16.54%	(0.74)
OIL	iPath S&P GSCI Crude Oil Total Return ETN	0.75%	8/31/2006	$867.43M	Energy Crude Oil	-47.94%	-32.89%	-24.82%	(0.78)
UBM	ETRACS UBS Bloomberg CMCI Industrial Metals Total Return ETN	0.65%	4/30/2008	$3.11M	Industrial Metals	-23.03%	-13.32%	-13.93%	(0.76)
OLO	DB Crude Oil Long ETN	0.75%	6/30/2008	$12.01M	Energy Crude Oil	-37.72%	-28.18%	-20.83%	(0.76)
JJS	iPath Bloomberg Softs Subindex Total Return ETN	0.75%	6/30/2008	$975.18K	Agriculture Softs	+8.40%	-9.27%	-15.37%	(0.76)
JJM	iPath Bloomberg Industrial Metals Subindex Total Return ETN	0.75%	12/31/2007	$5.35M	Industrial Metals	-23.50%	-13.80%	-15.44%	(0.77)
DBO	PowerShares DB Oil Fund	0.62%	1/31/2007	$478.80M	Energy Crude Oil	-38.53%	-29.04%	-21.67%	(0.82)
JJU	iPath Bloomberg Aluminum Subindex Total Return ETN	0.75%	6/30/2008	$2.11M	Industrial Metals Aluminum	-16.92%	-13.75%	-17.05%	(0.86)
GAZ	iPath Bloomberg Natural Gas Subindex Total Return ETN	0.75%	10/31/2007	$4.31M	Energy Natural Gas	-67.50%	-47.85%	-45.50%	(0.87)
UNG	United States Natural Gas Fund LP	1.01%	4/30/2007	$526.93M	Energy Natural Gas	-46.46%	-31.37%	-31.93%	(0.93)
JJE	iPath Bloomberg Energy Subindex Total Return ETN	0.75%	10/31/2007	$1.35M	Energy	-43.01%	-30.03%	-24.55%	(0.96)
DCNG	iPath Seasonal Natural Gas ETN	0.85%	4/29/2011	$587.46K	Energy Natural Gas	-18.22%	-18.64%	-20.12%	(0.96)
UNL	United States 12 Month Natural Gas Fund LP	0.86%	1/29/2010	$12.82M	Energy Natural Gas	-22.38%	-20.45%	-22.68%	(0.97)

** data shown is through 5/31/2016*

*** SHARPE ratio time frame is from inception date or from 5/31/20011.*

Appendix A

Description of Maki's Cointegration Testing with Structural Breaks

We briefly describe Maki (2012)'s cointegration test (MB*k*). This methodology is offers several improvements over previous methods for testing cointegration. First, the MB*k* method allows for unknown number of structural breaks in the return generating process (Bai and Perron (2003)). Second, the unit roots tests are conducted assuming structural breaks (Kapetanios (2005)), assuming that that the number of breaks of the cointegrating vector is smaller than or equal to the maximum number of breaks set a priori. Third, Maki's methodology is not computationally intensive. Finally, based on the Monte Carlo simulations, Maki (2012) advocates that MB*k* test performs better than the tests of Gregory and Hansen (1996a) and Hatemi-J (2008) when the cointegration relationship has more than three breaks or persistent Markov switching shifts.

Maki (2012) proposes four regression models in order to test cointegration allowing for multiple structural breaks:

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta' \mathbf{x}_t + u_t \quad (1)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta' \mathbf{x}_t + \sum_{i=1}^{k} \beta_i' \mathbf{x}_t D_{i,t} + u_t \quad (2)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \gamma t + \beta' \mathbf{x}_t + \sum_{i=1}^{k} \beta_i' \mathbf{x}_t D_{i,t} + u_t \quad (3)$$

$$y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \gamma t + \sum_{i=1}^{k} \gamma_i t D_{i,t} + \beta' \mathbf{x}_t + \sum_{i=1}^{k} \beta_i' \mathbf{x}_t D_{i,t} + u_t \quad (4)$$

where $t = 1, 2, ..., T$. y_t (dependent) and $x_t = (x_{1t}, ..., x_{mt})'$ (regressors) indicate observable integrated of order one ($I(1)$) variables, and u_t is the equilibrium error. $D_{i,t}$ takes value of 1 if $t > T_{Bi}$ $(i = 1, ..., k)$ and of 0 otherwise, where k is the maximum number of breaks and T_{Bi} indicates the time period of break. The first model, level shift model, captures changes in the level (μ) only. Second model accounts for structural breaks both in the level (μ) and regressors (x), called regime shift model. Third model is regime shift model with trend (γ); and the fourth model constitutes structural breaks of levels, trends, and regressors.

MB*k* with the null hypothesis of no cointegration against the alternative hypothesis of cointegration with i breaks ($i \leq k$) are implemented in the following steps (Maki, 2012:2012): First, we estimate one of the four regression models and then save the residuals. Second, we compute the t-statistics in order to test for unit root in the residuals, obtained from the estimated model, for all possible periods of the break. Let the set of all possible partitions and the t-statistics be represented by T_i^a and τ_ρ^i, respectively. Third, the i^{th} breakpoint ($\hat{bp}_i$) is chosen by minimizing the sum of squared residuals (SSR) for the estimated model. Here, the breakpoint i can be indicated as $\hat{bp}_i = \arg\min_{T_i^a} SSR_i$. Finally, we adopt $\tau_{\min}^k$ as the test statistic (MB*k*), that is, the minimum t-statistic over the set $\tau_\rho^k = \tau_1 \cup \tau_2 \cup ... \cup \tau_k$.