The Impact of Index and Swap Funds in Commodity Futures Markets

by

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Executive Summary

Investment in long-only commodity index funds soared over the last five years. Some refer to this surge and its attendant impacts as the "financialization" of commodity futures markets. In view of the scale of this investment—in the hundreds of billions of dollars—it is not surprising that a world-wide debate has ensued about the role of index funds in commodity futures markets. A flurry of studies has been completed recently in an attempt to sort out which side of the debate is correct. Some of these studies find evidence that commodity index funds have impacted commodity futures prices. However, the data and methods used in these studies are subject to a number of important criticisms that limits the degree of confidence one can place in the results. Several studies find little evidence of a relationship between index fund positions and movements in commodity futures prices and this constitutes a rejection of the first theoretical requirement for speculative impacts. The most recent evidence in crude oil markets also indicates a rejection the second theoretical requirement for speculative impacts—a zero or near zero price elasticity of demand.

Our empirical analysis relies on two related data sets compiled by the U.S. Commodity Futures Trading Commission (CFTC). Data from the *Supplemental Commodity Index Trader* (CIT) report shows the positions held by index funds in 12 grain, livestock, and soft commodity futures markets. The *Disaggregated Commitments of Traders* (DCOT) report provides details as to the positions held by swap dealers—which are assumed to reflect index-type investments—in 22 commodity futures markets that include metals and energy. The two data sets are used to test if index funds impact either returns or price volatility across 14 grain, livestock, soft and energy futures markets. The sample period begins on June 13, 2006 and ends on December 29, 2009, yielding a total of 186 weekly observations for analysis.

Bivariate Granger causality regressions provide no convincing evidence that positions held by index traders or swap dealers impact market returns. Except for a few instances in individual markets, Granger-style causality tests fail to reject the null hypothesis that that trader positions do not lead market returns. These results tilt the weight of the evidence even further in favor of the argument that index funds did *not* cause a bubble in commodity futures prices. The evidence in our study is strongest for the agricultural futures markets because the data on index trader positions are measured with reasonable accuracy. The evidence is weaker in the two energy markets studied because of considerable uncertainty about the degree to which the available data actually reflect index trader positions in these markets. Perhaps the most surprising result is the consistent tendency for increasing index fund positions to be associated with *declining* market volatility. This result is contrary to popular notions about the market impact of index funds, but is not so surprising in light of the traditional problem in commodity futures markets of the *inadequacy* of speculation.

The policy implication of the available evidence on the market impact of commodity index funds is straightforward: current regulatory proposals to limit speculation—especially on the part of index funds—are not justified and likely will do more harm than good. In particular, limiting the participation of index fund investors would rob the commodity futures markets of an important

source of liquidity and risk-absorption capacity at a time when both are in high demand. More ominously, tighter position limits on speculation in commodity futures markets combined with the removal of hedge exemptions could force commodity index funds into cash markets, where truly chaotic results could follow. The net result is that moves to tighten regulations on index funds are likely to make commodity futures markets less efficient mechanisms for transferring risk from parties who don't want to bear it to those that do, creating added costs that ultimately are passed back to producers in the form of lower prices and to consumers as higher prices.

JEL Codes: G13, Q11, Q13

Key Words: Commitment of Traders, index funds, commodity futures markets, speculation

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1. Introduction

The financial industry has developed new products that allow institutions and individuals to invest in commodities through long-only index funds, over-the-counter (OTC) swap agreements, exchange traded funds, and other structured products.[1] Regardless of form, these instruments have a common goal—provide investors with buy-side exposure to returns from a particular index of commodity prices. The S&P GSCI Index™ is one of the most widely tracked indexes and generally considered an industry benchmark. It is computed as a production-weighted average of the prices from 24 commodity futures markets. While the index is well-diversified in terms of number of markets and sectors, energy markets are relatively heavily weighted.[2]

Several influential studies in recent years purport that investors can capture substantial risk premiums and reduce portfolio risk through relatively modest investment in long-only commodity index funds (e.g., Gorton and Rouwenhorst, 2006). Combined with the availability of deep and liquid exchange-traded futures contracts, this evidence fueled a dramatic surge in index fund investment. Domanski and Heath (2007) describe this surge and its attendant impacts as the "financialization" of commodity futures markets. Given the size and scope of the index fund boom it should probably not come as a surprise that a world-wide debate has ensued about

[1] This highlights the variety of investment instruments that are typically lumped under the heading "commodity index fund." Institutions may enter directly into over-the-counter (OTC) contracts with swap dealers to gain the desired exposure to returns from a particular index of commodity prices. Some firms also offer investment funds whose returns are tied to a commodity index. Exchange-traded funds (ETFs) and structured notes (ETNs) have also been developed that track commodity indexes. ETFs and ETNs trade on securities exchanges in the same manner as stocks on individual companies. In the remainder of this report, the term "commodity index fund" or "index fund" is used generically to refer to all of the varied long-only commodity investment instruments.

[2] Engelke and Yuen (2008) and Stoll and Whaley (2009) provide excellent overviews of the development and mechanics of commodity index investments.

the role of index funds in commodity markets. The debate has important ramifications from a policy and regulatory perspective as well as practical implications for the efficient pricing of commodity products.

There are a few indisputable facts about commodity futures markets over 2006-2008, the period of most controversy regarding the impact of money inflows from commodity index funds. First, inflows into long-only commodity index funds did increase rather substantially throughout 2006-2008 (see Figure 1). According to the most widely-quoted industry source (Barclays) index fund investment increased from $90 billion at the beginning of 2006 to a peak of just under $200 billion at the end of 2007. Second, commodity prices also increased rather dramatically—71% as measured by the Commodity Research Bureau index—from January 2006 through June of 2008 (see Figure 2). Third, prices declined almost equally dramatically from June 2008 through early 2009 (see Figure 2). These facts are clear and not in dispute. It's the interpretation of the interaction among these facts that is so controversial.

On one side, some hedge fund managers, commodity end-users, and policy-makers assert that speculative buying by index funds on such a wide scale created a "bubble," with the result that commodity futures prices far exceeded fundamental values during the boom (e.g., Masters, 2008; Masters and White, 2008; USS/PSI, 2009). The following statement by Fadel Gheit, Managing Director and Senior Oil Analyst for Oppenheimer & Co. Inc., before the Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce, U.S. House of Representatives in June 2008 is representative of this viewpoint:

> "I firmly believe that the current record oil price in excess of $135 per barrel is inflated. I believe, based on supply and demand fundamentals, crude oil prices should not be above $60 per barrel…There were no unexpected changes in industry fundamentals in the last 12 months, when crude oil prices were below $65 per barrel. I cannot think of any reason that explains the run-up in crude oil price, beside excessive speculation."

This and other similar sentiments have led to new regulatory initiatives to limit speculative positions in commodity futures markets (Acworth 2009a,b).

On the other side, a number of economists have expressed skepticism about the bubble argument, citing logical inconsistencies in bubble arguments and contrary facts (e.g., Krugman, 2008; Pirrong, 2008; Sanders and Irwin, 2008; Smith, 2009). These economists argue that commodity markets were driven by fundamental factors that pushed prices higher. The main factors cited as driving the price of crude oil include strong demand from China, India, and other developing nations, a leveling out of crude oil production, a decrease in the responsiveness of consumers to price increases, and U.S. monetary policy (Hamilton, 2009a; Kilian and Murphy, 2010). In the grain markets, the diversion of row crops to biofuel production and weather-related production shortfalls are cited, as well as demand growth from developing nations and U.S. monetary policy (Trostle, 2008; Wright, 2009).

Even though almost two years have passed since the 2008 peak in commodity prices, the controversy surrounding index funds continues unabated. For instance, Michael Masters Portfolio Manager for Masters Capital Management, LLC, made the following statement at a recent CFTC hearing:

> "Passive speculators are an invasive species that will continue to damage the markets until they are eradicated. The CFTC must address the issue of passive speculation; it will not go away on its own. When passive speculators are eliminated from the markets, then most consumable commodities derivatives markets will no longer be excessively speculative, and their intended functions will be restored." Masters (2010, p.5)

As another example, Joachim von Braun, director of Germany's Center for Development Research, made these comments at a recent conference:

> "We have good analysis that speculation played a role in 2007 and 2008…Speculation did matter and it did amplify, that debate can be put to rest. These spikes are not a nuisance, they kill. They've killed thousands of people." (Ruitenberg, 2010)

With rhetoric like this it is no surprise that policymakers have been under substantial pressure to tighten regulations on speculators (re: index funds). We contend that a detailed and dispassionate synthesis of the arguments and latest research will be of great utility to market observers and policymakers given the raucous and strident nature of much of the debate. Policymakers need to have a full picture of the current state of scientific knowledge on the impact of commodity index funds before imposing costly new regulations.

The objectives of this research report are two-fold. The first is to provide a thorough review and synthesis of the arguments concerning the impact of index funds in commodity futures markets as well as an assessment of the latest research on the subject. The second is to provide new empirical evidence on the market impact of commodity index funds. Our empirical analysis relies on two related data sets compiled by the U.S. Commodity Futures Trading Commission (CFTC). Data from the *Supplemental Commodity Index Trader* (CIT) report shows the positions held by index funds in 12 grain, livestock, and soft commodity futures markets. The *Disaggregated Commitments of Traders* (DCOT) report provides details as to the positions held by swap dealers—which are assumed to reflect index-type investments—in 22 commodity futures markets that include metals and energy. The two data sets are used to test if index funds impact either returns or price volatility across 14 grain, livestock, soft and energy futures markets.

Bivariate Granger causality tests are used to investigate lead-lag dynamics between index fund positions and futures returns (price changes) or price volatility in each commodity futures market. In addition, a new systems approach to testing lead-lag dynamics is introduced and applied. The systems approach improves the power of statistical tests by taking into account the contemporaneous correlation of model residuals across markets and allows a test of the overall impact of index funds across markets.

The first section of the report provides an overview of economists' attempts to define a price bubble, the conditions in which one might occur, and reviews and synthesizes the arguments and evidence for and against a price bubble in commodity futures markets in recent years. The next section presents the available data on index fund positions along with a descriptive analysis of trends and statistical characteristics. The following section presents empirical procedures and price impact test results. The last section summarizes the empirical test results and draws implications regarding policy and regulatory measures.

2. The Arguments and Evidence to Date

2.1. What is a Bubble?

Brunnermeier (2008, p.578) defines a bubble as, "…asset prices that exceed an asset's fundamental value because current owners believe that they can resell the asset at an even higher price in the future." While this definition is slightly different from some of the more classical references (see O'Hara, 2008), it is largely consistent with popular notions. That is, a bubble is characterized by two elements. First, prices are "inexplicable based on fundamentals" (Garber, 2000, p. 4). Second, the trading motive itself is unrelated to fundamental values, as market participants believe they can always sell to a greater fool. The end result is the classic market action identified (*ex post*) as "…an upward price movement over an extended range that then implodes" (Kindleberger, 1996, p. 13).

Theoretical conditions that can support a bubble are many and varied; however, regardless of the modeling approach there are usually some reoccurring constraints that also work to prevent bubbles. For instance, rational bubbles under both symmetric and asymmetric information assumptions cannot arise in securities with finite horizons and unlimited short-selling. Likewise, bubbles are unlikely in commodities with close substitutes. However, limited arbitrage can lead to asset bubbles as rational traders restrain their arbitrage positions due to both fundamental risk and noise trader risk (DeLong et al., 1990). Noise trader risk stems from the unpredictability of noise trader positions and the assumption that assets are infinitely-lived. If noise traders do not behave in an unpredictable fashion or if the asset has a finite life, then noise traders cannot "create their own space." Heterogeneous beliefs among traders can also create theoretical bubbles; but, again, only when short-sales are constrained (Brunnermeier, 2008).

From the perspective of theory, commodity futures contracts are not the type of market one would predict as likely to be susceptible to bubble-like activity. Specifically, futures contracts are finite-horizon instruments with virtually no constraints on short-sales, which eliminates the potential for a bubble in nearly all theoretical models. In addition, long-lasting bubbles are less likely in markets where deviations from fundamental value can be readily arbitraged away (easily "poached" in the terminology of Patel, Zeckhauser, and Hendricks (1991)). There are few limitations to arbitrage in commodity futures markets because the cost of trading is relatively low, trades can be executed literally by the second, and prices are highly transparent. This stands in contrast to markets where arbitrage is more difficult, such as residential housing. The low likelihood of bubbles is also supported by numerous empirical studies on the efficiency of price discovery in commodity futures markets (e.g., Zulauf and Irwin, 1998; Carter, 1999). Finally, experimental evidence—which largely supports the existence of bubbles—shows that the introduction of a futures market lessens the incidence of bubbles in experimental markets (Forsythe, Palfrey, and Plott, 1984; Noussair and Tucker, 2006).

While bubbles (at least in the sense defined by economists) may have been relatively scarce in U.S. financial history, they have definitely become more in vogue during the last decade, with proclaimed bubbles in Internet stocks and residential housing as well as suspected bubbles in U.S. Treasury securities and commodity futures prices. Indeed, while academics are typically careful in their use of the term "bubble," the popular press has seemingly adopted the term for any market that makes a large advance quickly and then an equally hasty retreat. However, as discussed above, the theoretical conditions required for a price bubble are somewhat restrictive and are not easily applied to many market situations. Indeed, the occurrence of a well-publicized bubble tends to lessen the coincidence and magnitude of subsequent occurrences (Brunnermeier, 2008).

2.2. It Was a Bubble

Masters (2008) has interwoven investment and price data to create the most widely-cited bubble argument, painting the activity of index funds as akin to the infamous Hunt brothers' cornering of the silver market. He blames the rapid increase in overall commodity prices from 2006-2008 on institutional investors' embrace of commodities as an investable asset class. As noted in the introduction, it is clear that considerable dollars flowed into commodity index funds over this time period. However, the evidence provided by Masters is limited to anecdotes and the temporal correlation between money flows and prices. Masters and White (2008) recommend specific regulatory steps to address the alleged problems created by index fund investment in commodity futures markets, including the re-establishment of speculative position limits for all speculators in all commodity futures markets and the elimination or severe restriction of index speculation.[3]

A similar position was taken by the U.S. Senate Permanent Subcommittee on Investigations in its examination of the performance of the Chicago Board of Trade's (CBOT) wheat futures contract (USS/PSI, 2009, p. 2):

> "This Report finds that there is significant and persuasive evidence to conclude that these commodity index traders, in the aggregate, were one of the major causes of "unwarranted changes"—here, increases—in the price of wheat futures contracts relative to the price of wheat in the cash market. The resulting unusual, persistent and large disparities between wheat futures and cash prices impaired the ability of participants in the grain market to use the futures market to price their crops and hedge their price risks over time, and therefore constituted an undue burden on interstate commerce. Accordingly, the Report finds that the activities of commodity index traders, in the aggregate, constituted "excessive speculation" in the wheat market under the Commodity Exchange Act."

Based on these findings, the Subcommittee recommended the: 1) phase out of existing position limit waivers for index traders in wheat, 2) if necessary, imposition of additional restrictions on index traders, such as a position limit of 5,000 contracts per trader, 3) investigation of index trading in other agricultural markets, and 4) strengthening of data collection on index trading in non-agricultural markets.

One of the limitations of the bubble argument made by Masters and others is that the link between money inflows from index funds and commodity futures prices is not well developed. This allows critics to assert that bubble proponents make the classical statistical mistake of

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[3] There is some dispute as to whether index fund positions should be considered speculative or not. Stoll and Whaley (2009) argue that commodity index investments are not speculation because the investments are long-only, passive, fully-collateralized, and motivated by portfolio diversification benefits. This is an accurate description of the way commodity index investments are developed and marketed to investors. However, what is not known with any degree of certainty is the actual motivation of investors in commodity index funds. While the funds are long-only they can be used by investors (institutional or individual) as a trading instrument, investing money in index funds when they believe expected returns are high and then withdrawing money when expected returns are low or negative. Evidence on the diversity of motivations is found in a recent survey of commodity investors by Barclays Capital. In response to the question, "Why do you invest in commodities," 43% of respondents said portfolio diversification, 31% said absolute returns, 9% said inflation hedge, and 17% said emerging market growth (Norrish, 2010). This survey suggests there is a significant speculative component in commodity index fund positions.

confusing correlation with causation. In other words, simply observing that large investment has flowed into the long side of commodity futures markets at the same time that prices have risen substantially does not necessarily prove anything without a logical and causal link between the two. One attempt to establish this linkage is found in Petzel's (2009, pp. 8-9) testimony at a CFTC hearing on position limits in energy futures markets:

> "Seasoned observers of commodity markets know that as non-commercial participants enter a market, the opposite side is usually taken by a short-term liquidity provider, but the ultimate counterparty is likely to be a commercial. In the case of commodity index buyers, evidence suggests that the sellers are not typically other investors or leveraged speculators. Instead, they are owners of the physical commodity who are willing to sell into the futures market and either deliver at expiration or roll their hedge forward if the spread allows them to profit from continued storage. This activity is effectively creating "synthetic" long positions in the commodity for the index investor, matched against real inventories held by the shorts. We have seen high spot prices along with large inventories and strong positive carry relationships as a result of the expanded index activity over the last few years."

In essence, Petzel argues that unleveraged futures positions of index funds are effectively synthetic long positions in physical commodities, and hence represent new demand. If the magnitude of index fund demand is large enough relative to physically-constrained supplies in the short-run, prices and price volatility can increase sharply. The bottom-line is that the size of index fund investment is "too big" for the current size of commodity futures markets.

Other observers seem to work under the null hypothesis that index funds have an undesirable and somewhat unexplainable impact on market prices. For instance, Robles, Torero, and von Braun (2009, p.2) simply claim that "Changes in supply and demand fundamentals cannot fully explain the recent drastic increase in food prices." Similarly, a study by the Agricultural and Food Policy Center (2008, p.32) declares that the "…large influx of money into the markets, typically long positions, has pushed commodities to extremely high levels" and also shows a graphical depiction of investment funds in the S&P GSCI Index™. Alternatively, some analysts have tended to use speculation as a catch-all for those market movements that cannot otherwise be easily explained. For example, Childs and Kiawu (2009, p.1) report that "the primary cause of the rise in prices for these commodities from 2006-2008 was rising global incomes, dietary changes, increased use of biofuels, tight grain supplies, and increased participation in futures markets by nontraditional investors."

Given the prominence of the issue in current economic policy debates and the intensity of beliefs held by bubble proponents (no doubt sincere), it may come as a surprise that there is a limited body of rigorous evidence to support the bubble position. We review here two studies that provide some statistical evidence of a bubble occurring in recent commodity futures price movements. We also review two other studies, one that compares predictions from a theoretical model to actual market outcomes and another that finds a significant relationship between commodity price movements and index investment but does not interpret this as evidence of a bubble. These studies were selected because they contain formal statistical tests or analysis of specific market data to assess whether index fund trading impacted commodity futures price movements during the recent price spike.[4]

Hamilton (2009b) develops a theoretical model of price determination in the crude oil market and then asks whether predictions drawn from the model are consistent with a speculative impact in the crude oil market over 2007-2008. He begins by noting that the key challenge is reconciling a speculative (bubble) in crude oil prices with changes in the physical quantities of crude oil. A standard argument is that a price bubble will inevitably lead to a rise in inventories as the quantity supplied at the "bubble price" exceeds the quantity demanded (Krugman, 2008). Hamilton's theoretical model is based on a profit maximizing representative refiner of crude oil into gasoline, an exogenous supply of crude oil, and a demand function for gasoline. Solution of

[4] We make no claim to having uncovered any and all studies that may contain such evidence. This is certainly an active area of current economic research around the world and additional studies will undoubtedly emerge.

the model for the optimal inventory management condition of the refiner leads to important predictions about price behavior and inventories. In particular if the demand for gasoline is perfectly inelastic and speculators are able to force up the forward price of crude oil for non-fundamental reasons this will force the current (spot) price of crude oil to rise in order to maintain equilibrium in the storage market. However, if the elasticity of gasoline demand is less than perfectly inelastic the standard result follows that inventories must also increase. He also notes that if the price elasticity is small, but not zero as several studies of gasoline demand suggest then the buildup in inventories could be subtle and it might take some time before mispricing in the futures market is detected and corrected.

Hamilton considers the conditions in the crude oil market during 2007-2008 relative to the model predictions and concludes:

> "With hindsight, it is hard to deny that the price rose too high in July 2008, and that this miscalculation was influenced in part by the flow of investment dollars into commodity futures contracts. It is worth emphasizing, however, that the two key ingredients needed to make such a story coherent—a low price elasticity of demand, and the failure of physical production to increases—are the same key elements of a fundamentals-based explanation of the same phenomenon. I therefore conclude that these two factors, rather than speculation per se, should be construed as the primary cause of the oil shock of 2007-08." (p. 240)

While this conclusion is not definitive, Hamilton's theoretical work is important because it focuses attention on the conditions that must occur for index fund speculation to lead to bubble impacts in a storable commodity market such as crude oil. First, index fund positions in the futures market must have a positive relationship to the level of futures prices. Otherwise there is no mechanism for the flow of index fund investment to initiate the bubble that starts in the futures market. Second, the elasticity of demand for the commodity (or the final product, gasoline in the case of crude oil) must be zero or very close to zero. Third, inventories of the commodity must not increase. Each of these is a testable proposition.

Gilbert (2009) examines price behavior in crude oil futures, three metals futures, and three agricultural futures over 2006-2008. He first tests directly for bubbles using a new time-series test developed by Phillips, Wu, and Yu (2009). Tests using daily data indicate bubbles in seven of the nine markets but for a surprisingly small percentage of the days in the sample. For instance, statistically significant bubbles are present in only 21 out of 753 days for crude oil futures, or less than three percent of the entire 2006-2008 sample period. Not surprisingly, the "bubble days" are concentrated entirely near the peak of prices in the summer of 2008. Gilbert also constructs a quantum index of commodity index fund investment in futures markets using positions of index traders in the 12 agricultural markets reported in the CFTC's weekly *CIT* report. Granger causality tests are used to establish whether lagged changes in the quantum index help to forecast returns (price changes) in each of the seven markets included in the analysis.[5] The results indicate a significant relationship between index fund trading activity and returns in three of the seven markets: crude oil, aluminum, and copper. He estimates the maximum impact of index funds in these markets to be a price increase of 15%.

Gilbert's results seem to point towards a non-negligible impact of index funds on price in at least some commodity futures markets, and therefore, confirmation of Hamilton's first theoretical requirement for bubble impacts in these markets. There are reasons for skepticism, however. The first is that rejection of the null hypothesis in a Granger "causality" test should be viewed as only a preliminary indication of a true casual relationship. Newbold (1982) provides a classic discussion of the problems that can arise in rejecting the null in such tests. His most relevant points in the present context are: i) economic agents' expectations about the future can make it appear there is a relationship between two variables when in fact there is none, ii) the

[5] Granger causality tests will be explained in more detail in a later section on the empirical methods employed for the present study.

apparent causal relationship between two variables may actually be the result of a third variable omitted from the analysis, and iii) without an explicit theory that establishes a link between two variables the meaning of a non-zero correlation is unclear. In view of these problems, we concur with Newbold's advice that, "…one should remain skeptical about any conclusions reached until they have been verified through examination of post-sample forecasts." (p. 714)

A second reason for skepticism is the nature and application of Gilbert's index of commodity index fund activity. His quantum index is a weighted-average of index trader positions in agricultural futures markets (as reported in the CFTC's *CIT* report). The weights are nearby futures prices on the first date of his sample. Gilbert then applies this index not only to three of the agricultural markets included in the index but also to the energy and metal markets not included in the index. This is problematic on at least three levels. First, applying the same index to each of the agricultural markets ignores information on the variation of index fund positions that is specific to each of these markets. Index fund positions even in closely related markets like corn, soybeans, and wheat are less than perfectly correlated because the weights placed on these markets varies across commodity indexes, re-balancing policies differ across index funds, and inflows and outflows from the various commodity index investment instruments do not move in lockstep.[6] Second, applying an index constructed from the 12 *CIT* agricultural markets to the energy and metals markets is justified only if one believes the pattern of index trader positions in agricultural markets closely mirrors the pattern in energy and metals markets. This point is reinforced by noting that Gilbert did not find evidence of a relationship between index fund activity in agricultural markets, upon which the index is based, but did find evidence in energy and metals markets, which are not included in the index. It is certainly possible that the positive findings are simply spurious. Third, the price weights for the index are

[6] See Table A5 in the Appendix to this report for empirical confirmation of this point for the *CIT* data.

arbitrary. There is no *a priori* reason to select any particular date for computing the price weights and different dates may result in indexes with different characteristics because the distribution of prices across markets changes over time.

Einloth (2009) devises a test of bubbles based on the joint behavior of convenience yields and prices in a storable commodity futures market. Convenience yield is the flow of benefits that accrue to inventory holders from having stocks of the commodity on hand. For example, the costs of shutting down an oil refinery due to the unavailability of crude oil may be very high; thus, the operator may hold some stocks as insurance against this possibility. The basic theory of storage predicts that low inventories lead to a rising commodity price and an increasing marginal convenience yield. So, the combination of a falling marginal convenience yield and a rising futures price is a violation of this theory. Einloth uses this condition as a test for speculative impact in crude oil futures markets. He finds that marginal convenience yields (derived from spreads between futures prices) rose for most of the increase in crude oil futures prices up to \$100/barrel, but fell as crude oil increased from about \$100 to \$140/barrel. While this indicates that speculation may have played a role near the peak in crude oil prices the technique cannot attribute this to a particular group of market participants, such as index funds.

There is no doubt that Einloth is correct in arguing that the basic theory of storable commodity markets rules out the combination of falling marginal convenience yield and rising futures prices. However, more advanced versions of the theory show that this combination can occur, not due to speculative impacts, but because market participants are reacting rationally to a particular set of incentives. Specifically, Routledge, Seppi, and Spatt (2000) develop an equilibrium model of price behavior for a storable commodity where the spot commodity has an embedded timing option that is a function of endogenous inventory and exogenous supply and demand shocks. In this model, falling marginal convenience yield can be observed at the same time that futures prices are rising if the value of the timing option is large enough. This could occur if the probability of a sequence of large positive demand shocks or negative supply shocks increases substantially. The implication is that Einloth's test may not identify bubbles, but instead unusual periods where the timing option derived from holding inventories is increasing at the same time that price is also rising.

Tang and Xiong (2010) do not test for bubbles in commodity futures prices. Instead, they begin by arguing that commodity markets were not fully integrated with financial markets prior to the development of commodity index investments and that the "…increasing presence of index investors in commodities markets precipitated a fundamental process of financialization amongst the commodities markets, through which commodity prices now become exposed to shocks to financial markets and to other commodities." (p. 2) Statistical tests confirm that the correlation of commodity futures returns (as measured by the S&P GSCI Index™) with stock, bond, and dollar returns increased significantly starting in 2004. Other tests show that correlations with shocks to macro variables including crude oil prices have tended to increase more for commodities included in major indexes compared to commodities not included in the indexes. Tang and Xiong conclude that index investment has impacted commodity futures prices; however, the impact is the outcome of the process of tying commodity futures and financial markets together rather than a bubble.

While certainly an intriguing alternative argument, there are significant problems with the conclusions reached by Tang and Xiong. First, there is well-known evidence that commodity futures markets have been integrated with financial markets for decades. Bjornson and Carter (1997) examine seven commodity futures markets over 1969-1994 and find that expected returns are lower during times of high interest rates, expected inflation, and economic growth, leading them to conclude that commodities provide a natural hedge against business cycles. Second, it is difficult to interpret the increased correlations reported by Tang and Xiong without controlling for other fundamental factors affecting commodity futures prices. Ai, Chatrath, and Song (2006) show how failure to condition on market fundamentals can lead to incorrect inferences in such tests. Furthermore, there is an obvious channel that can explain at least part of the increased correlation of commodity futures returns with macro shocks. Biofuels policies in the U.S., E.U., and other countries are responsible for linking together agricultural commodities with crude oil and related energy markets in recent years (e.g., de Gorter and Just, 2010). The link is most direct for corn through the ethanol market and soybeans through the biodiesel market, but the links extend through soft commodities like cotton due to allocation of land and livestock through feed costs. These linkages have emerged simultaneously with the rise of index funds, which confounds a conclusion that increased correlations were solely induced by 'financialization.'

The studies reviewed in this section are rigorous, interesting, and make a valuable contribution to the debate about the market impact of commodity index funds. Results in these studies also negate the argument that *no* evidence exists of a relationship between index fund trading and movements in commodity futures prices. The data and methods used in some of these studies are subject to a number of important criticisms that limits the degree of confidence one can place in the statistical test results. Hamilton's (2009b) study, while not definitive in terms of empirics, is the most important of this group because his theoretical model shows the conditions that must occur for index fund speculation to lead to bubble impacts in a storable commodity market such as crude oil.

2.3. It Was Not a Bubble

A number of economists have expressed skepticism about the bubble argument (e.g., Krugman, 2008; Pirrong, 2008; Sanders and Irwin, 2008; Smith, 2009). These economists cite several contrary facts and argue that commodity markets were driven by fundamental factors that pushed prices higher. Irwin, Sanders, and Merrin (2009) present a useful summary of the counter arguments made by these economists. Specifically, they note three logical inconsistencies in the arguments made by bubble proponents as well as five instances where the bubble story is not consistent with observed facts. Here, we review these points as well as some additional arguments made by both pro- and anti-bubble proponents in response.

The first possible logical inconsistency within the bubble argument is equating money inflows to commodity futures markets with demand. With equally informed market participants, there is no limit to the number of futures contracts that can be created at a given price level. Index fund buying in this situation is no more "new demand" than the corresponding selling is "new supply." Combined with the observation that commodity futures markets are zero-sum games, this implies that money flows in and of themselves do not necessarily impact prices. Prices will only change if new information emerges that causes market participants to revise their estimates of physical supply and/or demand.

What happens when market participants are not equally informed? When this is the case, it is rational for participants to condition demands on both their own information and information about other participants' demands that can be inferred ("inverted") from the futures price (Grossman, 1986). The trades of uninformed participants can impact prices in this more realistic model if informed traders mistakenly believe that trades by uninformed participants reflect valuable information. Hence, it is possible that other traders in commodity futures markets interpreted the large order flow of index funds on the long side of the market as a reflection of valuable private information about commodity price prospects, which would have had the effect of driving prices higher as these traders revised their own demands upward. Of course, this would have required a large number of sophisticated and experienced traders in commodity futures markets to reach a conclusion that index fund investors possessed valuable information that they themselves did not possess.

The second possible logical inconsistency is to argue that index fund investors artificially raised both futures and cash commodity prices when they only participated in futures markets. These contracts are financial transactions that only rarely involve the actual delivery of physical commodities. In order to impact the equilibrium price of commodities in the cash market, index investors would have to take delivery and/or buy quantities in the cash market and hold these inventories off the market. Index investors are purely involved in a financial transaction using futures markets; they do not engage in the purchase or hoarding of the cash commodity and any causal linkages between their futures market activity and cash prices is unclear at best (Headey and Fan, 2008). Hence, it is wrong to draw a parallel (e.g., Masters and White, 2008) between index fund positions and past efforts to "corner" commodity markets, such as the Hunt brother's effort to manipulate the silver market in 1979-80.

A third possible logical inconsistency is a blanket categorization of speculators, in particular, index funds, as wrongdoers and hedgers as victims of their actions. In reality, the "bad guy" is not so easily identified since hedgers sometimes speculate and some speculators also hedge. For example, large commercial firms may have valuable information gleaned from their far-flung cash market operations and trade based on that information.[7] The following passage from a recent article on Cargill, Inc. (Davis, 2009) nicely illustrates the point:

> Wearing multiple hats gives Cargill an unusually detailed view of the industries it bets on, as well as the ability to trade on its knowledge in ways few others can match. Cargill freely acknowledges it strives to profit from that information. "When we do a good job of assimilating all those seemingly unrelated facts," says Greg Page, Cargill's chief executive, in a rare interview, "it provides us an opportunity to make money...without necessarily having to make directional trades, i.e., outguess the weather, outguess individual governments."

The implication is that the interplay between varied market participants is more complex than a standard textbook description of pure risk-avoiding hedgers and pure risk-seeking speculators. The reality is that market dynamics are ever changing and it can be difficult to understand the motivations and market implications of trading, especially in real-time.

In addition to the logical inconsistencies, there are several ways the bubble story is not consistent with the observed facts. First, as Krugman (2008) asserts, if a bubble raises the market price of a storable commodity above the true equilibrium price, then stocks of that commodity should increase (much like a government imposed price floor can create a surplus). Stocks were declining, not building, in most commodity markets over 2006-2008, which is inconsistent with the depiction of a price bubble in these markets.[8]

Second, the relationship between prices and inventories for storable commodities is highly convex (Wright, 2009). This means that a given reduction in the quantity of inventories

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[7] Hieronymus (1977) argued that large commercial firms dominated commodity futures markets and speculators tended to be at a disadvantage. Based on his theoretical analysis, Grossman (1986, p. S140) asserted, "…it should come as no surprise if a study of trading profit finds that traders representing large firms involved in the spot commodity (i.e., commercial traders) make large trading profits on futures markets." In the classic empirical study on this subject, Hartzmark (1987) showed that large commercial firms in six of seven futures markets make substantial profits on their futures trades.

[8] As discussed in the previous section, Hamilton (2009b) shows that the buildup in inventories due to a price bubble could be so small that it is not easily detected if the elasticity of demand for a storable commodity is very small or zero.

due a supply and/or demand shock will have a much larger impact on price when inventories are already low compared to when inventories are high. It also implies that relatively minor reductions in inventories can result in very large increases in price when inventories are small. Smith (2009) argues that it is plausible that a series of seemingly small supply disruptions in the spring and summer of 2008 could explain the large increase in crude oil prices during this time period in view of the extreme convexity of the pricing function for crude oil in the short-run.

Third, theoretical models that show uninformed or noise traders impacting market prices rely on the unpredictable trading patterns of these traders to make arbitrage risky (De Long et al., 1990). Because the arbitrage—needed to drive prices to fundamental value—is not riskless, noise traders can drive a wedge between market prices and fundamental values. Importantly, index fund buying is very predictable. That is, index funds widely publish their portfolio (market) weights and roll-over periods. Thus, it seems highly unlikely that other large and rational traders would hesitate to trade against an index fund if they were driving prices away from fundamental values.[9]

Fourth, if index fund buying drove commodity prices higher then markets without index fund investment should not have seen prices advance. Again, the observed facts are inconsistent

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[9] The problems created by the mechanical trading of index funds is well-illustrated by a recent story (Meyer and Cui, 2009) on problems experienced by the U.S. Oil Fund L.P., the largest exchange-traded crude oil index fund, when rolling positions from one nearby contract to the next:

> "It's like taking candy from a baby," said Nauman Barakat, senior vice president at Macquarie Futures USA in New York. That candy comes out of the returns of investors in the fund. Take Feb. 6, when U.S. Oil moved its 80,000 contracts from March to April at the end of the trading day, selling the March contract and buying April. Because U.S. Oil publishes the dates of its roll in advance, traders knew the switch was coming. At 2 p.m., 30 minutes before closing, trading in New York Mercantile Exchange oil contracts soared, and the price of the April contract narrowed to $4 more than the March contract. Within minutes, that gap had widened and closed at $5.98, according to trading records. As the fund's managers were about to roll their contracts, "suddenly came the awfully extreme move," said one manager. Some said the move is a sign that big trades were placed ahead of U.S. Oil's roll. The price move instantly made it more expensive for U.S. Oil to roll into the April contract and cost the fund about $120 million more than it would have a day earlier."

with this notion. Irwin, Sanders, and Merrin (2009) show that markets without index fund participation (fluid milk and rice futures) and commodities without futures markets (apples and edible beans) also showed price increases over the 2006-2008 period. Stoll and Whaley (2009) report that returns for CBOT wheat, Kansas City Board of Trade (KCBOT) wheat, and Minneapolis Grain Exchange (MGEX) wheat are all highly positively correlated over 2006-2009, yet only CBOT wheat is used heavily by index investors. In a similar fashion, Commodity Exchange (COMEX) gold, COMEX silver, New York Mercantile (NYMEX) palladium, and NYMEX platinum futures prices are highly correlated over the same time period but only gold and silver are included in popular commodity indexes. Headey and Fan (2008) cite the rapid increases in the prices for “non-financialized” commodities such as rubber, onions, and iron ore as evidence that rapid price inflation occurred in commodities without futures markets. While certainly instructive, the limits of these kinds of comparisons also need to be kept in mind. Bubble proponents have pointed out that commodity markets selected for the development of futures contracts may be more naturally volatile than those commodities without futures markets.

Fifth, speculation was not excessive when correctly compared to hedging demands. The statistics on long-only index fund trading reported in the media and discussed at hearings tend to view speculation in a vacuum—focusing on absolute position size and activity. Working (1960) argued that speculation must be gauged relative to hedging needs. In particular, speculation can only be considered ‘excessive’ relative to the level of hedging activity in the market. Utilizing Working’s speculative “T-index,” Sanders, Irwin, and Merrin (2010) demonstrate that the level of speculation in nine agricultural futures markets from 2006-2008 (adjusting for index fund positions) was not excessive. Indeed, the levels of speculation in all markets examined were within the realm of historical norms. Across most markets, the rise in index buying was more than offset by commercial (hedger) selling. Buyuksahin and Harris (2009) use daily data from the CFTC's internal large trader database to show that Working's T-index in the crude oil futures market increased in parallel with crude oil prices over 2004-2009 but the peak of the index was still well within historical norms. Till (2009) reports similar results for crude oil, heating oil, and gasoline futures over 2006-2009 using recently available data in the CFTC's *DCOT* report.

The sixth observable fact revolves around the impact of index funds across markets. A priori, there is no reason to expect index funds to have a differential impact across markets given similar position sizes. That is, if index funds can inflate prices, they should have a uniform impact across markets for the same relative position size. It is therefore difficult to rationalize why index fund speculation would impact one market but not another. Further, one would expect markets with the highest concentration of index fund positions to show the largest price increases. Irwin, Sanders, and Merrin (2009) find just the opposite when comparing grain and livestock futures markets. The highest concentration of index fund positions was often in livestock markets, which had smallest price increases through the spring of 2008. This is difficult to reconcile with the assertion that index buying represents demand.

Several studies have been completed recently that do not find compelling evidence of a speculative impact in commodity futures price movements during recent years, and therefore, corroborate the previous no-bubble arguments.[10] We review here five studies that directly test for a relationship between index fund trading and commodity futures price movements, and hence, represent tests of Hamilton's (2009b) first theoretical requirement for speculative impacts

[10] As before, we make no claim to presenting an exhaustive review of all such studies.

in commodity futures markets.[11] That is, index fund positions in commodity futures markets should be positively related to the level of futures prices. We also review one recent study that estimates the price elasticity of crude oil (and gasoline) demand, which represents a test of Hamilton's second theoretical requirement for speculative impacts—zero or near zero price elasticity of demand. As in the previous section, these studies were selected because they contain formal statistical tests or analysis of specific market data to assess whether index fund trading impacted commodity price movements during the recent price spike.

Stoll and Whaley (2009) use data from the CFTC's weekly *CIT* report to conduct a variety of tests of the null hypothesis that index fund trading does not cause commodity futures price changes. They examine all 12 grain, livestock, and soft commodity markets included in the *CIT* report over January 2006-July 2009: corn, soybeans, soybean oil, CBOT wheat, KCBOT wheat, feeder cattle, lean hogs, live cattle, cocoa, cotton, coffee, and sugar. Granger causality tests between weekly futures returns (price changes) and weekly index fund investment flows reject the null of no causality in only 1 out of the 12 markets. They also examine the contemporaneous relationship between returns and changes in index fund investment flows after controlling for changes in other speculator investment flows. A significant contemporaneous relationship is found for only 2 of the 12 markets. Stoll and Whaley conclude that commodity index investing does not cause futures prices to change.[12]

[11] Like several of the studies reviewed here, Robles, Torero, and von Braun (2009) utilize weekly *CIT* data to conduct Granger causality tests between index positions and futures returns. Despite the overwhelmingly negative results of their statistical analysis, they nonetheless assert there is sufficient evidence of the damaging role of speculation to warrant the creation of a new international organization to counteract this market failure. See Wright (2009) for further discussion.

[12] Stoll and Whaley also conduct two "roll" tests to determine whether the shifting of index fund positions between contracts impacts the relative price movements of the nearest- and next-nearest futures contracts. This analysis is conducted for six commodities tracked in the *CIT* report as well as crude oil. These tests find evidence of a significant relative price impact only in crude oil. Overall, they conclude that the rolling of index fund positions in commodity futures markets has little futures price impact.

Stoll and Whaley's analysis is thorough and appears to generate a strong rejection of the hypothesis that index trading impacted commodity futures price movments. However, the strength of their findings is diminished by the use of dollar flows to measure index fund participation. Dollar flow measures are computed by multiplying each week's net position (in contracts) by the price of the futures contract nearest-to-expiration to obtain a total notional value and then differencing the total from week-to-week. As discussed previously, the crux of the argument is whether or not index fund investment represents new effective demand in commodity futures markets. "Demand" is a quantity concept in the present debate and this suggests index fund market participation should be denominated in quantity terms, such as the change in number of contracts held. The issue is not whether the increase in index fund positions represents, say, an increase in notional value of $20 million versus $30 million but the increase in the number of contracts underlying the change in notional value.[13]

The use of dollar flow measures is problematic not only from a conceptual standpoint but also statistically. In particular, such measures may reduce the power of statistical tests to reject the null hypothesis of no causality. The reasons are twofold. First, dollar flows impound into activity measures both the variability of prices and positions, and since the variability in prices likely swamps the variability in positions, a much noisier measure of index funds activity results. Second, dollar flows join together two variables— price and positions—that likely have quite different time-series characteristics. Price should be close to a random walk (serially uncorrelated) while index fund positions are likely highly persistent (serially correlated) due to the unchanging long-only nature of the underlying investment instruments. Joining the two

[13] Of course, the price impact of a given trade may differ depending on the initial price level. For storable commodities, this reflects the highly convex relationship between price and inventory levels (see Wright, 2009). The key is that the relationship is based on quantity of inventories not the notional value of inventories.

variables together in dollar flow form may mask a true underlying relationship between index fund positions and subsequent futures price changes.

Buyuksahin and Harris (2009) use daily data from the CFTC's internal large trader database over July 2000-March 2009 to conduct a variety of tests of the relation between crude oil futures prices and positions of various types of traders. Granger causality tests provide no statistical evidence that position changes (number of contracts) by any trader group systematically precede price changes. This result holds for the entire sample period and when the sample is broken into two parts: July 2000-June 2004 and July 2004-March 2009. Buyuksahin and Harris assume that swap dealer positions are linked to commodity index investing, and hence, the results for swap dealers can be interpreted as a failure to reject the null hypothesis of no relation between crude oil futures prices and index fund trading. A key question, then, is whether it is reasonable to assume that swap dealer positions in crude oil futures are generally linked to commodity index investments. Calculations found in CFTC (2008b) suggest that no more than 50 percent of swap dealer positions can be considered index fund positions. Hence, the measurement error inherent in using swap dealer positions to represent index fund positions in crude oil futures may be substantial and limit the conclusions that can be drawn with this data.

Sanders and Irwin (2010a) investigate the relationship between index fund trading and futures prices using a cross-sectional regression approach. They note that modeling market returns with traditional time-series approaches, such as those used by Stoll and Whaley (2009) and Buyuksahin and Harris (2009), can be criticized for a lack of statistical power due to the considerable volatility of the dependent variable (returns). An alternative approach to testing for speculative impact that may have greater power is the cross-sectional approach of Fama and

MacBeth (1973), which is widely used to test for factors impacting asset prices. A bubble scenario suggests that returns on a given date should be positively correlated with relative position size (market share) of index funds across commodity futures markets. Sanders and Irwin examine all 12 grain, livestock, and soft commodity markets included in the *CIT* report over January 2006-Decmeber 2008 and test if the relative size of index fund positions (net long *CIT* contracts/total long market open interest) is correlated to subsequent returns across the 12 markets. The null hypothesis of no cross-sectional impact is only rejected in one of twelve models, leading the authors to conclude that the evidence linking index fund positions and returns across commodity futures markets is scant.

Sanders and Irwin (2010b) investigate the price impact of index fund trading in four grain futures markets. Weekly data compiled by the CFTC for corn, soybeans, CBOT wheat, and KCBT wheat futures contracts over January 2004-August 2009 is used in the analysis. This sample period is advantageous for two reasons. First, previous research suggests that the buildup in index positions was most rapid during 2004-2005 (Sanders, Irwin, and Merrin 2008), and hence, this period is most likely to show the impact of index traders, if any. Second, the additional two years of data increases the sample size of weekly observations considerably compared to the publically available *CIT* data, which should improve the power of time-series statistical tests. The data confirm that there was a fairly dramatic and massive build-up in index fund positions in the four grain markets examined. For instance, the number of contracts held by index funds in the CBOT wheat contract increased nearly fourfold from 2004 to 2006. However, the build-up in index contracts and the peak level of index holdings pre-dates the 2007-2008 increase in grain futures prices for which they are blamed. This observation alone casts doubt on the hypothesis that index speculation drove the 2007-2008 increase in grain futures prices. Both

Granger causality tests and long-horizon regression tests generally fail to reject the null hypothesis that commodity index positions (net long *CIT* contracts or net long *CIT* contracts/total long market open interest) have no impact on futures prices. Overall, the authors conclude that data trends and statistical test results are not consistent with the widely-touted bubble theory. A limitation of this study is that tests are restricted to four grain futures markets. A key question is whether the results generalize to a broader set of commodity futures markets.

Aulerich, Irwin, and Garcia (2010) conduct a comprehensive time-series test of the impact of index fund trading in commodity futures markets. Studies such as those by Stoll and Whaley (2009) and Sanders and Irwin (2010b) are based on *CIT* data from the CFTC that is available only on a weekly basis and aggregated across all contracts. This may limit the power of statistical tests because positions cannot be tracked over higher frequency daily intervals, changes in prices and positions cannot be matched precisely to contract maturity months, and aggregate positions mask very large changes in positions for specific contracts during the roll period of index funds. Daily positions of index traders in 12 commodity futures markets over January 2004-July 2008 period are drawn from the internal large trader reporting system used by the CFTC. Index trader positions are disaggregated by contract maturity. Over 1,100 daily observations are available for analysis in each of the 12 markets. The only other comparable study is Buyuksahin and Harris (2009), who use data from the CFTC's large trader database to test the relationship between positions of various trader groups and price changes in the crude oil futures market.

Several Granger causality-type tests are performed by Aulerich, Irwin, and Garcia on nearby and first deferred contracts separately and for the 2004-2005 and 2006-2008 periods. There is no evidence that index positions (net long *CIT* contracts or net long *CIT* contracts/total long market open interest) had a greater impact on returns during 2004-2005, when their positions were growing most rapidly. A total of 31 out of 192 estimated cumulative impacts (16%) are statistically significant, barely more than what one would expect based on randomness. The signs of the relatively few significant coefficients are as likely to be negative as positive and the magnitudes of the economic effects are very small. These test results provide negligible evidence that index traders impact commodity future returns. Some evidence is found that price volatility has been influenced by the presence of index traders in several markets, but only using one of the measures of index position changes. These effects appear to be small in economic magnitude, except in several traditionally less liquid markets.

Kilian and Murphy (2010) develop a structural VAR (vector autoregression) model of the global market for crude oil that explicitly allows for shocks to the speculative demand for crude oil as well as shocks to the flow demand and flow supply. Their median estimate of the short-run price elasticity of demand for crude oil is -0.41, about seven times higher than typical conjectures in the recent literature. In a related fashion, their median estimate of the short-run price elasticity of demand for gasoline is -0.20, several times higher than previous estimates. This leads Kilian and Murphy to reject Hamilton's second theoretical requirement for a speculative impact in crude oil (zero or near-zero short-run price elasticity). The model estimates also imply that the surge in crude oil prices over 2003-2008 was caused by fluctuations in the flow demand for oil driven by the global business cycle. As with all structural modeling exercises, Kilian and Murphy's structural VAR model depends on a fairly lengthy list of identifying restrictions. The impact of these restrictions on elasticity estimates will undoubtedly be the subject of further research.

Overall, the results of the studies reviewed in this section provide a sound rejection of Hamilton's first theoretical requirement for speculative impacts in commodity futures markets. No compelling evidence is found of a relationship between index fund trading and commodity futures price changes. These results are consistent with the majority of academic evidence pertaining to speculation and price behavior (e.g., Petzel, 1981; Sanders, Boris, and Manfredo, 2004; Bryant, Bessler, and Haigh, 2006; Sanders, Irwin, and Merrin, 2009). The most recently available evidence in crude oil markets also indicates a rejection of Hamilton's (2009b) second theoretical requirement for speculative impacts—a zero or near zero price elasticity of demand.

2.4. Summary

The debate about the role of index funds in commodity futures markets has generated a plethora of arguments and analysis. Those who believe index funds were responsible for a bubble in commodity futures prices make what seems like an obvious argument—the sheer size of index investment overwhelmed the normal functioning of these markets. Those who do not believe index funds were behind the run-up in commodity futures prices point out logical inconsistencies in the bubble argument and several contradictory facts.

Not surprisingly, a flurry of studies has been completed recently in an attempt to sort out which side of the debate is correct. Some of these studies find evidence that commodity index funds have impacted commodity futures prices (Gilbert, 2009; Einloth, 2009; Tang and Xiong, 2010). However, the data and methods used in these studies are subject to a number of important criticisms that limits the degree of confidence one can place in the results. A number of studies find little evidence of a relationship between index fund positions and movements in commodity futures prices (Stoll and Whaley, 2009; Buyuksahin and Harris, 2009; Sanders and Irwin, 2010a, 2010b; Aulerich, Irwin, and Garcia, 2010) and this constitutes a rejection of Hamilton's (2009b) first theoretical requirement for speculative impacts. The most recent evidence in crude oil markets (Kilian and Murphy, 2010) also indicates a rejection of Hamilton's second theoretical requirement for speculative impacts—a zero or near zero price elasticity of demand. In sum, the weight of the evidence at this point in time clearly tilts in favor of the argument that index funds did not cause a bubble in commodity futures prices.

There is still a need for further research on the market impact of commodity index funds. The first reason is ongoing concerns about the power of time-series statistical tests used in the studies that fail to find evidence of a relationship between index fund positions and movements in commodity futures prices. The time-series tests may lack statistical power to reject the null hypothesis because the dependent variable—the change in futures price—is extremely volatile. The second reason is that direct tests of the relationship between index fund positions and price movements in energy futures markets have been hampered by the lack of publically-available data on positions of index funds in these markets. In the empirical analysis that follows, we attempt to address both of these deficiencies. We do not address issues associated with structural models and elasticity estimates.

3. Commitments of Traders Reports

3.1. Traditional COT Report

The traditional *COT* report provides a breakdown of each Tuesday's open interest for markets in which 20 or more traders hold positions equal to or above the reporting levels established by the CFTC.[14] Two versions of the report are released. The *Futures-Only*

[14] See Hieronymus (1971), McDonald and Freund (1983), and Fenton and Martinaitas (2005) for extensive discussions of the history and evolution of the *COT* Report. CFTC (2008b) contains a detailed explanation of current *COT* reports.

Commitments of Traders report includes futures market open interest only. The *Futures-and-Options-Combined Commitments of Traders* report aggregates futures market open interest and "delta-weighted" options market open interest. Open interest for a given market is aggregated across all contract expiration months in both versions of the report. The weekly reports are released every Friday at 3:30 p.m. Eastern Standard Time.

Reports also are available in both a short and long format. The short report shows open interest separately by reportable and non-reportable positions. For reportable positions, additional data are provided for commercial and non-commercial holdings, spreading, changes from the previous report, percentage of open interest by category, and number of traders. The long report, in addition to the information in the short report, also groups the data by crop year, where appropriate, and shows the concentration of positions held by the largest four and eight traders.

Using the information in the short report, non-commercial open interest is divided into long, short, and spreading; whereas, commercial and non-reporting open interest is simply divided into long or short. The following relation explains how the market's total open interest (TOI) is disaggregated:

(1) $$\underbrace{[NCL + NCS + 2(NCSP)] + [CL + CS]}_{\text{Reporting}} + \underbrace{[NRL + NRS]}_{\text{Non-Reporting}} = 2(TOI),$$

where, NCL, NCS, and NCSP are non-commercial long, short, and spreading positions, respectively. CL (CS) represents commercial long (short) positions, and NRL (NRS) are long (short) positions held by non-reporting traders. Reporting and non-reporting positions must sum to the market's total open interest (TOI), and the number of longs must equal the number of short positions.

A frequent complaint about the traditional *COT* data is that the trader designations may be somewhat inaccurate (e.g., Peck, 1982; Ederington and Lee, 2002). For speculators, there may be an incentive to self-classify their activity as commercial hedging to circumvent speculative position limits. In contrast, there is little incentive for traders to desire the non-commercial designation. So, it is often thought that the non-commercial category is a relatively pure subset of reporting speculators (Sanders, Boris, and Manfredo, 2004). The available evidence about the composition of non-reporting traders is dated (Working, 1960; Larson, 1961; Rutledge, 1977-78; Peck, 1982), so little is known about this group other than their position size is less than reporting levels. The data set is further limited because it is purely a classification system and provides no insight as to the motives that drive actual trading decisions (see Williams, 2001).

While there may be some incentive for reporting traders to desire the commercial designation, the CFTC implements a fairly rigorous process—including statements of cash positions in the underlying commodity—to ensure that commercial traders have an underlying risk associated with their futures positions. However, in recent years industry participants began to suspect that these data were "contaminated" because the underlying risk for many reporting commercials were not positions in the actual physical commodity (CFTC, 2006a,b). Rather, the reporting commercials were banks and other swap dealers hedging risk associated with over-the-counter (OTC) derivative positions.

For example, a commercial bank may take the opposite side of a long commodity swap position desired by a customer.[15] The commercial bank, not wanting the market risk, will then

[15] According to Hull (2000, p. 121), "A swap is an agreement between two companies to exchange cash flows in the future. The agreement defines the dates when the cash flows are to be paid and way that they are to be calculated. Usually the calculation of the cash flows involves the future values of one or more market variables." A cash forward contract is a simple example of a swap in commodities markets. Suppose a farmer enters into a forward

buy commodity futures contracts to mitigate their market exposure associated with the swap position. Technically, the bank's position is a *bona fide* hedge against an underlying risk in the swap market. Yet, the bank clearly is not a traditional commercial hedger who deals with the underlying physical commodity; rather, the bank has paper or swap risk that may or may not emanate from the physical market. Indeed, the third party or bank customer who initiated the position may be hedging or speculating; their motives are not necessarily known even to the swap dealer. However, the OTC swap positions that can be identified are those "…seeking exposure to a broad index of commodity prices as an asset class in an unleveraged and passively-managed manner" (CFTC, 2008a). In this instance, the bank customer is essentially long a commodity index such as the S&P GSCI Index™ via a swap with the bank. The bank then mitigates their long exposure by hedging each commodity component (e.g., crude oil, corn, and live cattle) in the respective individual futures markets. Because the banks and swap dealers can identify swaps associated with commodity indices, it allows the CFTC to further segregate the reporting trader categories to include "index traders."

3.2. Commodity Index Traders (CIT) Report

Starting in 2007—in response to complaints by traditional traders about the rapid increase in long-only index money flowing into the markets—the CFTC released *Supplemental Commodity Index Traders* (CIT) reports, which break out the positions of index traders for 12 agricultural markets. According to the CFTC, the index trader positions reflect both pension funds that would have previously been classified as non-commercials as well as swap dealers

contract with a grain merchant today to deliver 10,000 bushels of soybeans on October 1, 2008 at $12 per bushel. Since the grain merchant can sell the grain as soon as it is delivered by the farmer, the forward contract is equivalent to a "swap" agreement where the grain merchant will pay a cash flow of $120,000 on October 1, 2008, and in return, will receive a cash flow of 10,000 x S, where S is the spot price of soybeans on October 1, 2008. Hull notes that swap agreements typically have cash flows on more than one date, whereas the forward contract "swap" has cash flows on a single date.

who would have previously been classified as commercials hedging OTC transactions involving commodity indices. Sanders, Irwin and Merrin (2008) show that approximately 85% of index trader positions in the 12 *CIT* markets are in fact drawn from the long commercial category with the other 15% from the long non-commercial category. This implies that the bulk of CIT positions are initially established in the OTC market and the underlying position is then transmitted to the futures market by swap dealers hedging OTC exposure.

The CFTC readily admits that the *CIT* classification procedure has flaws and that the, "… data have to be viewed ultimately as estimates of index trading, because the reported futures positions of swaps dealers doing index trading includes internal netting and the other business—single-commodity swaps and proprietary—that they bring to the futures markets." (CFTC, 2008b, p.27) Furthermore, "…some traders assigned to the Index Traders category are engaged in other futures activity that could not be disaggregated….Likewise, the Index Traders category will not include some traders who are engaged in index trading, but for whom it does not represent a substantial part of their overall trading activity" (CFTC, 2008a). With these limitations in mind, the *CIT* data still represent a considerable improvement over the more heavily aggregated traditional *COT* classifications and generally are regarded as providing new insights into trader activity.

The *CIT* data are released in conjunction with the traditional *COT* report showing combined futures and options positions. The index trader positions are simply removed from their prior categories and presented as a new category of reporting traders. The *CIT* data include the long and short positions held by commercials (less index traders), non-commercials (less index traders), index traders, and non-reporting traders aggregated across all contracts for a particular market:

$$(2)\quad \underbrace{[(NCL-CITL)+(NCS-CITS)+2(NCSP)]+[(CL-CITL)+(CS-CITS)]+[CITL+CITS}_{\text{Reporting}}$$

$$+\underbrace{[NRL+NRS]}_{\text{Non-Reporting}}=2(TOI)$$

The above relation is analogous to that for the traditional COT report, except commercial and noncommercial positions are adjusted for the index trader long (CITL) and index trader short (CITL) positions.

While the *CIT* data represent an improvement over the traditional *COT* data, concerns were expressed almost immediately that the data did not extend to other markets, particularly energy and metals futures. The CFTC explained the omission as follows:

> "In the case in energy and metals markets, however, there are alternative U.S. and non-U.S. exchanges and a multitude of OTC markets and derivative products. Many swap dealers, in addition to their commodity index related OTC activity, enter into other OTC derivative transactions in individual commodities, both with commercial firms hedging price risk and with speculators taking on price risk. In addition, some swap dealers are very actively engaged in commercial activity in the underlying cash market, such as a physical merchandising or dealing activity. As a result of these other activities, the overall futures positions held by these energy and metals traders in Commission regulated markets do not necessarily correspond closely with their hedging of OTC commodity index transactions. Indeed, placing the futures positions of such swap dealers in a commodity index trader category would not accurately reflect commodity index trading activity for energy and metals markets." (CFTC, 2006b, p.2)

3.3. Disaggregated Commitments of Traders (DCOT) Report

In response to requests for more information about the composition of open interest in a broader set of markets, the CFTC began publishing the *Disaggregated Commitments of Traders* (DCOT) report in September 2009 and ultimately provided historical data back to June of 2006 (CFTC, 2009). The *DCOT* data are available for the same 12 agricultural markets covered by the *CIT* report plus a number of energy and metal futures markets. Like the *CIT* report, the positions in the *DCOT* report represent the combined futures and delta-adjusted options positions aggregated across all contracts for a particular market. The *DCOT* reports breaks down combined futures and options positions as follows:

$$(3)\quad \underbrace{[SDL+SDS+2(SDSP)]+[MML+MMS+2(MMSP)]+[PML+PMS]+[ORL+ORS+2(ORSP)]}_{\text{Reporting}}$$
$$+\underbrace{[NRL+NRS]}_{\text{Non-Reporting}}=2(TOI),$$

where reporting traders are classified as swap dealer (SD), managed money (MM), processors and merchants (PM), and other reporting traders (OR). Positions are divided into long (L), short (S), and spreading (SP) as indicated by the corresponding suffixes. For example, the SDL, SDS, and SDSP are the swap dealers' long, short, and spreading positions, respectively.

Swap dealers (SD) are those traders who deal primarily in swaps and hedge those transactions in the futures market. There is some uncertainty whether swap dealer positions represent an underlying speculative or hedging position. Managed money (MM) represents positions held by commodity trading advisors, commodity pool operators and hedge funds who manage and conduct futures trading on behalf of clients. The traders included in the managed money category would largely represent the more traditional class of speculative traders. Processors and merchants (PM) include traditional users, processors, and producers of the commodity who are actively engaged in the physical markets and are using the futures to hedge those risks. Other reportable (OR) are traders who are large enough to report but do not fit into one of the other categories. For the swap dealers, managed money and other reportables, off-setting long and short positions in the same market but with different contract months are reported as spreading positions.

There is a straightforward mapping of the *DCOT* categories to the original *COT* categories. Commercial traders in the *COT* report are subdivided into processors and merchants and swap dealers for the *DCOT* report while non-commercial traders in the *COT* are subdivided into managed money and other reporting traders (CFTC, 2009).[16] In contrast, for markets contained in both reports, there are some differences between the index trader category in the *CIT* report and the swap dealer category in the *DCOT* report. The swap dealer category of the *DCOT* includes swap dealers who do not have commodity index-related positions, and therefore, are not included in the index trader category of the *CIT*. Also, the "index trader" category of the *CIT* includes pension and other investment funds that place index investment directly into the futures markets rather than going through a swap dealer. These traders are classified as managed money or other reportables in the *DCOT*.

An important question, especially for the energy futures markets, is the degree to which the *DCOT* swap dealers category represents index fund positions. One can infer from comparisons found in the CFTC's September 2008 report on swap dealer positions (CFTC, 2008b) that *DCOT* swap dealer positions in agricultural futures markets correspond reasonably closely to index trader positions. Since swap dealers operating in agricultural markets conduct a limited amount of non-index long or short swap transactions there is little error in attributing the net long position of swap dealers in these markets to index funds. However, swap dealers in energy futures markets conduct a substantial amount of non-index swap transactions on both the long and short side of the market, which creates uncertainty about how well the net long position

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[16] The CFTC provides the following detailed explanation of the relationship between *DCOT* and *COT* report categories:

> "The legacy COT reports divide reportable traders into the two broad categories of "commercial" and "non-commercial." The "commercial" trader category has always included producers, merchants, processors and users of the physical commodity who manage their business risks by hedging. It has also included swap dealers that may have incurred a risk in the over-the-counter (OTC) market and then offset that risk in the futures markets, regardless of whether their OTC counterparty was a commercial trader or a speculator. Those two categories of what has been reported as "commercial" traders are separately reported in the Disaggregated COT. The "non-commercial" category of the legacy COT included professional money managers (CTAs, CPOs, and hedge funds) as well as a wide array of other non-commercial (speculative) traders. These two categories of what has been reported as "non-commercial" traders are separately reported as "money managers" and "other reportables" in the Disaggregated COT." (CFTC, 2009)

of swap dealers in energy markets represent index fund positions.[17] For example, the CFTC estimates that only 41 percent of long swap dealer positions in crude oil futures on three dates in 2007 and 2008 are linked to long-only index fund positions (CFTC, 2008b).

4. Sample, Markets, and Activity Measures

4.1. Sample Period and Markets

The *CIT* data are available weekly from January 3, 2006 through December 29, 2009 and the *DCOT* data are available at the same frequency starting on June 13, 2006. To facilitate the comparison of the data sets and results, a common sample starting on June 13, 2006 containing 186 weekly observations through December 29, 2009 is used in all empirical work.

Index trader positions are collected for the 12 *CIT* agricultural markets: Chicago Board of Trade (CBOT) corn, CBOT soybeans, CBOT soybean oil, CBOT wheat, Kansas City Board of Trade (KCBOT) wheat, New York Board of Trade (NYBOT) cotton, Chicago Mercantile Exchange (CME) live cattle, CME feeder cattle, CME lean hogs, NYBOT coffee, NYBOT sugar, and NYBOT cocoa. Corresponding *DCOT* data are collected for these 12 *CIT* markets along with the *DCOT* data for New York Mercantile Exchange (NYMEX) crude oil and natural gas. The focus in the *DCOT* data will be on swap dealer positions because of their link to index fund positions.

4.2. Calculation of Returns and Volatility

For these same markets, weekly returns are calculated using nearby futures contracts adjusting for contract roll-overs as follows:

[17] As noted in the previous section, this was precisely the reason that the CFTC excluded energy futures markets from the *CIT* report.

(4) $$R_t = \ln \frac{p_t}{p_{t-1}} \cdot 100$$

where p_t is the futures price of the nearest-to-expiration contract on Tuesday of each week corresponding with the *CIT* as-of dates. In order to avoid distortions associated with contract rollovers, p_{t-1} in the log relative price return is always calculated using futures prices for the same nearest-to-expiration contract as p_t. Roll-over dates for the 12 *CIT* agricultural commodities occur on or before the first of the delivery month such that no return is calculated using prices during the delivery month. For the energy markets, the roll-over occurs on or before the 16th of the month preceding the delivery month.

The markets examined and the summary statistics for the weekly returns by market are presented in Table 1. Mean weekly returns are very small with the exception of the natural gas market (-1.2%). Crude oil (6.0%) and natural gas (6.9%) have the highest standard deviations of weekly returns. Live cattle (2.0%) and feeder cattle (2.2%) have the lowest standard deviations.

In order to test for traders' impact on market variability, two measures of volatility are computed. A forward-looking volatility measure or implied volatility is extracted from the options quotes for each market. Implied volatility is provided by CRB/Barchart online quote services and is calculated in the following manner:

> "This volatility is measured by entering the prices of options premiums into an options pricing model, then solving for volatility. The implied volatility value is based on the mean of the two nearest-the-money calls and the two nearest-the-money puts using the Black options pricing model. This value is the market's estimate of how volatile the underlying futures will be from the present until the option's expiration. " (Barchart/CRB, 2010).

While this method of deriving the market's implied volatility assumes that Black's pricing model is correct, it is a commonly-accepted method of calculating the volatility implied in the options markets and is generally regarded as providing reasonably efficient volatility estimates (e.g., Hull, 2000, p. 255; Manfredo and Sanders, 2004). The resulting volatility is expressed as an annualized percent.

Table 2 presents the summary statistics for the implied volatility (annualized standard deviation) for each market. The highest volatility is 59.4% for natural gas. Live cattle (17.1%) and feeder cattle (15.3%) have the lowest implied volatility among the markets examined. The remainder of the markets tends to have implied volatility in the range of 30%-35%.

Actual market volatility or realized volatility is calculated using the high-low range estimator originally developed by Parkinson (1980) and widely used by financial analysts (e.g., SITMO, 2010):

(5)
$$\sigma_t = \sqrt{\frac{Z}{n4\ln 2}\sum_{i=1}^{n}\left(\ln\frac{H_i}{L_i}\right)^2}$$

where Z is equal to 52 in order to annualize the volatility estimate, n is equal to 1 week, and H_i and L_i are the high and low prices for the week. Specifically, H_i and L_i are extracted from the daily highs and lows of the nearest-to-expiration futures contract recorded from Wednesday through Tuesday (inclusive) corresponding with the *CIT* as-of dates. The same contract rollover rules are used for computing realized volatility and returns.

The summary statistics for Parkinson's high-low volatility (annualized standard deviation) are presented in Table 3. The data show a wide range of variability across the markets with natural gas at nearly 50% and live cattle below 13% annualized volatility. Generally, the implied volatility measures (Table 2) are larger than Parkinson's estimates (Table 3).

4.3. Working's Speculative "T" Index

As an alternative measure of speculation, Working's speculative T-index is calculated for each market included in the *CIT* data set. As outlined by Sanders, Irwin, and Merrin (2010), Working (1960) developed a mathematical index of speculation based on the view that futures markets are hedging markets and a certain level of speculation is necessary to facilitate hedging. Working's speculative index has been used in several studies to examine grain and livestock futures markets for adequate speculative activity (Working, 1960; Nathan Associates, 1967; Labys and Granger, 1970; Peck 1980, 1981; Leuthold 1983). Surprisingly, most prior research is concerned about a lack of sufficient speculative activity to support hedging demands in the marketplace. Working's T provides an objective measure of speculative activity relative to hedging levels.

Working's speculative "T" index is easily calculated using the traditional *COT* trader categories:

$$T = 1 + SS / (HL + HS) \qquad \text{if } (HS \geq HL) \tag{6}$$

or

$$T = 1 + SL / (HL + HS) \qquad \text{if } (HL > HS) \tag{7}$$

where open interest held by speculators (non-commercials) and hedgers (commercials) is denoted as follows: SS = Speculation, Short; SL = Speculation, Long; HL = Hedging, Long; and HS = Hedging, Short. Peck (1980, p. 1037) notes that the speculative index, "…reflects the extent by which the level of speculation exceeds the minimum necessary to absorb long and short hedging, recognizing that long and short hedging positions could not always be expected to offset each other even in markets where these positions were of comparable magnitudes."

Working (1960, p. 197) is careful to point out that what may be "technically an 'excess' of speculation is economically necessary" for a well-functioning market.

As a highly simplified example of the calculation and interpretation of Working's speculative T index, consider the intuitive case where HL=0; then, T= SL/HS = 1+ (SS/HS).[18] It follows, if long speculation (SL) just equals short hedging (HS), then T equals its minimum value of 1.00, where the level of speculation is just sufficient to off-set hedging needs. Now, consider if HL=0, HS=100, SL=110, and SS=10, then T equals 1.10 or there is 10% speculation in excess of that necessary to meet short hedging needs. As shown, the T-index is driven higher by speculators trading with speculators, not by speculators taking the opposite position of hedgers. Working (1960, p. 210) argued that trading between speculators generally was "unneeded" and reflected either, "entry into the market of a considerable group of inexpert or ill-informed speculators" or "recognition by one group of speculators of significant economic conditions or prospects that are currently being ignored by other, equally expert and generally well-informed, speculators." Either case could result in a deterioration of market performance. In contrast, Working asserted that speculators trading with hedgers is beneficial to overall market performance since speculators provide liquidity and risk-bearing capacity for hedgers.

As noted by several authors (e.g., Leuthold, 1983), Working's T suffers from the problem of how to classify the non-reporting traders. Non-reporting traders can be classified as speculators, creating an upper bound on the speculative index. Or, they can be classified as hedgers, creating a lower bound on the index. With either of these approaches however, the index will be impacted through time if the proportion of non-reporting traders in a market changes. Given the declining importance of non-reporting traders in modern markets, we follow

[18] Note that SS + HS = SL + HL must hold in a zero sum futures market if all positions are categorized as speculative or hedging. If HL = 0, the identity reduces to SS + HS = SL. Dividing through by HS and re-arranging yields T = SL/HS = 1 + (SS/HS).

the advice of Rutledge (1977-78) and allocate the non-reporting traders' positions to the commercial, non-commercial, and index trader categories in the same proportion as that which is observed for reporting traders.

Working's T provides a measure of the aggregate level of speculation in the marketplace, incorporating the relative amounts of speculation and hedging. The T-index is silent on the direction of speculation (long or short) and instead measures speculation in absolute terms. So, the T-index will not be examined for linkages to returns. Instead, the T-index will be used to test if the aggregate level of speculation in the marketplace impacts price volatility. Following Sanders, Irwin, and Merrin (2010), Working's T-index will be calculated using the *CIT* data, allocating index trader positions to the speculator category. Computation of the T-index with the *DCOT* data would be redundant for the 12 *CIT* agricultural markets because of the relationship between *DCOT*, *CIT*, and *COT* categories.[19] Given the uncertainties about how to classify swap dealer positions in crude oil and natural gas, the T-index is not computed for these two markets using *DCOT* data.

Table 4 shows the summary statistics for the calculated T-index for the 12 *CIT* markets (re-categorizing index traders as speculators). Generally, the T-index values are close to those reported by Sanders, Irwin, and Merrin (2010). The markets that show the highest levels of speculation—adjusted for commodity index positions—are generally in the livestock markets with feeder cattle at 1.86 and lean hogs at 1.43. As an example, the lean hog index value of 1.43 can be interpreted as speculation exceeding the level needed to balance hedging by 43%. The highest level of speculation in the grain markets is in CBOT wheat which has a T-index value of

[19] Assuming that index trader positions have been removed from the commercial and non-commercial categories, the following relationships hold approximately for the 12 *CIT* markets:

Hedgers = Commercials = Processors and Merchants, and
Speculators = Non-Commercials + Index = Swap Dealers + Managed Money + Other Reportables.

1.44. Notably, both feeder cattle (3.28) and lean hogs (2.01) have maximum T-index values that are above two. Strictly interpreted, this suggests that these markets on occasion have speculation that is more than double that needed to balance hedging needs. On the flipside, all markets—except feeder cattle—have minimum T indices that are sometimes below 1.10. This is a level that has historically raised concerns about inadequate speculation in futures markets (Peck, 1980). These shifts in relative speculative levels suggest that Working's T-index may provide an interesting variable for explaining price volatility.

5. Empirical Methods and Results

Arguments for a bubble in commodity prices have focused primarily on the role of long-only index funds that purchase commodity futures as an asset class. Therefore, the analysis that follows concentrates on index trader positions reported in the *CIT* report and the swap dealer positions reported in the *DCOT* report. The *CIT* index trader data are representative of positions held by long-only index funds in agricultural markets. It is reasonable to assume the same for the *DCOT* swap dealer data in agricultural markets. However, as discussed in the previous section, there is considerable uncertainty regarding the degree to which *DCOT* swap dealer data represent index trader positions in energy futures markets. Lacking any other data to represent in index fund positions in the energy markets, we follow Buyuksahin and Harris (2009) and assume swap dealer positions are representative of index trader positions in the crude oil and natural gas futures markets. The following analysis of the summary statistics and data trends helps provide some insight as to the reasonableness of this assumption.

5.1. Data Trends and Characteristics

5.1.1. Number of Reporting Traders

Both the *CIT* and *DCOT* reports provide information on the number of reporting traders in each category. The averages for the 12 *CIT* markets are shown in Table 5 and for the *DCOT* categories in Table 6. Because some traders are counted in both long and short categories, the sum of the numbers by category will not necessarily equal the market total. The total number of reporting traders for the *CIT* and *DCOT* reports are the same.

In Table 5, the number of long and short traders in the commercial and non-commercial categories are relatively equal. However, in the index trader category, most markets have roughly 20-25 long index traders and just 5 or so short index traders. This certainly speaks to the tendency for index traders to be long-only. It also suggests that there are a fairly limited number of firms providing index tracking services in these markets.

In Table 6, the *DCOT* producer and merchant category tends to have more reporting short traders than long traders. However, the largest discrepancy is in the swap dealer category where the long traders clearly outnumber short traders. For instance, in both KCBOT wheat and lean hogs there are 15 swap dealers reporting as long traders and zero reporting as short traders. This characteristic is consistent across the 12 agricultural commodities and is consistent with number of long and short index traders reported in Table 5.

There is a notable difference between the number of long and short reporting swap dealers in the 12 agricultural markets and the two energy markets. In crude oil and natural gas, the number of long and short reporting swap dealers is roughly equal. This suggests that the swap dealer category in these markets likely contain a number of traders other than just long-only index funds.

5.1.2. Average Position Size Held by Trader Group

Using the number of contracts held by each trader group and simply dividing by the number of traders in that group (see Table 5 and 6), the average position size per reporting trader can be calculated. Because reporting traders can appear in more than one category, this may underestimate a particular trader's total market size. The results for the *CIT* and *DCOT* categories are shown in Tables 7 and 8.

In Table 7, among the *CIT* trader groups, the largest average position size in each market is held by long index traders. For example, the soybean market, long index trader average position size is 5,889 contracts. The next biggest average position size is 1,746 soybean contracts held by commercial short traders. The size of the average position does support claims that index funds are large players in the markets who can generate considerable market activity when altering positions. The average index traders long position is typically more than twice as large as the next largest position size in each market. Moreover, as shown in the final column of Table 7, the average position held by index traders often approaches the speculative position limit and exceeds it in the case of CBOT wheat.

Comparable average position sizes are calculated and presented in Table 8 for the *DCOT* categories. Similar results are found for 12 agricultural markets with the exception of cocoa. That is, the average position size is largest for long swap dealers which likely represents mostly index traders. In some markets, such as corn, the difference is overwhelming with the average swap dealer's long position more than 5 times larger than the next largest average position size. The average position size for long swap dealers exceeds the speculative limits for CBOT wheat, live cattle, and lean hogs. While this is clearly not illegal, it does suggest that swap dealers have used hedge exemptions to build positions larger than those typically allowed for speculators.

Again, a very different story is seen in the natural gas and crude oil markets. In these markets, the largest average position size is held by swap dealers that are spreading: holding simultaneous long and short positions in the same market, but different delivery months. Spreading is a relatively market- or delta-neutral position and may represent either speculative or hedging activities. The average long and short position size held by swap dealers in crude oil and natural gas are not materially different than those held by producers and merchants or the managed money categories. This again lends support to a more mixed trader profile for swap dealers in the energy markets. Confirming the discussion in previous sections, the composition of the *DCOT* categories for the energy markets seems to be structurally different than in the 12 agricultural markets.

5.1.3. Percent of Open Interest Held by Trader Group

To put the size of trader group positions on a relative scale, their total positions (long + short) are expressed as a percent of the total open interest (long + short) in each market. The summary statistics for the percent of each market's open interest held by the *CIT* trader classifications is shown in Table 9. The largest percent of open interest is generally held by either the commercial or non-commercial category within the *CIT* reports. Index traders hold from 7% (cocoa) to 23% (CBOT wheat) of the open interest. Three of the 12 agricultural markets (CBOT wheat, live cattle, and lean hogs) have index participation levels in excess of 20% of outstanding open interest. So, even though the average index trader holds a very large position (see Table 7), the overall level of participation is not necessarily overwhelming compared to the other trader categories.

Table 10 presents the analogous data for the *DCOT* trader categories. Among the 12 agricultural commodities, the percent of open interest held by swap dealers is comparable to that of index traders in Table 9, highlighting the close intersection of these two data sets. The largest percent of open interest is held by traditional hedgers defined as producers and merchants in the 12 agricultural commodities. The lone exception is feeder cattle, where the largest amount of open interest is held by non-reporting traders. This lends some support to Working's (1960) assertions that these markets are first and foremost hedging markets. In stark contrast, swap dealers—who may be taking either speculative or hedging positions—hold the largest percent of crude oil open interest. In natural gas, managed money traders—who are clearly speculators—hold the largest percent of outstanding contracts.

5.1.4. Percent Net Long by Trader Group

One of the criticisms leveled against index funds is that they do not trade both sides of the market; so, they may dominant the buy-side within the marketplace. To examine this issue, we first calculate the percent net long (PNL) for each trader category. The PNL is simply the net position held by the category divided by the total positions held [(long-short)/(long+short)]. The PNL by *CIT* categories are presented in Table 11. It is clear that the index traders are indeed mostly long. The PNL for the index category ranges from 70% (sugar) to 97% (live cattle). Interestingly, for two markets—CBOT wheat and lean hogs—index traders represent the only group that had a net long position over the sample period. Not surprisingly, for all 12 *CIT* agricultural markets, commercial traders are on average short, reflecting the traditional short-hedging of producers and merchandisers.

Similar results are found for the PNL in the *DCOT* positions in Table 12. In particular, the producer and merchant category is on average short for all markets (except natural gas) reflecting the hedging of inventories and production. Meanwhile, swap dealers are on average long, confirming that their positions to some large degree correspond to commodity index fund investment. Indeed, the swap dealers PNL is often larger than for that of the corresponding index trader category (Table 11). For instance, in soybeans the *CIT* index category is 88% net long while the *DCOT* swap dealers are 93% net long. The managed money category also tends to carry a net long position across all of the markets except natural gas.

Again, there is a notable difference in the swap dealer data across the market groups. For the 12 agricultural commodities, the swap dealers are largely long. Although, the percentage falls off with the tropical or soft commodities (coffee, sugar, and cocoa). In the crude oil and natural gas markets, the swap dealers' PNL is not any larger than that displayed by other groups.

5.1.5. Percent Side of Market Held by Trader Group

It is sometimes asserted that index funds dominate the long side of the market. So, the percent of the long and short side of each market held by index funds and swap dealers is also calculated. Tables 13 and 14 show the percent of long and short positions held by each trader category in the *CIT* and *DCOT* data, respectively. Based on the high PNL values for the index traders (Table 11), it is not surprising that they comprise a large portion of the long side of the market. Because they hold predominantly long positions, the index traders sometimes represent as much as 40% of the long positions within a few markets (CBOT wheat, lean hogs, and live cattle, Table 13, Panel A). Not surprisingly, comparable numbers are shown for the swap dealers (Table 14, Panel A) who hold more than 35% of the long positions in these same markets.

Interestingly, there is far more concentration on the short side of the market. For the *CIT* data (Table 13, Panel B), the commercials hold over 50% of the short positions in 6 of the 12 markets with a maximum of 69% in cocoa. Similarly, the producer and merchants in Table 14, Panel B are shown to hold over 50% of the short positions in 6 of the 12 agricultural markets. If position concentration on one side of the market is an indicator of groups impacting price then suspicion would need to focus on commercial short hedgers, not just index funds. The data in Tables 13 and 14 also highlight the need for long speculation to balance short hedging and the possibility that index funds are fulfilling this role (see Sanders, Irwin, and Merrin, 2010).

From the data, it would appear that swap dealer positions and index trader positions are closely aligned in the 12 agricultural markets. The intersection of these two categories seems to be a bit smaller in the coffee, sugar, and cocoa markets than in the other nine agricultural markets. This may be related the international scope of the tropical or soft commodities where swap dealers may be transacting in more hedging-related swaps or non-index speculative positions. The simple correlation coefficient between the percent of long positions held by *CIT* index traders and *DCOT* swap dealers for the 12 agricultural markets range from a low of 0.49 for soybean oil to a high of 0.99 for cotton with six of the twelve markets having a correlation above 0.90.[20] Based on the structural differences observed for crude oil and natural gas, it is difficult to assume that *DCOT* swap dealer positions necessarily reflect index trader positions. Mindful of this limitation, the *DCOT* swap dealers classification for crude oil and natural gas will be used as the best proxy available for index trader positions.

[20] See the figures in the Appendix for graphical comparisons of the *CIT* index trader and *DCOT* swap dealer net long positions for selected markets.

5.2. Position Measures and Stationarity

The first position variable is the net long position of index traders or swap dealers, where net position is simply long positions minus short positions (long contracts - short contracts). A positive number is a net long position, while a negative number is a net short position. This measure directly captures the essence of the complaints leveled against index funds; that is, the large size of their trading pressures prices upward (downward) when they are buying (selling). This measure is also consistent with the assertion earlier in this report that index fund market participation should be denominated in quantity terms not dollar terms. A second position measure also is computed: percent of long positions. Index trader or swap dealer long positions (in contracts) are divided by the total long positions in the market (contracts) to obtain the percent of long positions within that market held by index traders or swap dealers. This simply normalizes the index funds' long participation by the total long open interest of the market.

The summary statistics for net long position for *CIT* index traders and *DCOT* swap dealers are shown in Tables 15 and 16, respectively. In Table 15, the size of index positions had a wide range over the sample period. For instance, in the corn futures market the index trader position had maximum of 452,568 contracts and a minimum of 223,985 for a range of over 100%. Similar or greater ranges are observed across all of the markets and in no market did the index traders ever have a net short position (minimum is never negative). For the 12 agricultural markets, the mean swap dealer net long position (Table 16) is fairly close in magnitude, but smaller, than those for index traders (Table 15). Unlike the index trader category, the swap dealer categories do have minimum net positions that are short (negative) for sugar, cocoa, crude oil, and natural gas. This again suggests that the swap dealer positions in these markets contain positions other than those held by long-only index funds.

The summary statistics for percent of long positions are provided in Tables 17 and 18 for the *CIT* index traders and *DCOT* swap dealers, respectively. The percent of the long positions held by *CIT* index traders can be quite volatile (Table 17). For instance, CBOT wheat ranges from a low of 32.0% to a high of 50.1% and coffee ranges from a low of 18.9% to a high of 42.7%. In a similar fashion, the percent of long positions held by *DCOT* swap traders (Table 18) can vary over a wide range. In cotton, the average is 31.1% but it ranges from a maximum of 41.9% to a minimum of 22.1%. Even the energy markets show relatively high maximum levels, with the percent of long positions for swap dealers having a maximum of 45.0% in crude oil and 38.6% in natural gas.

Prior to formal statistical modeling, it is important to determine if the series in question are stationary (fixed mean and variance). If not, then tests of statistical significance may be invalid (Enders, 1995, p. 216). Here, we follow the standard testing procedure popularized by Dickey and Fuller to test the null hypothesis of a unit root. The results of the augmented Dickey-Fuller test are presented in Tables 19-22 for all series of interest.

The results suggest that returns, volatility, and Working's T are generally stationary, while the position measures need to be differenced to achieve stationarity. So, in the following time series models, the position measures—net positions and percent of longs—will be differenced while returns and volatility will be used in levels to achieved "balanced" regression equations (same order of integration on the right- and left-hand side of the equations).

5.3. Granger Causality Tests

Hamilton (1994) suggests the direct, or bivariate, Granger test for examining the lead-lag or “causal” relationship between two series. Granger causality is a standard linear technique for determining whether one time series is useful in forecasting another. In our case the time series of interest are market measures of returns (R), implied volatility (IV), and realized volatility (RV). The causal variables are measures of trader positions and speculation, including net positions (NET), the percent of long positions (LONG), and Working's T-index (TIndex).

As an example, consider the causal relationship between market returns and *CIT* net positions. Under the null hypothesis that index traders' net position does not Granger cause market returns, the following linear regression is estimated for each market, *k*:

(8)
$$R_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} R_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k}.$$

The lag structure (*m*,*n*) for each market is determined by a search procedure over *m*=4 and *n*=4 using OLS and choosing the model that minimizes the Schwartz criteria to avoid overparameterization (Enders, 1995, p. 88). If the OLS residuals demonstrate serial correlation (Breusch-Godfrey Lagrange multiplier test), additional lags of the dependent variable are added until the null of no serial correlation cannot be rejected. As discussed earlier, hypothesis test results based on (8) require careful interpretation if the null hypothesis of no causality is rejected (Newbold, 1982).

Previous time-series studies of lead-lag relationships between index fund market participation and commodity futures returns have conducted tests market-by-market when data on multiple markets is available (e.g., Stoll and Whaley, 2009; Sanders and Irwin, 2010b; Aulerich, Irwin, and Garcia, 2010). As noted earlier, standard time-series approaches can be criticized for a lack of statistical power when the dependent variable demonstrates extreme volatility such as that observed for market returns. Summers (1986) demonstrates that traditional time-series tests may also have low statistical power against a random walk null hypothesis if the true data generating process is driven by fad or sentiment. Researchers have proposed alternative, more powerful time-series tests (e.g., Jegadeesh, 1991) and they have been applied in previous work (Sanders and Irwin, 2010b; Aulerich, Irwin, and Garcia, 2010); however, they can still suffer from a lack of robustness under the alternative hypothesis (see Daniel, 2001).

In this research, the power of causality tests based on (8) is increased by modeling the K markets as a system of seemingly unrelated regressions (SUR). Since the error term, $\varepsilon_{t,k}$, in (8) is correlated across markets the power of causality tests can be increased by employing a GLS estimator within Zellner's seemingly unrelated regression (SUR) framework (see Harvey, 1991, p. 66).[21] Previous researchers have used the SUR framework to increase the power of market efficiency tests in foreign exchange markets (Frankel, 1980; Bilson, 1981). Under the SUR approach, GLS parameter estimates are the best linear unbiased coefficient estimates. The efficiency gains over OLS estimates increase with the correlation between the residuals ($\varepsilon_{t,k}$) and with the number of equations. Harvey also points out additional efficiency gains by imposing the constraint of equal parameters across equations, where appropriate. Moreover, estimating equation (8) as a system of K regressions also allows for a more complete set of hypothesis tests.

Traditional bivariate causality in a single market, k, is tested under the null hypothesis in (8) that traders' net positions (NET) cannot be used to predict (do not lead) market returns: $H_0 : \beta_{j,k} = 0$ for all j. A rejection of this null hypothesis, using an F-test of the stated restriction provides direct evidence that trader positions are indeed useful for forecasting returns in that market. In order to gauge the aggregate impact of trader positions in that market, the null hypothesis that $\sum_{j=1}^{n} \beta_{j,k} = 0$ in each k market will reveal the cumulative directional impact of traders positions on returns (if any). Clearly, in the event that the lag structure is n=1 then the

[21] The correlation matrix of residuals for the OLS estimates of (1) showed correlation coefficients ranging from a high of 0.96 (CBOT wheat and KCBOT wheat) to a low of -0.12 (corn and feeder cattle) with an average of 0.28.

test of null hypothesis that $\sum_{j=1}^{n} \beta_{j,k} = 0$ is equivalent to a simple test on the parameter restriction that $\beta_{1,k} = 0$.

When estimated as a system of *K* equations in a SUR framework, equation (8) allows for the testing of systematic or aggregate impacts across all markets. To further increase the efficiency gains, coefficients are restricted across market equations where appropriate (see Harvey, 1991, p. 69). Specifically, the strategy for selecting the restricted SUR model follows the sequential testing procedure outlined by Harvey (p. 186) where the most general model is estimated (no cross-market parameter restrictions) and using a Wald test of the hypothesis of equal parameter estimates across markets. When the null of equal parameter estimates is not rejected, then the restriction is placed on the model. Specifically, all *K* models are first estimated as a SUR system using the lag structure chosen with the OLS search procedure. Second, for each estimated parameter the null hypothesis that the cross-equation parameters are equivalent is tested (e.g., $\gamma_{1,1} = \gamma_{1,2} = \ldots = \gamma_{1,K}$). If we fail to reject the null hypothesis at the 10% level, then that parameter restriction is imposed resulting in a pooled estimate or single parameter across equations (e.g., $\gamma_{1\cdot}$). A 10% significance level is used (instead of 5%) to be somewhat conservative in the imposition of parameter restrictions. By pooling parameters—when we fail to reject that they are equivalent—the number of parameter estimates is decreased and efficiency is further enhanced (Harvey, 1991, p. 69).

To illustrate, consider again equation (8) and two extreme examples. First, the most restrictive case, where for all parameters the null of equivalency across markets is not rejected. In this case, all of the parameter estimates are pooled. Then, causality testing proceeds using the pooled parameter under the null, $H_0 : \beta_{j\cdot} = 0$ for all *j* (where *j.* represents a parameter common across the K markets). Rejection of the null hypothesis suggests that positions lead returns across the system (all markets jointly). Additionally, the aggregate impact, that $\sum_{j=1}^{n} \beta_j. = 0$, can be tested for the system as a whole. In this most restrictive case, there are no tests for individual markets as the pooled result applies equally to all markets.

At the other extreme, assume that we reject the null hypothesis of equal cross-market parameters in all cases. This is the least restrictive case where none of the parameter estimates are pooled and individual coefficients are estimated for all K markets. In this case, the null hypothesis is tested for each k under the null, $H_0 : \beta_{j,k} = 0$ for all j, as well as the aggregate impact, $\sum_{j=1}^{n} \beta_{j,k} = 0$, is tested for each k (market). Moreover, the SUR estimation allows for the testing of system-wide causality, $H_0 : \beta_{j,k} = 0$ for all j and k, and for the systematic impact across markets, $\sum_{k=1}^{K} \sum_{j=1}^{n} \beta_{j,k} = 0$. This is an important improvement over a strictly market-by-market OLS approach to causality testing because it allows for broader statements about systematic impacts.

5.3.1. Positions Lead Returns Test Results

The first set of causality tests focus on the null hypothesis that positions do not lead returns. In this case, the independent variable in (8) is market returns (R) and the explanatory variables are either the change in the net position (ΔNET) or the change in the percent of long positions held by the trader group (ΔLONG).

Table 23 shows the SUR test results for the null hypothesis that the *CIT* net positions do not lead returns for each market. The *m,n* lag structure that minimized the SIC was a 1,1 for each market except live cattle and feeder cattle. In this particular model, the hypothesis of equal cross-market (k) parameters for the constant terms (α_k) and the first ($\gamma_{1,k}$) and second ($\gamma_{2,k}$) lag of returns are not rejected (10% level).[22] Therefore, the restrictions are imposed on the system and these parameter estimates are pooled across the equations. The estimated β coefficients are not restricted and allowed to vary across markets.

As shown in the third column, the null hypothesis that positions do not lead returns $H_0 : \beta_{j,k} = 0$ for all j is rejected at the 5% level for corn and cotton. The next two columns show the cumulative direction of the impact $\sum_{j=1}^{n} \beta_{j,k}$ in each market (k) and the p-value testing if the cumulative direction is different from zero. In those cases where n=1, $\sum_{j=1}^{n} \beta_{j,k} = \beta_{1,k}$ and the p-value is clearly equivalent to the p-value for $H_0 : \beta_{j,k} = 0, \forall j$ and it is not repeated in the table. As shown, the estimated β_1 parameter is negative for corn (-0.1210) and positive for cotton (0.3590). These results are somewhat consistent with Stoll and Whaley (2009) who also document some impact in the cotton market (p. 45).

Given these individual market results, it is not surprising that the two strong rejections in corn and cotton generate a system wide rejection of no causality (p-value = 0.0001). However, because the direction of the impact is different across markets (especially in corn and cotton), the cumulative direction of the impact across the system (-0.4010) is not statistically different from zero (p-value = 0.3836). Therefore, while we do find causation running from net positions to returns in two markets, the evidence is not consistent with a systematic influence across the markets.

[22] The cross-market coefficient restrictions used in each estimation are stated in the notes below Tables 23-36.

Table 24 presents the parallel test using the change in the percent of long positions held (LONG) as the position measure. In this SUR system, the parameters are restricted or pooled for the constant term (α_k) and the estimated $\beta_{2,k}$ on the second lag of the LONG position variable. The null hypothesis that the percent of long positions do not lead returns is rejected in one market at the 5% level (corn). The directional impact is negative as it was in Table 23. The system-wide test again rejects the null of no causality from positions to returns (*p*-value=0.0119) due to a number of marginally significant results in individual markets. For instance, feeder cattle have a *p*-value of 0.0960 and sugar has a p-value of 0.0740. However, the directional impact in feeder cattle is negative (-0.0881) while it is positive in sugar (0.5949). So, while these markets contribute to a rejection of $\beta_{j,k} = 0$ for all *j* and *k* across the system, the direction of the impact across markets are simply not consistent with a systematic effect. Therefore, the test for a systematic or cumulative impact across the system (0.3178) is not statistically different from zero (*p*-value=0.6711).

The analogous tests are conducted for positions leading returns using the net positions and percent of long positions held by *DCOT* swap dealers. The SUR results are presented in Tables 25 and 26. In Table 25, the testing of parameter restrictions was unable to reject that the $\beta_{1,k}$ coefficients were equivalent across markets, *k*, which results in a pooled estimation of $\beta_{1.}$, across all K markets. As a consequence, all of the markets with for which n=1 have the same causality test result where β_1=-0.0018 and is not statistically different from zero. The $\beta_{2,k}$ was only specified and estimated for live cattle. So, this market generates an incremental result but also fails to reject the null of no causality (*p*-value = 0.2994). In this particular system, there is a common $\beta_{1.}$ and a single $\beta_{2,k}$ estimated for live cattle. Therefore, the test for system-wide causality ($\beta_{1.} =\beta_{2,k}=0$) is equivalent to the test for just the live cattle market. So, the system results likewise show a cumulative impact that is not statistically different from zero. In total, there is no evidence that the net positions held by *DCOT* swap dealers impact market returns.

In Table 26, the SUR approach for *DCOT* swap dealers percent of long positions yields results similar to those found in Table 25. Again, the null hypothesis that the $\beta_{1,k}$ estimates are equivalent across markets cannot be rejected, so that parameter is estimated in a pooled fashion ($\beta_{1\cdot}$). The $\beta_{2,k}$ is again estimated separately for those markets where n=2 (live cattle and feeder cattle). Still, for no market is the null hypothesis of no causality rejected at the 5% level. Moreover, we fail to reject the null of no causality for the system (p-value = 0.1239) and the aggregate direction of causality is not statistically different from zero. These results are consistent with those in Table 25 and they provide scant evidence that swap dealer positions impact market returns.

Given the paucity of evidence in prior studies linking index positions with market returns, the causality test results in Tables 21-24 are not surprising. The null hypothesis of no causality is not consistently rejected for any given market or across the SUR systems. When there are individual rejections, such as for corn and cotton in Table 23, the direction of index traders' impact is inconsistent across markets. As a result, the strongest overall test—the cumulative impact across each system of equations—is not statistically significant for any of the models.

5.3.2. Positions Lead Implied Volatility Test Results

While there is a growing body of empirical work on the impact of trader positions on returns, there is less empirical evidence with regard to trader positions and market volatility. In an early study, Leuthold (1983) finds no linkage between speculation—measured by Working's T-index—and the level of price volatility in livestock futures markets. Streeter and Tomek report that price volatility in the soybean futures market is negatively related to increased speculation, again measured by Working's T-index. Du, Yu, and Hayes (2009) report the opposite result for crude oil futures. Finally, Aulerich, Irwin, and Garcia (2010) report some evidence that price volatility has been influenced by the presence of index traders in several markets, but only using one of the measures of index position changes. These effects also appear to be small in economic magnitude, except in several traditionally less liquid markets.

Granger causality tests are run in a similar fashion to those used to test the linkages between positions and returns. For instance, an equation analogous to (8) is used to test that null hypothesis that net trader positions (NET) do no lead implied volatility (IV) in an SUR framework:

(9) $$IV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} IV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k}$$ for each market k and time t.[23]

The results for the *CIT* trader data are presented in Table 27 for the net positions and Table 28 for the percent of long positions.

In Table 27, the null hypothesis that *CIT* index trader net positions do not lead implied volatility is rejected at the 5% level in 2 of 12 markets (soybeans and live cattle). This is fairly weak evidence of a causal relationship; however, it is made slightly stronger by the consistent negative direction of the impact. In both soybeans and live cattle, the results suggest that larger net long positions lead to a lower implied volatility. For instance, if the net position size for index traders increases by 1,000 contracts in soybeans then implied volatility declines by 0.293%. Partially because of the strong rejections in soybeans and live cattle, the null of no causality is also rejected for the system (p-value = 0.0019). Despite the fact that 9 of the 12

[23] Equation (9) and all other Granger causality equations involving either implied or realized volatility were also estimated with monthly dummy variables to test for seasonality in volatility. For this sample period, the null hypothesis of equal volatility across months was not rejected. So, the monthly dummy variables were not included in the final model specifications.

markets have a negative directional impact, the cumulative impact across all markets (-8.0800) is not statistically different from zero.

The implied volatility results using the percent of long positions (Table 28) are considerably more consistent. Here, we find 3 rejections in the 12 individual market results. The null hypothesis that the percent of long positions held by index traders does not lead implied volatility is rejected at the 5% level for soybeans, soybean oil, and coffee. The direction of the impact is uniformly negative, again suggesting that larger index positions precede lower implied volatility levels. For example, in soybean oil, a 1% increase in the percent of longs held by index traders is followed by 0.69% decline in implied volatility. In this SUR system, the strength of the individual results are again strong enough to drive a rejection of no causality across the system (p-value = 0.0060). More important, the systematic impact is statistically negative at the 5% level. This provides some stronger evidence that there is a systematic negative causal relationship from changes in index positions to implied volatility.

A parallel set of causality tests are run using the *DCOT* swap dealer positions. The results for the SUR estimations using net positions held by *DCOT* swap dealers are shown in Table 29. Using these data, there are 2 rejections at the 5% level in 14 markets. The null hypothesis of no causality is rejected at the 5% level again for soybeans and also for natural gas. Once again, the estimated direction of the impact is negative in both markets, suggesting that larger swap dealer positions lead to lower implied volatility. While the null hypothesis of no causality is rejected for the system (p-value =0.0005), the cumulative directional impact (-4.0300) is not statistically different from zero (p-value=0.5821).

Similar but stronger findings are again found when measuring positions with the percent of longs. As shown in Table 30, the null hypothesis is rejected in 4 of the 14 individual markets at the 5% level. The agricultural markets with rejections--soybeans, soybean oil, and coffee--are the same as those with those rejections in Table 28, plus the null is also rejected for natural gas. The direction of the impact is negative in all 4 of the rejections and in 10 of the 14 markets overall. Not surprisingly, the system-wide test rejects the null hypothesis that of no causality (*p*-value=0.0001); but, more importantly the cumulative direction of the impact is systematically negative (*p*-value=0.0083).

The results in Tables 27-30 are reasonably consistent in suggesting that higher levels of index trader or swap dealer participation in the markets—especially as measured by the percent of long positions—are associated with lower levels of implied volatility in subsequent weeks. While there are some markets (soybeans, soybean oil, and coffee) with consistent rejections, the strongest results are manifest in the system-wide rejections. Specifically, in both Tables 28 and 30 a systematic negative leading relationship is found from trader positions to subsequent implied volatility.

Care must be taken when interpreting these results. The lead-lag relationship does not necessarily imply that index trader positions have some dampening impact on implied volatility. It may simply indicate that larger index fund or swap dealer positions coincide with other fundamental factors that portend lower volatility levels.

5.3.3. Positions Lead Actual Volatility Test Results

While the prior set of tests focused on implied or forward-looking volatility. Granger causality tests are also performed to see if positions lead actual or realized volatility (RV) as measured by Parkinson's high-low estimator. For example, the model analogous to (9) would be as follows,

(10) $$RV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} RV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k}$$ for each market k and time t.

Tables 31 and 32 represent realized volatility (RV) test results for (10) that are analogous to the implied volatility (IV) results in Tables 27 and 28. The results are relatively consistent, except the rejections generally occurs using net positions (Table 31) instead of the percent of long positions (Table 32).

In Table 31, the tests of coefficient restrictions failed to reject that the $\beta_{1,k}$ coefficients were the same across markets, k. So, this is a common or pooled parameter ($\beta_{1,\cdot}$) across all of the equations. Only the coffee market was specified with a $\beta_{2,k}$, yielding slightly different results for this market. Still, the common pooled $\beta_{1\cdot}$ coefficient is negative and statistically less than zero. Likewise, the $\beta_{2,k}$ coefficient for coffee is negative, leading to a negative and statistically significant cumulative impact for the system ($\beta_{1\cdot}+\beta_{2,k}$ =-11.92). In Table 32, $\beta_{1\cdot}$ is again pooled as a common parameter across equations; but, in this case, it is not statistically different from zero (p-value=0.4307). Since no other lags of LONG positions enter the equations, then the only test of importance is just that regarding the common parameter ($\beta_{1\cdot}$). Overall, these results (especially Table 31) are reasonably consistent with the results for implied volatility, suggesting that the directional impact between index trader positions and volatility is negative.

In Tables 33 and 34, the parallel tests for are conducted using the swap dealer positions. These results are consistent with those using *CIT* positions. In Table 33, the SUR system rejections the null of no causality in soybeans and cocoa at the 5% level. Coffee is the only market with two lags of positions and it has a negative cumulative impact (p-value = 0.0581). The system results are consistent with those in Table 31: the null of no causality is rejected at the 5% level and the cumulative impact is negative (p-value=0.0131). Similarly, the results in Table

34 are consistent with Table 32: the β_1 coefficient is pooled as a common parameter that is not statistically different from zero.

The results for the causality tests between actual volatility and positions tend to hinge on the market measure. When positions are measured as the net position (in contracts) there is a consistent and systematic rejection of the null hypothesis where the cumulative directional impact between positions and realized volatility is negative (see Tables 31 and 33). When positions are measured as the percent of net longs (see Tables 32 and 34) there is no causal relationship found between positions and subsequent realized volatility. These results highlight the potential sensitivity of causality tests to model specification and position measures. While the findings for realized volatility are not overwhelming, they are directionally consistent with those for implied volatility and provide some incremental evidence suggesting that index and swap dealer positions actually portend less price variability.

5.3.4. Speculative Index Leads Volatility Test Results

Market observers often suggest that speculation leads to greater market volatility. The previous tests have focused on the impact of index trader positions or swap dealer positions on returns and market volatility. An alternative approach is to focus on a more rigorous measure of speculative levels within the markets. The positions held by one group of speculative traders, may or may not reflect a higher level of overall speculation in the market place. Here we directly test the hypothesis that excessive speculation impacts variability by performing the SUR Granger causality tests between measures of market volatility and Working's speculative "T" index. For example, the following model is estimated to test for the lead-lag relationship between the "T" index and implied volatility (IV):

(11) $$IV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} IV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} TIndex_{t-j,k} + \varepsilon_{t,k}$$ for each market k at time t.

Due to classification considerations, the "T" index can only be calculated for the *CIT* data, so estimation of (11) focus on the 12 agricultural markets included in the *CIT* data set.

The null hypothesis that the speculative index does not lead implied volatility is tested using Granger causality in the same SUR framework. The results are presented in Table 35. In this case, a test of common $\beta_{1,k}$ parameters is not rejected, so a common $\beta_{1.}$ is estimated for system. The T-index does not enter the model specifications at any lag beyond one time period. So, the only test of importance is for the null that $\beta_{1.}$=0, which is not rejected at conventional levels. There is no evidence that an increase in speculation—as measured by Working's T index—leads to higher implied volatility.

In Table 36, the measure of volatility is now the realized or actual volatility. In this case, the null hypothesis of a common $\beta_{1,k}$ parameter across markets is rejected allowing for market-by-market causality tests. The null hypothesis that the T-index does not lead actual volatility is rejected at the 5% level for corn, feeder cattle, lean hogs, and cocoa. In each of these markets, the estimated direction of the impact is positive, suggesting that higher levels of speculation (in excess of that needed to balance hedging) may lead to greater market volatility. For example, if the speculative index in lean hogs increases by 0.10, then actual volatility the following week increases by 1.18%. The four individual market rejections lead to a system rejection of no causality (p-value=0.0028); however, the mixed signs on the $\beta_{1,k}$ coefficients lead to a positive but statistically insignificant cumulative directional impact.

The results for the causality tests using Working's T are mixed depending on the use of actual or implied volatility. Still, the findings in Table 36 are noteworthy when compared to the analogous model in Table 31. In Table 31, the directional relationship between net positions held by index traders and realized volatility is statistically significant and negative. Conversely, the results in Table 36 suggest some positive directional relationship between Working's speculative index and realized volatility in certain markets. The direction of the impact in these two systems is clearly at odds. This suggests that the focus of regulators on index fund positions in isolation may be misguided. Rather, the level of speculation relative to hedging, as measured by Working's T-index may be a more useful indicator. This is very consistent with the original concept of Working (1960) that only speculation beyond that needed to balance hedging is truly excessive. The debate in regards to speculation and market performance may benefit from additional reliance on this classic speculative measure (see also Sanders, Irwin, and Merrin, 2010).

6. Summary and Conclusions

Investment in long-only commodity index funds soared over the last five years. Some refer to this surge and its attendant impacts as the "financialization" of commodity futures markets. In view of the scale of this investment—in the hundreds of billions of dollars—it is not surprising that a world-wide debate has ensued about the role of index funds in commodity futures markets. Those who believe index funds were responsible for a bubble in commodity futures prices (e.g., Masters, 2008) make what seems like an obvious argument—the sheer size of index investment overwhelmed the normal functioning of these markets. Those who do not believe index funds were behind the run-up in commodity futures prices in recent years point out logical inconsistencies in the bubble argument and several contradictory facts (e.g., Irwin, Sanders, and Merrin, 2009).

Not surprisingly, a flurry of studies has been completed recently in an attempt to sort out which side of the debate is correct. Some of these studies find evidence that commodity index funds have impacted commodity futures prices (Gilbert, 2009; Einloth, 2009; Tang and Xiong, 2010). However, the data and methods used in these studies are subject to a number of important criticisms that limits the degree of confidence one can place in the results. A number of studies find little evidence of a relationship between index fund positions and movements in commodity futures prices (Stoll and Whaley, 2009; Buyuksahin and Harris, 2009; Sanders and Irwin, 2010a, 2010b; Aulerich, Irwin, and Garcia, 2010) and this constitutes a rejection of Hamilton's (2009b) first theoretical requirement for speculative impacts. The most recent evidence in crude oil markets (Kilian and Murphy, 2010) also indicates a rejection of Hamilton's second theoretical requirement for speculative impacts—a zero or near zero price elasticity of demand. In sum, the weight of the existing evidence clearly tilts in favor of the argument that index funds did not cause a bubble in commodity futures prices.

There is still a need for further research on the market impact of commodity index funds. The first reason is ongoing concerns about the power of time-series statistical tests used in the studies that fail to find evidence of a relationship between index fund positions and movements in commodity futures prices. The time-series tests may lack statistical power to reject the null hypothesis because the dependent variable—the change in futures price—is extremely volatile. The second reason is that direct tests of the relationship between index fund positions and price movements in energy futures markets have been hampered by the lack of publically-available data on positions of index funds in these markets. In our empirical analysis, we attempted to address both of these deficiencies.

Our empirical analysis relies on two related data sets compiled by the U.S. Commodity Futures Trading Commission (CFTC). Data from the *Supplemental Commodity Index Trader* (CIT) report shows the positions held by index funds in 12 grain, livestock, and soft commodity futures markets. The *Disaggregated Commitments of Traders* (DCOT) report provides details as to the positions held by swap dealers—which are assumed to reflect index-type investments—in 22 commodity futures markets that include metals and energy. The two data sets are used to test if index funds impact either returns or price volatility across 14 grain, livestock, soft and energy futures markets. The sample period begins on June 13, 2006 and ends on December 29, 2009, yielding a total of 186 weekly observations for analysis.

Bivariate Granger causality tests are used to investigate lead-lag dynamics between index fund positions and futures returns (price changes) or price volatility in each commodity futures market. In addition, a new systems approach to testing lead-lag dynamics is introduced and applied. The systems approach improves the power of statistical tests by taking into account the contemporaneous correlation of model residuals across markets and allows a test of the overall impact of index funds across markets.

Examination of the data characteristics and subsequent empirical modeling leads to the following general conclusions:

1. The overlap between index trader positions (*CIT* data set) and those held by swap dealers (*DCOT* data set) is quite large for the traditional grain and livestock markets. It appears to be a somewhat weaker correspondence for the coffee, sugar, and cocoa markets. It is clear that the swap dealer positions for the energy markets contain many traders other than index funds. Swap dealer positions are at best an imperfect proxy for index fund positions in the energy markets.

2. Index fund and swap dealer positions are large. In an absolute sense, the largest average position sizes held in nearly every market is by long index funds or swap dealers . In some markets, such as CBOT wheat, the average position size for these traders is in excess of the speculative position limits. In a relative sense, index and swap dealer positions can also be quite large. Index traders often hold as much as 40% of the long positions in a market and the swap dealer category frequently holds over 30% of the long positions in a given market.

3. There is no convincing evidence that positions held by index traders or swap dealers impact market returns. Except for a few instances in individual markets, Granger-style causality tests fail to reject the null hypothesis that that trader positions do not lead market returns.

4. Larger long positions by index traders and swap dealers lead to lower market volatility in a Granger sense. There is a consistent tendency across a number of position and volatility measures to reject the null hypothesis that index trader positions do not lead market volatility. The direction of the impact is routinely negative. While index positions lead to lower volatility in a statistical sense, it is possible that trader positions coincide with some other fundamental variable that is actually causing the lower market volatility. Still, this result is contrary to popular notions about index traders increasing market volatility.

5. Excessive speculation—as measured by Working's T-index—is associated with greater subsequent variability in a few markets. These results conflict with negative relationships found between index trader positions and market volatility. The contrasting results suggests that excessive speculation is broader than just index fund activity and may be better measured with Working's T-index, which measures excessive speculation relative to hedging demands.

The results summarized above tilt the weight of the evidence even further in favor of the argument that index funds did *not* cause a bubble in commodity futures prices. The evidence in our study is strongest for the agricultural futures markets because the data on index trader positions are measured with reasonable accuracy. The evidence is weaker in the two energy markets studied because of considerable uncertainty about the degree to which the available data actually reflect index trader positions in these markets. Perhaps the most surprising result is the consistent tendency for increasing index fund positions to be associated with *declining* volatility. This result is contrary to popular notions about the market impact of index funds, but is not so surprising in light of the traditional problem in commodity futures markets of the *inadequacy* of speculation (see Sanders, Irwin, and Merrin, 2010).

The policy implication of the available evidence on the market impact of commodity index funds is straightforward: current regulatory proposals to limit speculation—especially on the part of index funds—are not justified and likely will do more harm than good. In particular, limiting the participation of index fund investors would rob the commodity futures markets of an important source of liquidity and risk-absorption capacity at a time when both are in high demand. More ominously, tighter position limits on speculation in commodity futures markets combined with the removal of hedge exemptions could force commodity index funds into cash markets, where truly chaotic results could follow. The net result is that moves to tighten regulations on index funds are likely to make commodity futures markets less efficient mechanisms for transferring risk from parties who don't want to bear it to those that do, creating added costs that ultimately are passed back to producers in the form of lower prices and to consumers as higher prices.

As is usually the case, there is room for further research on the market impact of commodity index funds. First, better data is needed on the positions of index funds in energy futures markets in order to conduct more precise tests of return and volatility impacts in these important markets. Second, failure to reject the null hypothesis of no causality in a bivariate Granger framework does not preclude the possibility of impacts in a multivariate framework. Stoll and Whaley (2009) estimate a multivariate model of returns and changes in index fund and other speculator investment flows. While this did not alter their bivariate results it still may be a promising avenue for further investigation. Third, failure to reject the null hypothesis of no causality in a linear Granger framework does not preclude potentially nonlinear impacts or impacts over alternative time horizons. Certainly, many ways exist to model volatility (e.g., GARCH models) and these could produce different results than those presented here. There also are new models in the "econophysics" literature that may yield additional insights into market dynamics in the presence of large-scale index fund participation in commodity futures markets (e.g., Sornette, Woodward, and Zhou, 2009).

These conclusions do not necessarily imply that commodity futures markets have functioned flawlessly during the last several years. In particular, the lack of consistently acceptable convergence performance for CBOT corn, soybean, and wheat contracts since late 2005 has been widely discussed (e.g., Henriques, 2008). The failure of cash and futures prices to converge at contract expiration has existed for extended and varied periods. Performance has been consistently weakest in wheat, with delivery location basis at times exceeding one dollar per bushel, a level of disconnect between cash and futures not previously experienced in grain futures markets. The possible role of index funds in contributing to convergence problems has also been widely discussed (USS/PSI, 2009). Further research is needed to better understand the impact of index fund trading on this aspect of commodity market performance.

7. References

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8. Tables

Table 1. Summary Statistics, Weekly Percent Market Returns, June 2006-December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	-0.05	18.41	-16.49	5.50
Soybeans	0.31	11.34	-12.74	4.28
Soybean Oil	0.09	14.05	-11.60	4.38
CBOT Wheat	-0.13	14.65	-17.63	5.49
KCBOT Wheat	-0.12	14.78	-16.37	4.98
Cotton	-0.20	12.23	-16.84	4.26
Live Cattle	-0.23	5.45	-5.40	2.02
Feeder Cattle	-0.16	6.38	-6.67	2.18
Lean Hogs	-0.49	8.86	-12.24	3.59
Coffee	0.00	8.73	-13.30	3.83
Sugar	-0.06	13.18	-18.82	5.22
Cocoa	0.42	14.31	-14.47	4.62
Crude Oil	-0.41	21.89	-25.14	5.95
Natural Gas	-1.16	20.76	-16.76	6.93

Table 2. Summary Statistics, Implied Volatility (annualized %), June 2006-December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	36.6	57.4	22.3	7.6
Soybeans	32.0	60.4	15.7	9.6
Soybean Oil	28.6	54.3	12.2	7.7
CBOT Wheat	39.7	75.0	23.0	9.2
KCBOT Wheat	36.5	71.3	21.4	8.7
Cotton	30.9	83.2	15.0	10.9
Live Cattle	17.1	27.8	11.0	3.1
Feeder Cattle	15.3	26.2	9.7	3.6
Lean Hogs	30.8	194.8	14.5	21.0
Coffee	33.3	50.2	21.5	6.4
Sugar	35.2	61.9	18.7	9.8
Cocoa	36.0	69.7	16.7	10.1
Crude Oil	45.7	141.5	24.1	21.4
Natural Gas	59.4	111.7	35.0	15.9

Table 3. Summary Statistics, Parkinson's High-Low Volatility Estimator (annualized %), June 2006-December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	32.1	79.7	9.6	14.0
Soybeans	26.2	82.4	8.4	13.0
Soybean Oil	24.8	84.5	7.3	12.3
CBOT Wheat	34.4	106.2	13.7	14.0
KCBOT Wheat	31.0	86.1	11.5	12.8
Cotton	26.6	83.9	4.1	14.4
Live Cattle	12.9	29.8	3.8	5.1
Feeder Cattle	13.6	35.5	4.7	5.9
Lean Hogs	21.2	61.8	4.8	9.1
Coffee	25.4	75.2	7.5	10.2
Sugar	32.2	105.3	7.3	15.3
Cocoa	28.4	88.1	8.8	13.4
Crude Oil	36.3	135.2	13.0	19.7
Natural Gas	48.6	121.5	15.7	20.1

Table 4. Summary Statistics, Working's Speculative T-Index, Adjusted for Index Trader Positions, June 2006- December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	1.15	1.34	1.07	0.06
Soybeans	1.17	1.53	1.09	0.09
Soybean Oil	1.12	1.36	1.04	0.07
CBOT Wheat	1.44	1.87	1.19	0.16
KCBOT Wheat	1.18	1.34	1.08	0.06
Cotton	1.16	1.48	1.03	0.11
Live Cattle	1.33	1.50	1.15	0.07
Feeder Cattle	1.86	3.28	1.32	0.38
Lean Hogs	1.43	2.01	1.17	0.19
Coffee	1.17	1.41	1.04	0.08
Sugar	1.15	1.26	1.06	0.04
Cocoa	1.14	1.28	1.06	0.05

Table 5. Average Number of Reporting Traders, *CIT* Trader Category, June 2006-December 2009.

		Non-Commercial			Commercial		Index	
Market	Total	Long	Short	Spread	Long	Short	Long	Short
Corn	739	185	142	240	259	321	26	14
Soybeans	461	140	106	170	110	156	26	11
Soybean Oil	202	56	42	64	51	58	18	6
CBOT Wheat	367	92	122	143	67	99	26	14
KCBOT Wheat	165	43	23	33	49	67	17	3
Cotton	276	108	66	81	58	59	24	7
Live Cattle	336	81	72	88	81	139	25	5
Feeder Cattle	132	30	28	28	28	41	18	2
Lean Hogs	217	61	68	81	28	45	22	5
Coffee	375	132	83	105	99	110	24	5
Sugar	230	68	50	71	70	74	24	11
Cocoa	164	57	31	37	37	43	19	3

Table 6. Average Number of Reporting Traders, *DCOT* Trader Category, June 2006-December 2009.

Market	Managed Money			Producers & Merchants		Swap Dealers			Other Reporting		
	Long	Short	Spread	Long	Short	Long	Short	Spread	Long	Short	Spread
Corn	88	37	64	251	314	20	4	19	109	105	179
Soybeans	80	28	49	103	150	18	5	15	72	78	123
Soybean Oil	41	19	17	47	54	15	2	8	21	24	47
CBOT Wheat	56	54	49	60	90	17	7	17	48	68	96
KCBOT Wheat	27	10	13	46	65	15	0	6	20	14	21
Cotton	64	37	27	49	52	18	6	11	54	30	55
Live Cattle	60	44	43	77	134	16	4	8	32	28	47
Feeder Cattle	24	15	10	27	40	11	1	2	13	13	19
Lean Hogs	42	39	34	26	43	15	0	7	28	29	49
Coffee	65	37	28	93	104	17	5	9	77	46	78
Sugar	44	23	27	59	62	17	9	20	34	27	45
Cocoa	46	15	14	32	37	15	5	7	18	16	23
Crude Oil	59	48	63	50	63	18	19	34	57	63	101
Natural Gas	44	40	49	57	50	15	13	25	28	33	50

Table 7. Average Position Size (# of contracts), *CIT* Trader Category, June 2006-December 2009.

Market	Non-Commercial			Commercial		Index		Spec.
	Long	Short	Spread	Long	Short	Long	Short	Limit[a]
Corn	1,078	629	2,101	1,522	2,354	14,947	1,935	22,000
Soybeans	594	324	1,027	1,021	1,746	5,889	817	10,000
Soybean Oil	734	550	1,139	1,722	3,177	3,967	661	6,500
CBOT Wheat	538	558	956	859	1,910	7,541	1,321	6,500
KCBOT Wheat	623	455	517	624	1,023	1,752	247	6,500
Cotton	364	343	1,001	964	2,763	3,797	511	5,000
Live Cattle	584	498	735	420	887	4,562	389	5,150
Feeder Cattle	235	182	193	160	150	450	148	1,000
Lean Hogs	417	435	611	682	1,863	3,681	407	4,100
Coffee	235	241	495	401	893	1,888	314	5,000
Sugar	1,655	1,164	3,100	3,908	7,842	11,941	4,531	15,000
Cocoa	763	685	511	1,531	2,465	1,042	378	6,000

[a]Limits for futures plus delta-adjusted options positions, all contract months combined.

Table 8. Average Position Size (# of contracts) of Reporting Traders, *DCOT* Trader Category, June 2006-December 2009.

Market	Producers & Merchants		Swap Dealers			Managed Money			Other Reporting		
	Long	Short	Long	Short	Spread	Long	Short	Spread	Long	Short	Spread
Corn	1,388	2,304	16,808	3,024	2,688	2,328	1,310	2,086	527	367	2,093
Soybeans	991	1,759	7,126	1,462	854	1,104	553	1,130	228	222	982
Soybean Oil	1,684	3,238	4,388	2,964	858	994	813	1,376	358	333	1,058
CBOT Wheat	783	1,910	9,655	2,211	1,074	1,198	893	994	258	292	928
KCBOT Wheat	624	1,045	1,546	82	213	951	714	594	509	214	467
Cotton	1,020	2,934	4,490	1,619	499	598	552	530	179	108	1,209
Live Cattle	406	886	5,793	1,097	423	959	615	661	332	309	785
Feeder Cattle	163	150	416	165	137	371	251	104	152	112	236
Lean Hogs	690	1,940	4,694	0	535	679	565	616	336	256	596
Coffee	405	905	2,383	978	232	431	451	454	112	83	508
Sugar	4,319	8,125	11,664	6,780	2,875	3,021	1,921	2,405	805	446	3,508
Cocoa	1,567	2,493	1,053	2,116	929	985	1,191	604	170	265	429
Crude Oil	7,334	8,117	9,817	7,132	22,904	2,664	1,529	5,711	1,172	823	5,457
Natural Gas	2,590	2,995	7,836	5,717	9,790	2,320	4,706	8,191	718	1,181	2,157

Table 9. Percent of Total Open Interest Held by *CIT* Category, June 2006-December 2009.

Market	Non-Commercial	Commercial	Index	Non-Reporting
Corn	39%	35%	13%	14%
Soybeans	40%	33%	14%	14%
Soybean Oil	35%	44%	12%	8%
CBOT Wheat	41%	26%	23%	10%
KCBOT Wheat	28%	39%	12%	20%
Cotton	39%	38%	17%	6%
Live Cattle	38%	28%	20%	14%
Feeder Cattle	38%	17%	14%	31%
Lean Hogs	39%	25%	21%	14%
Coffee	43%	39%	13%	5%
Sugar	31%	44%	17%	8%
Cocoa	33%	54%	7%	6%

Table 10. Percent of Total Open Interest Held by *DCOT* Category, June 2006-December 2009.

Market	Managed Money	Producers & Merchants	Swap Dealers	Other Reporting	Non-Reporting
Corn	16%	32%	13%	25%	14%
Soybeans	19%	31%	13%	23%	14%
Soybean Oil	17%	42%	14%	18%	8%
CBOT Wheat	22%	23%	22%	22%	10%
KCBOT Wheat	19%	38%	10%	13%	20%
Cotton	16%	35%	18%	25%	6%
Live Cattle	25%	27%	18%	16%	14%
Feeder Cattle	23%	17%	9%	20%	31%
Lean Hogs	23%	25%	19%	19%	14%
Coffee	20%	37%	14%	25%	5%
Sugar	16%	39%	19%	18%	8%
Cocoa	26%	48%	12%	9%	6%
Crude Oil	18%	18%	37%	23%	3%
Natural Gas	43%	12%	28%	11%	5%

Table 11. Percent Net Long by *CIT* Trader Category, June 2006-December 2009.

Market	Non-Commercial	Commercial	Index	Non-Reporting
Corn	35%	-31%	86%	-23%
Soybeans	39%	-40%	88%	-19%
Soybean Oil	22%	-34%	89%	17%
CBOT Wheat	-16%	-54%	83%	-25%
KCBOT Wheat	39%	-37%	94%	-16%
Cotton	26%	-50%	92%	26%
Live Cattle	13%	-56%	97%	-38%
Feeder Cattle	13%	-14%	89%	-39%
Lean Hogs	-6%	-64%	94%	-18%
Coffee	20%	-42%	93%	17%
Sugar	33%	-35%	70%	15%
Cocoa	37%	-29%	88%	27%

Table 12. Percent Net Long by *DCOT* Trader Category, June 2006-December 2009.

Market	Managed Money	Producers & Merchants	Swap Dealers	Other Reporting	Non-Reporting
Corn	57%	-34%	94%	19%	-23%
Soybeans	64%	-43%	93%	-2%	-19%
Soybean Oil	36%	-36%	86%	-5%	17%
CBOT Wheat	15%	-59%	83%	-23%	-25%
KCBOT Wheat	55%	-39%	96%	55%	-16%
Cotton	30%	-51%	80%	48%	26%
Live Cattle	36%	-58%	93%	10%	-38%
Feeder Cattle	38%	-15%	84%	15%	-39%
Lean Hogs	12%	-66%	99%	12%	-18%
Coffee	25%	-42%	84%	40%	17%
Sugar	46%	-33%	51%	41%	15%
Cocoa	48%	-29%	41%	-15%	27%
Crude Oil	36%	-16%	14%	13%	-2%
Natural Gas	-20%	0%	23%	-29%	32%

Table 13. Percent of Long and Short Positions by *CIT* Trader Category, June 2006-December 2009.

Panel A: Long Positions

Market	Non-Commercial	Commercial	Index	Non-Reporting
Corn	42%	24%	23%	11%
Soybeans	44%	19%	26%	11%
Soybean Oil	38%	29%	23%	10%
CBOT Wheat	39%	12%	41%	8%
KCBOT Wheat	34%	25%	24%	17%
Cotton	42%	19%	32%	8%
Live Cattle	39%	12%	40%	9%
Feeder Cattle	40%	15%	26%	19%
Lean Hogs	38%	9%	42%	12%
Coffee	45%	23%	26%	6%
Sugar	34%	28%	29%	9%
Cocoa	40%	38%	14%	8%

Panel B: Short Positions

Market	Non-Commercial	Commercial	Index	Non-Reporting
Corn	36%	45%	2%	17%
Soybeans	36%	46%	2%	16%
Soybean Oil	32%	60%	1%	7%
CBOT Wheat	44%	40%	4%	13%
KCBOT Wheat	22%	54%	1%	23%
Cotton	37%	57%	1%	5%
Live Cattle	36%	44%	1%	20%
Feeder Cattle	36%	20%	2%	43%
Lean Hogs	40%	41%	1%	17%
Coffee	40%	55%	1%	4%
Sugar	29%	59%	5%	7%
Cocoa	25%	69%	1%	4%

Table 14. Percent of Long and Short Positions by *DCOT* Trader Category, June 2006-December 2009.

Panel A: Long Positions

Market	Managed Money	Producers & Merchants	Swap Dealers	Other Reporting	Non-Reporting
Corn	20%	21%	22%	26%	11%
Soybeans	24%	18%	24%	23%	11%
Soybean Oil	21%	27%	24%	18%	10%
CBOT Wheat	24%	10%	37%	22%	8%
KCBOT Wheat	26%	23%	18%	15%	17%
Cotton	18%	17%	31%	26%	8%
Live Cattle	30%	11%	34%	17%	9%
Feeder Cattle	30%	14%	16%	21%	19%
Lean Hogs	25%	8%	36%	19%	12%
Coffee	22%	21%	24%	26%	6%
Sugar	20%	26%	26%	19%	9%
Cocoa	35%	34%	15%	8%	8%
Crude Oil	20%	15%	38%	24%	3%
Natural Gas	40%	12%	30%	11%	7%

Panel B: Short Positions

Market	Managed Money	Producers & Merchants	Swap Dealers	Other Reporting	Non-Reporting
Corn	11%	43%	4%	25%	17%
Soybeans	13%	44%	3%	23%	16%
Soybean Oil	13%	57%	4%	18%	7%
CBOT Wheat	21%	36%	7%	23%	13%
KCBOT Wheat	12%	53%	1%	10%	23%
Cotton	13%	53%	5%	24%	5%
Live Cattle	20%	42%	2%	16%	20%
Feeder Cattle	16%	20%	2%	20%	17%
Lean Hogs	22%	41%	1%	18%	17%
Coffee	17%	52%	3%	23%	4%
Sugar	12%	52%	12%	17%	7%
Cocoa	16%	62%	9%	9%	4%
Crude Oil	17%	21%	36%	23%	4%
Natural Gas	45%	13%	26%	12%	4%

Table 15. Summary Statistics, Net Long Positions Held by Index Traders (# of contracts), June 2006-December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	354,043	452,568	223,985	64,877
Soybeans	140,651	198,707	89,731	26,004
Soybean Oil	66,011	77,752	36,630	10,192
CBOT Wheat	174,677	205,585	126,545	21,769
KCBOT Wheat	28,654	46,527	16,293	6,011
Cotton	84,985	122,555	57,841	15,209
Live Cattle	110,006	156,752	80,276	20,632
Feeder Cattle	7,479	10,889	4,972	1,456
Lean Hogs	80,616	127,379	46,004	18,538
Coffee	44,451	67,021	30,572	9,697
Sugar	231,756	392,740	135,745	74,836
Cocoa	18,910	31,883	5,117	5,830

Table 16. Summary Statistics, Net Long Position Held by Swap Dealers (# of contracts), June 2006-December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	313,172	430,100	163,606	77,941
Soybeans	121,557	193,888	73,898	27,892
Soybean Oil	61,453	89,502	27,442	16,234
CBOT Wheat	142,550	189,217	91,681	25,373
KCBOT Wheat	22,073	33,863	9,952	6,906
Cotton	72,092	118,380	42,637	16,797
Live Cattle	88,844	128,967	65,368	16,351
Feeder Cattle	4,161	6,723	1,730	1,194
Lean Hogs	69,149	114,377	36,326	16,858
Coffee	37,179	56,959	21,667	8,718
Sugar	132,099	271,255	-32,149	81,371
Cocoa	8,380	16,474	-5,103	4,763
Crude Oil	40,912	106,176	-10,534	27,504
Natural Gas	49,018	253,500	-67,553	78,063

Table 17. Summary Statistics, Percent of Long Positions Held by Index Traders, June 2006-December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	23.3	33.1	16.7	3.5
Soybeans	25.7	32.7	19.8	2.5
Soybean Oil	23.2	31.1	17.8	2.6
CBOT Wheat	41.3	50.1	32.0	4.1
KCBOT Wheat	23.9	33.2	12.3	5.0
Cotton	31.9	43.9	21.1	5.5
Live Cattle	39.6	47.2	32.0	4.7
Feeder Cattle	26.4	35.2	16.8	4.5
Lean Hogs	41.6	47.8	30.9	3.5
Coffee	25.8	42.7	18.9	5.2
Sugar	28.7	37.7	21.9	4.1
Cocoa	13.6	22.2	7.8	3.4

Table 18. Summary Statistics, Percent of Long Positions Held by Swap Dealers, June 2006-December 2009.

Market	Mean	Maximum	Minimum	St. Dev.
Corn	22.5	29.0	17.0	2.4
Soybeans	23.7	28.2	19.8	1.6
Soybean Oil	23.9	30.5	17.4	2.9
CBOT Wheat	37.4	44.5	31.5	2.9
KCBOT Wheat	18.4	24.6	11.4	3.2
Cotton	31.1	41.9	22.1	4.7
Live Cattle	33.7	41.0	27.4	4.0
Feeder Cattle	15.6	22.2	10.1	2.9
Lean Hogs	36.0	42.6	26.7	3.4
Coffee	24.0	36.8	17.6	4.7
Sugar	25.9	34.2	20.5	3.7
Cocoa	14.6	23.8	9.8	3.4
Crude Oil	37.5	45.0	30.4	4.2
Natural Gas	30.2	38.6	22.3	5.1

Table 19. Augmented Dickey-Fuller (ADF) Test for Unit Root in Market Measures, June 2006-December 2009.

	Levels			Differences		
Market	Returns	Implied Volatility	Parkinson's Estimator	Returns	Implied Volatility	Parkinson's Estimator
Corn	Y	Y	Y	-	Y	Y
Soybeans	Y	**N**	Y	-	Y	Y
Soybean Oil	Y	N	**N**	-	Y	Y
CBOT Wheat	Y	Y	Y	-	Y	Y
KCBOT Wheat	Y	Y	Y	-	Y	Y
Cotton	Y	N	Y	-	Y	Y
Live Cattle	Y	Y	Y	-	Y	Y
Feeder Cattle	Y	Y	Y	-	Y	Y
Lean Hogs	Y	Y	Y	-	Y	Y
Coffee	Y	Y	Y	-	Y	Y
Sugar	Y	**N**	Y	-	Y	Y
Cocoa	Y	**N**	Y	-	Y	Y
Crude Oil	Y	**N**	**N**	-	Y	Y
Natural Gas	Y	Y	Y	-	Y	Y

Notes: "Y" indicates that the ADF test rejected the null hypothesis of a unit root at the 10% level, suggesting the data are stationary. "N" indicates that the ADF test failed to reject the null hypothesis of a unit root at the 10% level, suggesting the data are non-stationary.

Table 20. Augmented Dickey-Fuller (ADF) Test for Unit Root in *CIT* Positions, June 2006-December 2009.

	Levels			Differences		
Market	Net Position	Percent of Longs	Percent of Open Interest	Net Position	Percent of Longs	Percent of Open Interest
Corn	**N**	**N**	**N**	Y	Y	Y
Soybeans	**N**	**N**	**N**	**N**	Y	Y
Soybean Oil	**N**	**N**	**N**	Y	Y	Y
CBOT Wheat	**N**	Y	Y	Y	Y	Y
KCBOT Wheat	**N**	**N**	**N**	Y	Y	Y
Cotton	**N**	**N**	**N**	Y	Y	Y
Live Cattle	**N**	**N**	**N**	Y	Y	Y
Feeder Cattle	**N**	Y	Y	Y	Y	Y
Lean Hogs	**N**	**N**	**N**	Y	Y	Y
Coffee	**N**	**N**	**N**	Y	Y	Y
Sugar	**N**	**N**	**N**	Y	Y	Y
Cocoa	**N**	**N**	**N**	Y	Y	Y

Notes: "Y" indicates that the ADF test rejected the null hypothesis of a unit root at the 10% level, suggesting the data are stationary. "N" indicates that the ADF test failed to reject the null hypothesis of a unit root at the 10% level, suggesting the data are non-stationary.

Table 21. Augmented Dickey-Fuller (ADF) Test for Unit Root in *DCOT* Positions, Swap Dealers, June 2006-December 2009.

	Levels			Differences		
Market	Net Position	Percent of Longs	Percent of Open Interest	Net Position	Percent of Longs	Percent of Open Interest
Corn	**N**	**N**	**N**	**N**	Y	Y
Soybeans	**N**	**N**	**N**	Y	Y	Y
Soybean Oil	**N**	**N**	**N**	Y	Y	Y
CBOT Wheat	**N**	Y	Y	Y	Y	Y
KCBOT Wheat	**N**	Y	Y	**N**	Y	Y
Cotton	**N**	**N**	**N**	Y	Y	Y
Live Cattle	**N**	**N**	**N**	Y	Y	Y
Feeder Cattle	**N**	Y	Y	Y	Y	Y
Lean Hogs	**N**	**N**	Y	Y	Y	Y
Coffee	**N**	**N**	**N**	Y	Y	Y
Sugar	**N**	**N**	**N**	Y	Y	Y
Cocoa	**N**	**N**	**N**	Y	Y	Y
Crude Oil	Y	**N**	**N**	Y	Y	Y
Natural Gas	**N**	**N**	**N**	Y	Y	Y

Notes: "Y" indicates that the ADF test rejected the null hypothesis of a unit root at the 10% level, suggesting the data are stationary. "N" indicates that the ADF test failed to reject the null hypothesis of a unit root at the 10% level, suggesting the data are non-stationary.

Table 22. Augmented Dickey-Fuller (ADF) Test for Unit Root in Working's T-index, June 2006-December 2009.

	Levels	Differences
Market	T-Index	T-Index
Corn	**N**	Y
Soybeans	Y	Y
Soybean Oil	**N**	Y
CBOT Wheat	**N**	Y
KCBOT Wheat	Y	Y
Cotton	Y	Y
Live Cattle	Y	Y
Feeder Cattle	Y	Y
Lean Hogs	**N**	Y
Coffee	**N**	Y
Sugar	Y	Y
Cocoa	Y	Y

Notes: "Y" indicates that the ADF test rejected the null hypothesis of a unit root at the 10% level, suggesting the data are stationary. "N" indicates that the ADF test failed to reject the null hypothesis of a unit root at the 10% level, suggesting the data are non-stationary.

Table 23. Granger Causality Test Results for *CIT* Net Positions Do Not Lead Returns, June 2006-December 2009.

$$R_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} R_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k} \text{ for each market, } k \text{, and time, } t.$$

Market, k	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	1,1	0.0002	-0.1210	
Soybeans	1,1	0.4206	-0.0444	
Soybean Oil	1,1	0.2922	0.0874	
CBOT Wheat	1,1	0.3629	0.0319	
KCBOT Wheat	1,1	0.1261	-0.1460	
Cotton	1,1	0.0018	0.3590	
Live Cattle	2,2	0.1812	0.0008	0.9861
Feeder Cattle	2,1	0.1300	-0.3730	
Lean Hogs	1,1	0.2078	-0.1320	
Coffee	1,1	0.3348	-0.1730	
Sugar	1,1	0.2647	-0.0520	
Cocoa	1,1	0.4591	0.1610	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.0001	-0.4010	0.3836

Notes: $\sum \beta_j$ values are taken to the 10^5 power. The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\alpha_1 = \alpha_2 = \ldots = \alpha_K$; $\gamma_{1,1} = \gamma_{1,2} = \ldots = \gamma_{1,K}$; and $\gamma_{2,1} = \gamma_{2,2} = \ldots = \gamma_{2,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 24. Granger Causality Test Results for *CIT* Percent of Long Positions Do Not Lead Returns, June 2006-December 2009.

$$R_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} R_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta LONG_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market, k	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	1,1	0.0490	-0.5981	
Soybeans	1,1	0.7024	-0.0628	
Soybean Oil	1,1	0.3631	0.1591	
CBOT Wheat	1,1	0.8750	-0.0114	
KCBOT Wheat	1,1	0.3878	-0.0816	
Cotton	1,2	0.1962	0.3737	0.0197
Live Cattle	1,2	0.1584	0.2706	0.0017
Feeder Cattle	2,1	0.0960	-0.0881	
Lean Hogs	1,1	0.2278	-0.2057	
Coffee	1,1	0.6768	0.0719	
Sugar	1,1	0.0740	0.5949	
Cocoa	1,1	0.8478	0.0688	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.0119	0.3178	0.6711

Note: The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\alpha_1 = \alpha_2 = \ldots = \alpha_K$; $\beta_{2,1} = \beta_{2,2} = \ldots = \beta_{2,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 25. Granger Causality Test Results for *DCOT* Net Swap Dealer Net Positions Do Not Lead Returns, June 2006-December 2009.

$$R_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} R_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market,k	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	1,1	0.1694	-0.0018	
Soybeans	1,1	0.1694	-0.0018	
Soybean Oil	1,1	0.1694	-0.0018	
CBOT Wheat	1,1	0.1694	-0.0018	
KCBOT Wheat	1,1	0.1694	-0.0018	
Cotton	1,1	0.1694	-0.0018	
Live Cattle	2,2	0.2994	-0.0017	0.6868
Feeder Cattle	2,1	0.1694	-0.0018	
Lean Hogs	1,1	0.1694	-0.0018	
Coffee	1,1	0.1694	-0.0018	
Sugar	1,1	0.1694	-0.0018	
Cocoa	1,1	0.1694	-0.0018	
Crude Oil	1,1	0.1694	-0.0018	
Natural Gas	3,1	0.1694	-0.0018	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.2994	0.0017	0.6868

Notes: $\sum \beta_j$ values are taken to the 10^5 power. The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\alpha_1 = \alpha_2 = \ldots = \alpha_K$; $\gamma_{2,1} = \gamma_{2,2} = \ldots = \gamma_{2,K}$; $\beta_{1,1} = \beta_{1,2} = \ldots = \beta_{1,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 26. Granger Causality Test Results for *DCOT* Swap Dealer's Percent of Long Positions Do Not Lead Returns, June 2006-December 2009.

$$R_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} R_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta LONG_{t-j,k} + \varepsilon_{t,k} \text{ for each market, } k \text{, and time, } t.$$

Market	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	1,1	0.9299	-0.0035	
Soybeans	1,1	0.9299	-0.0035	
Soybean Oil	1,1	0.9299	-0.0035	
CBOT Wheat	1,1	0.9299	-0.0035	
KCBOT Wheat	1,1	0.9299	-0.0035	
Cotton	1,1	0.9299	-0.0035	
Live Cattle	1,2	0.1246	0.1623	0.0590
Feeder Cattle	2,2	0.4519	-0.1007	0.2383
Lean Hogs	1,1	0.9299	-0.0035	
Coffee	1,1	0.9299	-0.0035	
Sugar	1,1	0.9299	-0.0035	
Cocoa	1,1	0.9299	-0.0035	
Crude Oil	1,1	0.9299	-0.0035	
Natural Gas	1,1	0.9299	-0.0035	

		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.1239	0.0651	0.5713

Note: The models are estimated across the K markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\alpha_1 = \alpha_2 = \ldots = \alpha_K$; $\beta_{1,1} = \beta_{1,2} = \ldots = \beta_{1,K}$ for all K markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all K markets.

Table 27. Granger Causality Test Results for *CIT* Net Positions Do Not Lead Implied Volatility, June 2006-December 2009.

$$IV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} IV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	1,1	0.1124	-0.4800	
Soybeans	3,1	0.0001	-2.9300	
Soybean Oil	4,1	0.0681	-2.0300	
CBOT Wheat	2,1	0.9635	-0.0306	
KCBOT Wheat	2,1	0.9297	-0.1420	
Cotton	4,1	0.1782	2.8800	
Live Cattle	2,3	0.0044	-2.1600	0.0148
Feeder Cattle	1,1	0.3933	-2.4500	
Lean Hogs	1,1	0.8524	-0.8280	
Coffee	2,1	0.6685	-1.1700	
Sugar	2,1	0.6687	0.2800	
Cocoa	2,1	0.6077	0.9840	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.0019	-8.0800	0.2683

Notes: $\sum \beta_j$ values are taken to the 10^5 power. The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{4,1} = \gamma_{4,2} = \ldots = \gamma_{4,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 28. Granger Causality Test Results for *CIT* Percent of Long Positions Do Not Lead Implied Volatility, June 2006-December 2009.

$$IV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} IV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta LONG_{t-j,k} + \varepsilon_{t,k}$$ for each market, k, and time, t.

Market	m,n	p-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	p-value $\sum \beta_j=0$
Corn	1,1	0.9362	-2.2712	
Soybeans	3,1	0.0465	-46.9639	
Soybean Oil	4,1	0.0028	-69.1077	
CBOT Wheat	2,1	0.3081	-13.4826	
KCBOT Wheat	2,1	0.0616	-29.0745	
Cotton	4,1	0.1935	-35.2701	
Live Cattle	3,1	0.2486	-12.2874	
Feeder Cattle	1,1	0.5776	3.4201	
Lean Hogs	1,1	0.5030	48.5390	
Coffee	2,1	0.0240	-56.9122	
Sugar	2,1	0.1864	-60.8718	
Cocoa	2,1	0.1409	46.4895	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	p-value $\sum\sum \beta_{j,k}=0$
System		0.0060	-227.7928	0.0502

Note: The models are estimated across the K markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{2,1} = \gamma_{2,2} = \ldots = \gamma_{2,K}$; $\gamma_{4,1} = \gamma_{4,2} = \ldots = \gamma_{4,K}$ for all K markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all K markets.

Table 29. Granger Causality Test Results for *DCOT* Swap Dealers Net Positions Do Not Lead Implied Volatility, June 2006-December 2009.

$$IV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} IV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market	*m,n*	*p*-value β_j=0, $\forall$j	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j$=0
Corn	1,1	0.1822	-0.3630	
Soybeans	3,1	0.0000	-2.9400	
Soybean Oil	4,1	0.1688	-1.0500	
CBOT Wheat	2,1	0.2661	0.6510	
KCBOT Wheat	2,1	0.8405	-0.3430	
Cotton	3,1	0.1614	2.6000	
Live Cattle	3,1	0.9342	0.0538	
Feeder Cattle	1,1	0.3466	-3.1100	
Lean Hogs	1,1	0.5871	2.5700	
Coffee	2,1	0.2567	-2.8600	
Sugar	2,1	0.3046	-0.6420	
Cocoa	2,1	0.2979	1.9600	
Crude Oil	4,1	0.5051	0.2700	
Natural Gas	1,1	0.0045	-0.8260	
		p-value $\beta_{j,k}$=0, $\forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}$=0
System		0.0005	-4.0300	0.5821

Notes: $\sum \beta_j$ values are taken to the 10^5 power. The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{2,1}= \gamma_{2,2} =\ldots=\gamma_{2,K}$; $\gamma_{4,1}= \gamma_{4,2} =\ldots=\gamma_{4,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 30. Granger Causality Test Results for *DCOT* Swap Dealers Percent of Long Positions Do Not Lead Implied Volatility, June 2006-December 2009.

$$IV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} IV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta LONG_{t-j,k} + \varepsilon_{t,k}$$ for each market, k, and time, t.

Market	m,n	p-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	p-value $\sum \beta_j=0$
Corn	1,1	0.9763	0.9374	
Soybeans	3,1	0.0151	-66.8450	
Soybean Oil	2,1	0.0002	-85.2577	
CBOT Wheat	2,1	0.6649	-7.0153	
KCBOT Wheat	2,1	0.0710	-32.8991	
Cotton	4,1	0.2209	-39.5005	
Live Cattle	3,1	0.2228	-15.3593	
Feeder Cattle	1,1	0.3946	7.9469	
Lean Hogs	1,1	0.1321	122.9580	
Coffee	2,1	0.0038	-79.6630	
Sugar	2,1	0.1554	-74.7681	
Cocoa	2,1	0.3018	25.9635	
Crude Oil	4,1	0.3553	-53.7034	
Natural Gas	1,1	0.0377	-95.7391	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	p-value $\sum\sum \beta_{j,k}=0$
System		0.0001	-392.9447	0.0083

Note: The models are estimated across the K markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{2,1}= \gamma_{2,2} =\ldots=\gamma_{2,K}$; $\gamma_{4,1}= \gamma_{4,2} =\ldots=\gamma_{4,K}$ for all K markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all K markets.

Table 31. Granger Causality Test Results for *CIT* Net Positions Do Not Lead Realized Volatility, June 2006-December 2009.

$$RV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} RV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k}$$ for each market, k, and time, t.

Market	m,n	p-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	p-value $\sum \beta_j=0$
Corn	2,1	0.0162	-1.3200	
Soybeans	4,1	0.0162	-1.3200	
Soybean Oil	2,1	0.0162	-1.3200	
CBOT Wheat	3,1	0.0162	-1.3200	
KCBOT Wheat	3,1	0.0162	-1.3200	
Cotton	4,1	0.0162	-1.3200	
Live Cattle	3,1	0.0162	-1.3200	
Feeder Cattle	3,1	0.0162	-1.3200	
Lean Hogs	3,1	0.0162	-1.3200	
Coffee	1,2	0.0067	-11.9200	0.0204
Sugar	3,1	0.0162	-1.3200	
Cocoa	4,1	0.0162	-1.3200	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	p-value $\sum\sum \beta_{j,k}=0$
System		0.0067	-11.9200	0.0204

Notes: $\sum \beta_j$ values are taken to the 10^5 power. The models are estimated across the K markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{3,1} = \gamma_{3,2} = \ldots = \gamma_{23,K}$; $\beta_{1,1} = \beta_{1,2} = \ldots = \beta_{1,K}$ for all K markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all K markets.

Table 32. Granger Causality Test Results for *CIT* Percent of Long Positions Do Not Lead Realized Volatility, June 2006-December 2009.

$$RV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} RV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta LONG_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	2,1	0.4307	8.1839	
Soybeans	3,1	0.4307	8.1839	
Soybean Oil	2,1	0.4307	8.1839	
CBOT Wheat	2,1	0.4307	8.1839	
KCBOT Wheat	3,1	0.4307	8.1839	
Cotton	3,1	0.4307	8.1839	
Live Cattle	3,1	0.4307	8.1839	
Feeder Cattle	3,1	0.4307	8.1839	
Lean Hogs	3,1	0.4307	8.1839	
Coffee	2,1	0.4307	8.1839	
Sugar	3,1	0.4307	8.1839	
Cocoa	4,1	0.4307	8.1839	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.4307	8.1839	

Note: The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{3,1}= \gamma_{3,2} =\ldots=\gamma_{23,K}$; $\beta_{1,1}= \beta_{1,2} =\ldots=\beta_{1,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 33. Granger Causality Test Results for *DCOT* Swap Dealer Net Positions Do Not Lead Realized Volatility, June 2006-December 2009.

$$RV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} RV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta NET_{t-j,k} + \varepsilon_{t,k} \text{ for each market, } k \text{, and time, } t.$$

Market	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	2,1	0.8258	0.2000	
Soybeans	4,1	0.0242	-3.3700	
Soybean Oil	2,1	0.5347	-0.9500	
CBOT Wheat	2,1	0.6975	0.4370	
KCBOT Wheat	3,1	0.1308	-5.5000	
Cotton	3,1	0.9358	0.2340	
Live Cattle	3,1	0.0600	-2.4600	
Feeder Cattle	3,1	0.5317	-5.8200	
Lean Hogs	3,1	0.1531	3.7900	
Coffee	1,2	0.1568	-11.8200	0.0581
Sugar	3,1	0.8018	-0.3200	
Cocoa	4,1	0.0420	-12.0300	
Crude Oil	3,1	0.0889	1.0500	
Natural Gas	1,1	0.5975	0.4610	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.0408	-36.1000	0.0131

Notes: $\sum \beta_j$ values are taken to the 10^5 power. The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{3,1}= \gamma_{3,2} =...=\gamma_{23,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 34. Granger Causality Test Results for *DCOT* Swap Dealers' Percent of Long Positions Do Not Lead Realized Volatility, June 2006-December 2009.

$$RV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} RV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} \Delta LONG_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	2,1	0.7269	4.3225	
Soybeans	3,1	0.7269	4.3225	
Soybean Oil	2,1	0.7269	4.3225	
CBOT Wheat	2,1	0.7269	4.3225	
KCBOT Wheat	3,1	0.7269	4.3225	
Cotton	3,1	0.7269	4.3225	
Live Cattle	3,1	0.7269	4.3225	
Feeder Cattle	3,1	0.7269	4.3225	
Lean Hogs	3,1	0.7269	4.3225	
Coffee	2,1	0.7269	4.3225	
Sugar	3,1	0.7269	4.3225	
Cocoa	4,1	0.7269	4.3225	
Crude Oil	1,1	0.7269	4.3225	
Natural Gas	1,1	0.7269	4.3225	

		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.7269	4.3225	

Note: The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{3,1}= \gamma_{3,2} =\ldots=\gamma_{3,K}$; $\beta_{1,1}= \beta_{1,2} =\ldots=\beta_{1,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 35. Granger Causality Test Results for T-Index Does Not Lead Implied Volatility, June 2006-December 2009.

$$IV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} IV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} TIndex_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	1,1	0.2153	0.4532	
Soybeans	3,1	0.2153	0.4532	
Soybean Oil	2,1	0.2153	0.4532	
CBOT Wheat	2,1	0.2153	0.4532	
KCBOT Wheat	3,1	0.2153	0.4532	
Cotton	4,1	0.2153	0.4532	
Live Cattle	3,1	0.2153	0.4532	
Feeder Cattle	1,1	0.2153	0.4532	
Lean Hogs	1,1	0.2153	0.4532	
Coffee	2,1	0.2153	0.4532	
Sugar	2,1	0.2153	0.4532	
Cocoa	2,1	0.2153	0.4532	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.2153	0.4532	

Note: The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{2,1}=\gamma_{2,2}=\ldots=\gamma_{2,K}$; γ_4 $\beta_{1,1}=\beta_{1,2}=\ldots=\beta_{1,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

Table 36. Granger Causality Test Results for T-Index Does Not Lead Realized Volatility, June 2006-December 2009.

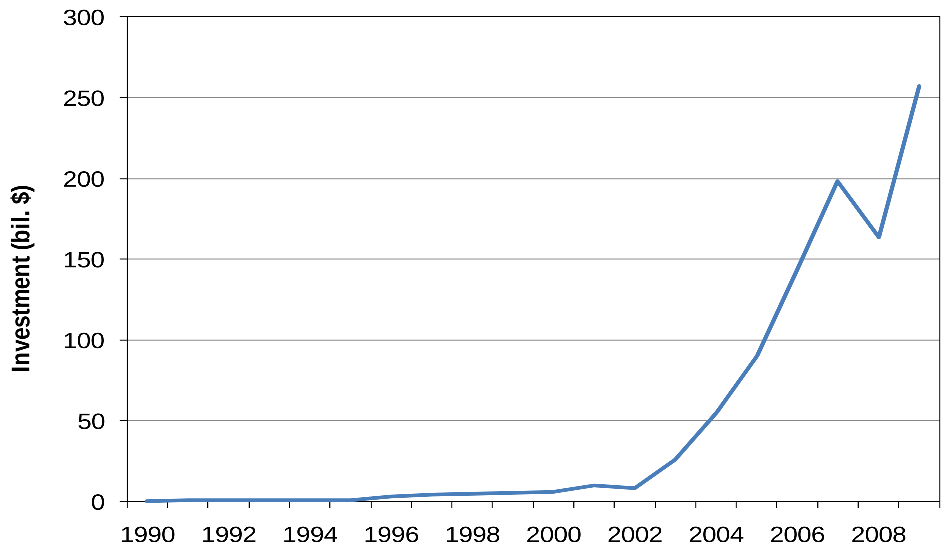
$$RV_{t,k} = \alpha_k + \sum_{i=1}^{m} \gamma_{i,k} RV_{t-i,k} + \sum_{j=1}^{n} \beta_{j,k} TIndex_{t-j,k} + \varepsilon_{t,k}$$ for each market, *k*, and time, *t*.

Market	*m,n*	*p*-value $\beta_j=0, \forall j$	Estimate $\sum \beta_j$	*p*-value $\sum \beta_j=0$
Corn	1,1	0.0470	24.8261	
Soybeans	4,1	0.6982	-2.5196	
Soybean Oil	2,1	0.7590	2.3205	
CBOT Wheat	2,1	0.5745	-1.7284	
KCBOT Wheat	3,1	0.7993	-1.8937	
Cotton	3,1	0.4823	-4.7687	
Live Cattle	3,1	0.3602	3.2854	
Feeder Cattle	3,1	0.0208	1.8090	
Lean Hogs	3,1	0.0003	11.7991	
Coffee	1,1	0.6234	-4.0321	
Sugar	4,1	0.2101	-30.5000	
Cocoa	4,1	0.0308	34.0968	
		p-value $\beta_{j,k}=0, \forall j,k$	Estimate $\sum\sum \beta_{j,k}$	*p*-value $\sum\sum \beta_{j,k}=0$
System		0.0028	32.6945	0.3844

Note: The models are estimated across the *K* markets as an SUR system. Wald tests could not reject the following cross-market coefficient restrictions: $\gamma_{2,1}= \gamma_{2,2} =\ldots=\gamma_{2,K}$; $\gamma_{3,1}= \gamma_{3,2} =\ldots=\gamma_{3,K}$ for all *K* markets. These restrictions are imposed on the system and the common coefficients are estimated as a single pooled parameter across all *K* markets.

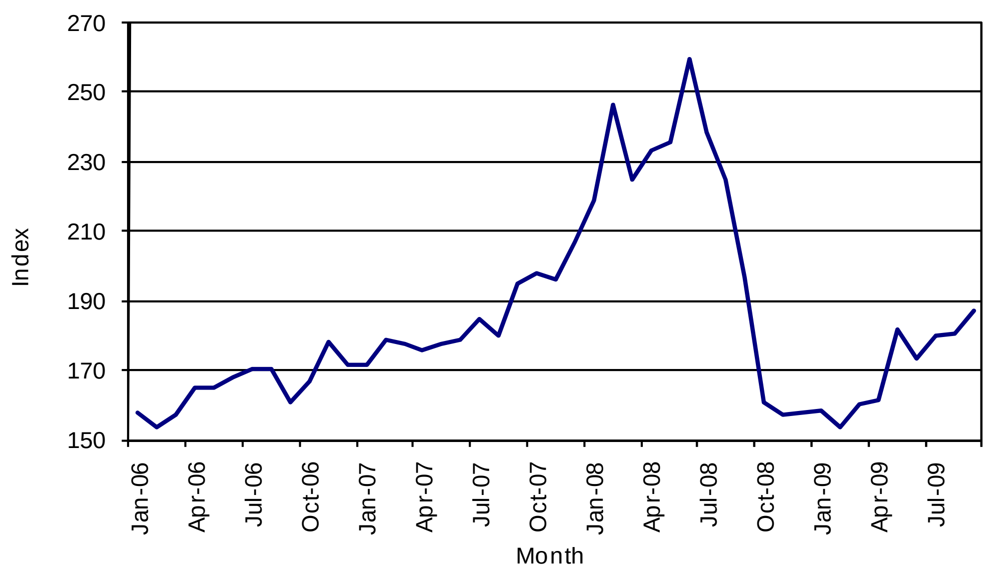
9. Figures

Figure 1. Commodity Index Fund Investment (year end), 1990 – 2009.



Source: Barclays

Figure 2. CRB Commodity Index, January 2006 - September 2009.



10. Appendix A: Supporting Tables and Figures

Table A1. Correlation Matrix, Weekly Percent Market Returns, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC	CL	NG
Corn (C)	1.00	0.60	0.53	0.56	0.54	0.30	0.21	-0.17	-0.03	0.33	0.30	0.26	0.38	0.31
Soybeans (S)		1.00	0.81	0.43	0.46	0.46	0.29	0.11	0.02	0.48	0.35	0.33	0.43	0.30
Soy Oil (BO)			1.00	0.48	0.49	0.49	0.33	0.21	0.04	0.51	0.33	0.35	0.60	0.39
C. Wheat (W)				1.00	0.96	0.30	0.20	0.00	0.05	0.32	0.27	0.28	0.40	0.23
K.Wheat (KW)					1.00	0.31	0.22	0.03	0.06	0.34	0.29	0.28	0.41	0.23
Cotton (CT)						1.00	0.12	0.05	-0.03	0.45	0.24	0.31	0.31	0.21
L. Cattle (LC)							1.00	0.76	0.24	0.17	0.17	0.15	0.39	0.19
F. Cattle (FC)								1.00	0.24	0.10	0.05	0.01	0.28	0.13
Ln. Hogs (LH)									1.00	0.01	-0.09	0.02	0.04	0.02
Coffee (KC)										1.00	0.24	0.40	0.38	0.28
Sugar (SG)											1.00	0.18	0.25	0.15
Cocoa (CC)												1.00	0.28	0.21
Crude (CL)													1.00	0.43
Nat Gas (NG)														1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).
Note, with 186 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A2. Correlation Matrix, Weekly Implied Volatility, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC	CL	NG
Corn (C)	1.00	0.74	0.75	0.61	0.57	0.62	0.51	0.64	0.20	0.39	0.50	0.74	0.61	-0.10
Soybeans (S)		1.00	0.78	0.65	0.65	0.72	0.44	0.53	0.26	0.42	0.55	0.75	0.59	-0.04
Soy Oil (BO)			1.00	0.51	0.45	0.71	0.55	0.66	0.16	0.49	0.56	0.75	0.70	0.11
C. Wheat (W)				1.00	0.93	0.58	0.23	0.47	0.38	0.34	0.40	0.54	0.41	-0.24
K.Wheat (KW)					1.00	0.58	0.17	0.39	0.36	0.37	0.37	0.54	0.33	-0.31
Cotton (CT)						1.00	0.48	0.55	0.36	0.55	0.54	0.71	0.66	0.10
L. Cattle (LC)							1.00	0.68	0.08	0.34	0.25	0.52	0.64	-0.02
F. Cattle (FC)								1.00	0.16	0.35	0.34	0.62	0.71	-0.15
Ln. Hogs (LH)									1.00	0.14	0.14	0.34	0.23	-0.07
Coffee (KC)										1.00	0.40	0.46	0.42	0.18
Sugar (SG)											1.00	0.62	0.43	0.16
Cocoa (CC)												1.00	0.72	0.01
Crude (CL)													1.00	0.13
Nat Gas (NG)														1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).
Note, with 186 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A3. Correlation Matrix, Weekly Realized Volatility, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC	CL	NG
Corn (C)	1.00	0.56	0.44	0.33	0.32	0.35	0.32	0.38	0.09	0.22	0.30	0.28	0.40	0.11
Soybeans (S)		1.00	0.82	0.41	0.42	0.54	0.18	0.29	0.23	0.40	0.39	0.40	0.39	0.06
Soy Oil (BO)			1.00	0.46	0.45	0.61	0.34	0.39	0.22	0.42	0.37	0.42	0.53	0.07
C. Wheat (W)				1.00	0.93	0.44	0.10	0.22	0.13	0.28	0.24	0.25	0.19	-0.09
K.Wheat (KW)					1.00	0.44	0.07	0.19	0.12	0.26	0.22	0.25	0.22	-0.13
Cotton (CT)						1.00	0.29	0.30	0.15	0.44	0.29	0.40	0.43	0.02
L. Cattle (LC)							1.00	0.65	0.14	0.03	0.02	0.22	0.37	0.07
F. Cattle (FC)								1.00	0.06	0.02	0.06	0.24	0.36	-0.04
Ln. Hogs (LH)									1.00	0.16	0.16	0.17	0.12	0.15
Coffee (KC)										1.00	0.36	0.33	0.26	0.17
Sugar (SG)											1.00	0.23	0.17	0.11
Cocoa (CC)												1.00	0.37	0.02
Crude (CL)													1.00	0.15
Nat Gas (NG)														1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).
Note, with 186 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A4. Correlation Matrix, Working's T-Index, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC
Corn (C)	1.00	0.38	0.82	0.70	0.51	-0.19	0.17	0.04	0.64	-0.01	-0.13	0.03
Soybeans (S)		1.00	0.36	-0.06	-0.01	0.42	-0.30	-0.17	-0.09	0.46	-0.47	0.04
Soy Oil (BO)			1.00	0.66	0.57	-0.16	0.27	0.26	0.52	-0.11	-0.13	0.18
C. Wheat (W)				1.00	0.62	-0.39	0.46	0.30	0.55	-0.35	0.17	0.40
K.Wheat (KW)					1.00	0.09	0.07	0.14	0.31	-0.05	0.23	0.03
Cotton (CT)						1.00	-0.51	-0.23	-0.44	0.69	-0.16	-0.04
L. Cattle (LC)							1.00	0.48	0.36	-0.55	-0.03	0.35
F. Cattle (FC)								1.00	-0.10	-0.40	0.07	0.41
Ln. Hogs (LH)									1.00	-0.27	-0.06	0.01
Coffee (KC)										1.00	0.09	-0.20
Sugar (SG)											1.00	-0.05
Cocoa (CC)												1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).

Note, with 186 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A5. Correlation Matrix, Change in *CIT* Net Positions, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC
Corn (C)	1.00	0.32	0.24	0.34	0.34	0.25	0.37	0.18	0.34	0.38	0.25	0.22
Soybeans (S)		1.00	0.33	0.33	0.30	0.25	0.41	0.18	0.04	0.31	0.16	0.19
Soy Oil (BO)			1.00	0.37	0.21	0.22	0.15	0.06	0.02	0.07	0.02	0.05
C. Wheat (W)				1.00	0.24	0.19	0.15	0.13	0.17	0.18	0.09	0.18
K.Wheat (KW)					1.00	0.11	0.18	0.04	0.07	0.14	0.06	0.19
Cotton (CT)						1.00	0.30	0.09	0.23	0.46	0.30	0.34
L. Cattle (LC)							1.00	0.18	0.52	0.46	0.43	0.22
F. Cattle (FC)								1.00	0.07	0.14	0.13	0.15
Ln. Hogs (LH)									1.00	0.45	0.31	0.17
Coffee (KC)										1.00	0.49	0.30
Sugar (SG)											1.00	0.10
Cocoa (CC)												1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).
Note, with 185 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A6. Correlation Matrix, Change in *CIT* Percent of Long Positions, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC
Corn (C)	1.00	0.40	0.41	0.71	0.42	0.12	0.06	0.21	0.08	0.22	0.00	0.05
Soybeans (S)		1.00	0.42	0.37	0.23	0.08	0.02	0.15	0.03	0.07	0.04	0.17
Soy Oil (BO)			1.00	0.41	0.29	0.03	0.07	0.06	0.03	0.06	0.08	0.13
C. Wheat (W)				1.00	0.47	0.14	0.02	0.17	0.03	0.14	-0.02	0.04
K.Wheat (KW)					1.00	0.10	-0.02	0.10	-0.01	0.11	-0.01	0.07
Cotton (CT)						1.00	-0.02	0.03	0.06	0.39	0.18	-0.01
L. Cattle (LC)							1.00	0.17	0.11	-0.08	-0.03	0.13
F. Cattle (FC)								1.00	0.00	-0.06	0.04	0.12
Ln. Hogs (LH)									1.00	0.06	0.07	0.01
Coffee (KC)										1.00	0.13	0.18
Sugar (SG)											1.00	0.01
Cocoa (CC)												1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).

Note, with 185 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A7. Correlation Matrix, *DCOT* Change in Net Positions, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC	CL	NG
Corn (C)	1.00	0.24	0.15	0.28	0.33	0.21	0.22	0.14	0.24	0.25	0.05	0.24	0.00	0.22
Soybeans (S)		1.00	0.30	0.25	0.23	0.22	0.29	0.10	-0.04	0.20	-0.11	0.16	-0.16	0.20
Soy Oil (BO)			1.00	0.27	0.10	0.20	0.12	0.06	0.01	0.07	-0.03	0.02	0.00	0.12
C. Wheat (W)				1.00	0.28	0.11	0.06	0.16	0.06	0.13	-0.05	0.16	-0.02	0.07
K.Wheat (KW)					1.00	0.00	0.12	0.09	0.10	0.04	-0.06	0.03	0.02	-0.04
Cotton (CT)						1.00	0.20	-0.02	0.11	0.45	0.15	0.19	-0.15	0.24
L. Cattle (LC)							1.00	0.02	0.45	0.40	0.27	0.15	-0.16	0.25
F. Cattle (FC)								1.00	-0.04	-0.01	0.04	0.03	-0.06	0.12
Ln. Hogs (LH)									1.00	0.37	0.25	0.14	-0.06	0.15
Coffee (KC)										1.00	0.30	0.15	0.01	0.30
Sugar (SG)											1.00	-0.04	-0.02	0.00
Cocoa (CC)												1.00	0.07	0.15
Crude (CL)													1.00	-0.12
Nat Gas (NG)														1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).

Note, with 185 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A8. Correlation Matrix, *DCOT* Change in Percent of Long Positions, June 2006-December 2009.

Market	C	S	BO	W	KW	CT	LC	FC	LH	KC	SG	CC	CL	NG
Corn (C)	1.00	0.40	0.35	0.65	0.47	0.09	0.04	0.23	0.06	0.21	-0.06	0.09	-0.10	0.05
Soybeans (S)		1.00	0.34	0.39	0.27	0.05	-0.01	0.11	-0.08	0.01	-0.05	0.10	-0.14	0.19
Soy Oil (BO)			1.00	0.39	0.22	0.00	0.05	0.05	-0.05	-0.01	0.03	0.12	-0.16	0.10
C. Wheat (W)				1.00	0.44	0.09	-0.03	0.18	-0.02	0.12	-0.06	0.14	-0.07	0.08
K.Wheat (KW)					1.00	0.06	0.01	0.15	0.02	0.12	-0.05	0.05	-0.05	0.01
Cotton (CT)						1.00	-0.03	0.06	0.03	0.40	0.13	0.03	0.15	-0.05
L. Cattle (LC)							1.00	0.01	0.09	-0.08	-0.04	0.12	0.00	-0.17
F. Cattle (FC)								1.00	-0.07	-0.06	-0.01	0.08	-0.15	0.14
Ln. Hogs (LH)									1.00	0.09	0.01	0.09	0.06	0.04
Coffee (KC)										1.00	0.13	0.09	0.09	0.03
Sugar (SG)											1.00	-0.06	0.01	0.09
Cocoa (CC)												1.00	0.00	0.11
Crude (CL)													1.00	-0.07
Nat Gas (NG)														1.00

Note: Markets are abbreviated using ticker symbols as follows (in parenthesis): corn (C), soybeans (S), soybean oil (BO), CBOT wheat (W), KCBOT wheat (KW), cotton (CT), live cattle (LC), feeder cattle (FC), lean hogs (LH), coffee (KC), sugar (SG), cocoa (CC), crude oil (CL), and natural gas (NG).
Note, with 185 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A9. Contemporaneous Correlations, Market Returns and Position Measures, June 2006-December 2009.

Market	*CIT* ΔNET	*CIT* ΔLONG	*DCOT* ΔNET	*DCOT* ΔLONG
Corn	0.25	-0.16	0.32	-0.04
Soybeans	0.45	-0.07	0.48	-0.01
Soybean Oil	0.21	-0.03	0.33	0.09
CBOT Wheat	0.14	-0.12	0.33	-0.06
KCBOT Wheat	0.17	0.03	0.12	0.01
Cotton	0.28	-0.33	0.30	-0.32
Live Cattle	0.25	-0.13	0.26	-0.08
Feeder Cattle	-0.03	-0.02	0.02	0.00
Lean Hogs	0.07	-0.14	0.05	-0.13
Coffee	0.26	-0.18	0.16	-0.18
Sugar	0.04	-0.11	-0.18	-0.17
Cocoa	0.32	0.06	0.25	-0.00
Crude Oil			-0.06	-0.12
Natural Gas			0.63	0.43

Note, with 185 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A10. Contemporaneous Correlations, Implied Volatility and Position Measures, June 2006-December 2009.

Market	*CIT* ΔNET	*CIT* ΔLONG	*DCOT* ΔNET	*DCOT* ΔLONG
Corn	-0.10	0.01	-0.11	0.02
Soybeans	-0.22	0.02	-0.24	-0.00
Soybean Oil	-0.12	-0.03	-0.07	-0.03
CBOT Wheat	-0.12	-0.03	-0.03	-0.04
KCBOT Wheat	0.01	0.11	-0.03	0.07
Cotton	-0.26	0.01	-0.21	-0.01
Live Cattle	-0.32	-0.08	-0.23	-0.07
Feeder Cattle	0.05	0.08	0.14	0.13
Lean Hogs	0.07	-0.00	0.13	0.04
Coffee	-0.18	-0.13	-0.16	-0.13
Sugar	-0.22	-0.16	-0.17	-0.11
Cocoa	-0.05	-0.03	-0.06	-0.07
Crude Oil			0.07	0.04
Natural Gas			-0.07	0.05

Note, with 185 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A11. Contemporaneous Correlations, Realized Volatility and Position Measures, June 2006-December 2009.

Market	*CIT* ΔNET	*CIT* ΔLONG	*DCOT* ΔNET	*DCOT* ΔLONG
Corn	-0.30	-0.18	-0.34	-0.26
Soybeans	-0.28	-0.08	-0.34	-0.17
Soybean Oil	-0.09	-0.08	-0.24	-0.18
CBOT Wheat	-0.25	-0.04	-0.16	-0.06
KCBOT Wheat	-0.13	-0.02	-0.17	-0.07
Cotton	-0.17	0.12	-0.13	0.09
Live Cattle	-0.22	-0.06	-0.18	-0.07
Feeder Cattle	-0.02	-0.11	0.01	-0.10
Lean Hogs	0.07	-0.00	0.01	-0.06
Coffee	-0.27	-0.02	-0.24	-0.03
Sugar	-0.19	-0.06	-0.12	-0.01
Cocoa	-0.10	0.02	-0.02	0.05
Crude Oil			0.05	0.01
Natural Gas			-0.14	-0.02

Note, with 185 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Table A12. Contemporaneous Correlation Working's T-index and Market Measures, June 2006-December 2009.

Market	Implied Volatility	Realized Volatility	Market Returns
Corn	0.25	0.17	-0.08
Soybeans	-0.18	-0.11	-0.12
Soybean Oil	0.39	0.14	-0.10
CBOT Wheat	0.35	0.10	-0.15
KCBOT Wheat	-0.11	-0.17	-0.07
Cotton	-0.20	-0.14	-0.10
Live Cattle	-0.16	-0.09	-0.18
Feeder Cattle	0.32	0.16	-0.11
Lean Hogs	0.19	0.29	-0.05
Coffee	-0.20	-0.25	0.03
Sugar	-0.14	-0.09	0.01
Cocoa	0.37	0.25	0.02

Note, with 186 observations, any correlation coefficient with an absolute value greater than 0.15 is statistically different from zero at the 5% level.

Figure A1. Corn *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

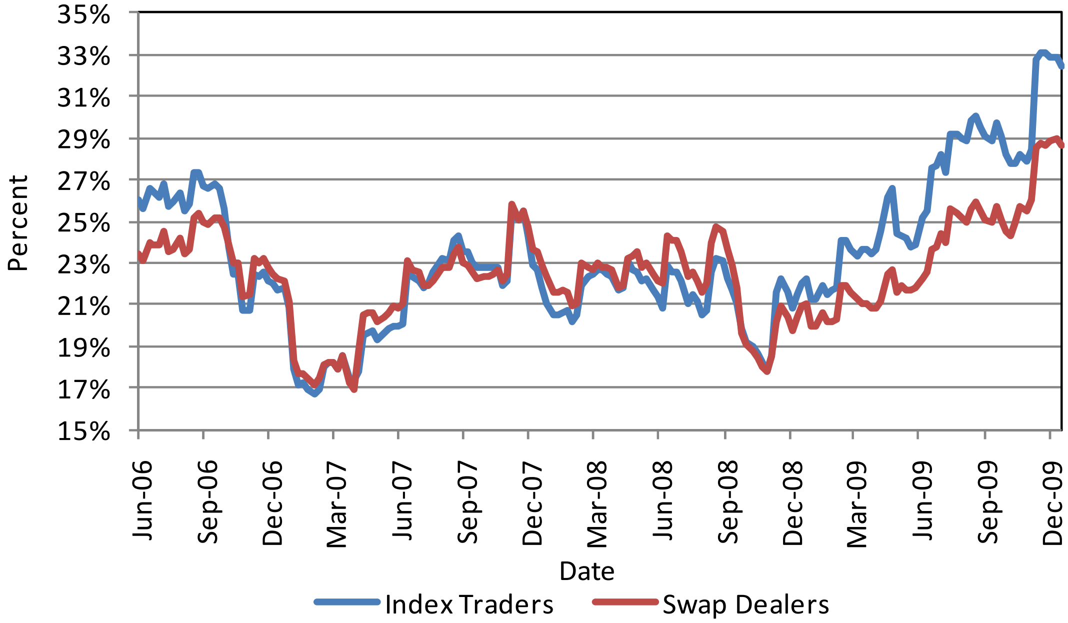


Figure A2. Soybeans *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

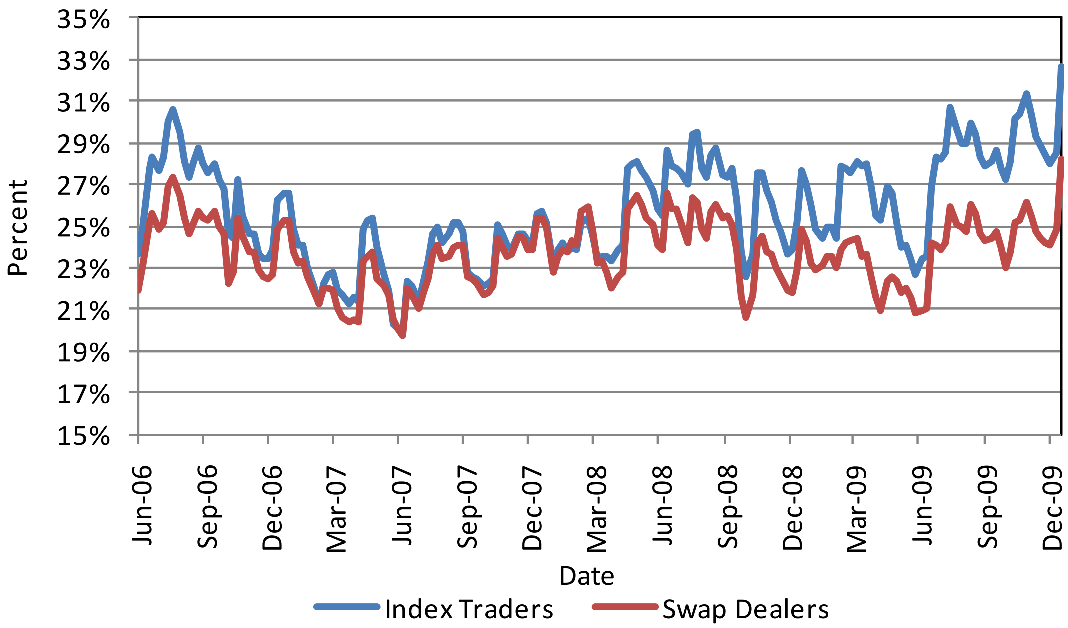


Figure A3. Soybean Oil *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

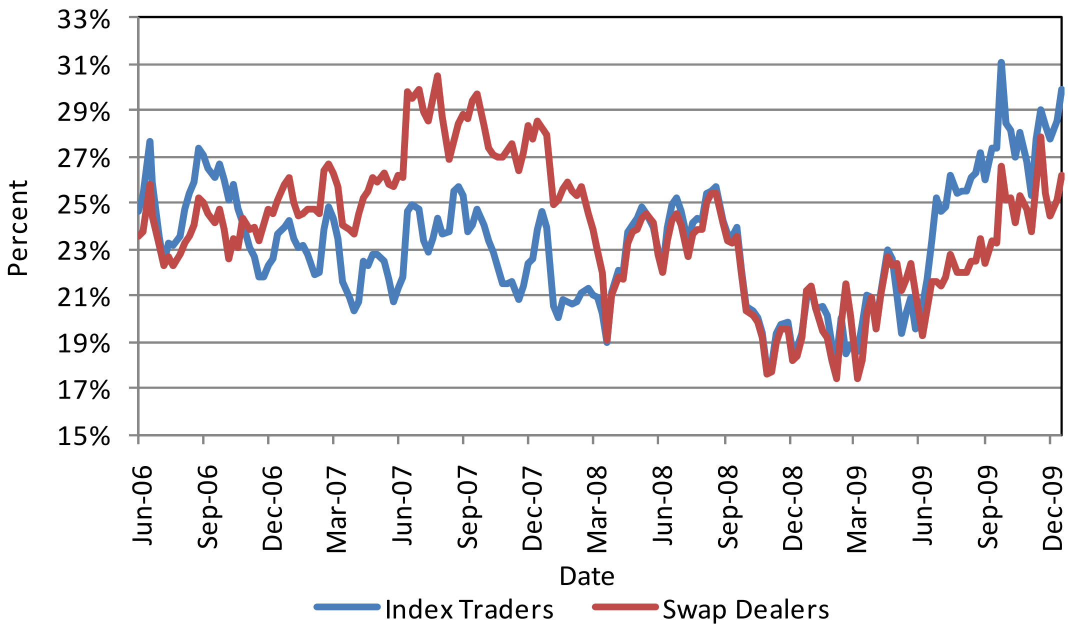


Figure A4. CBOT Wheat *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

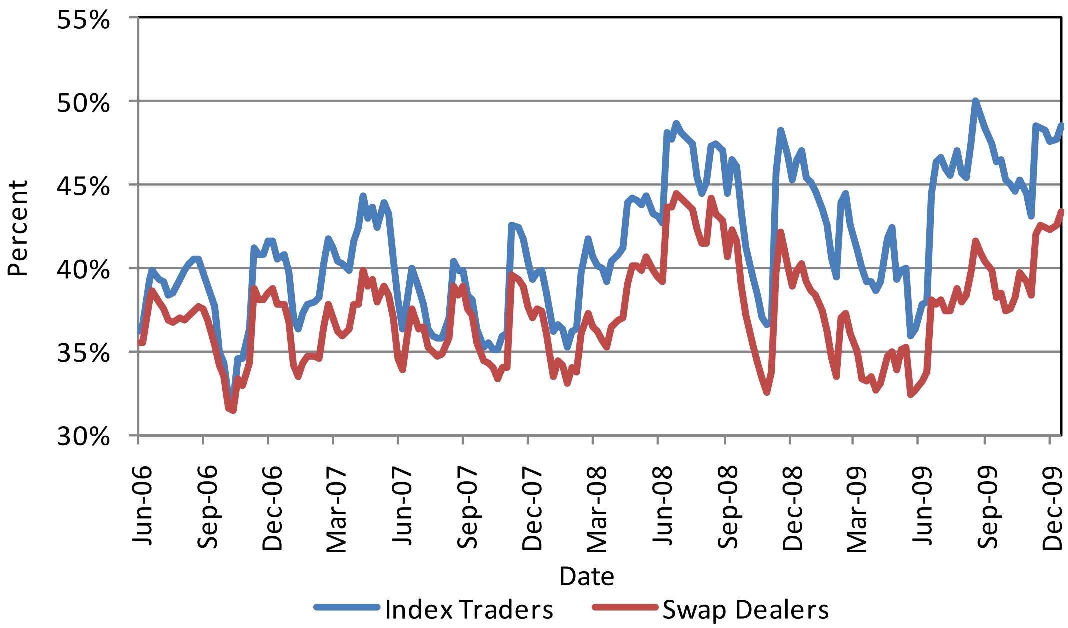


Figure A5. KCBOT Wheat *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

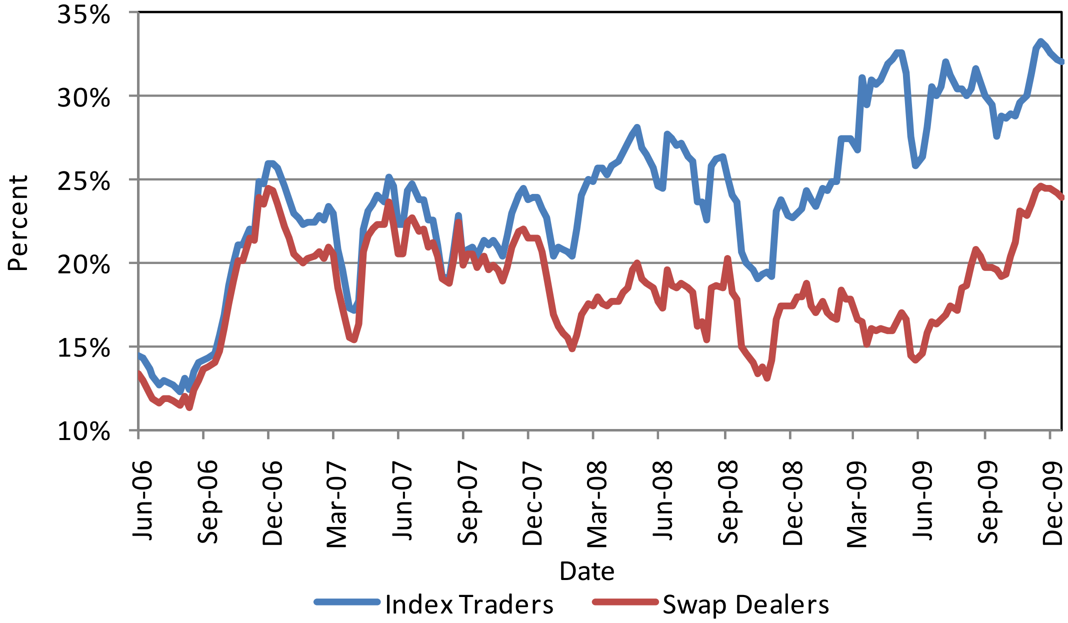


Figure A6. Cotton *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

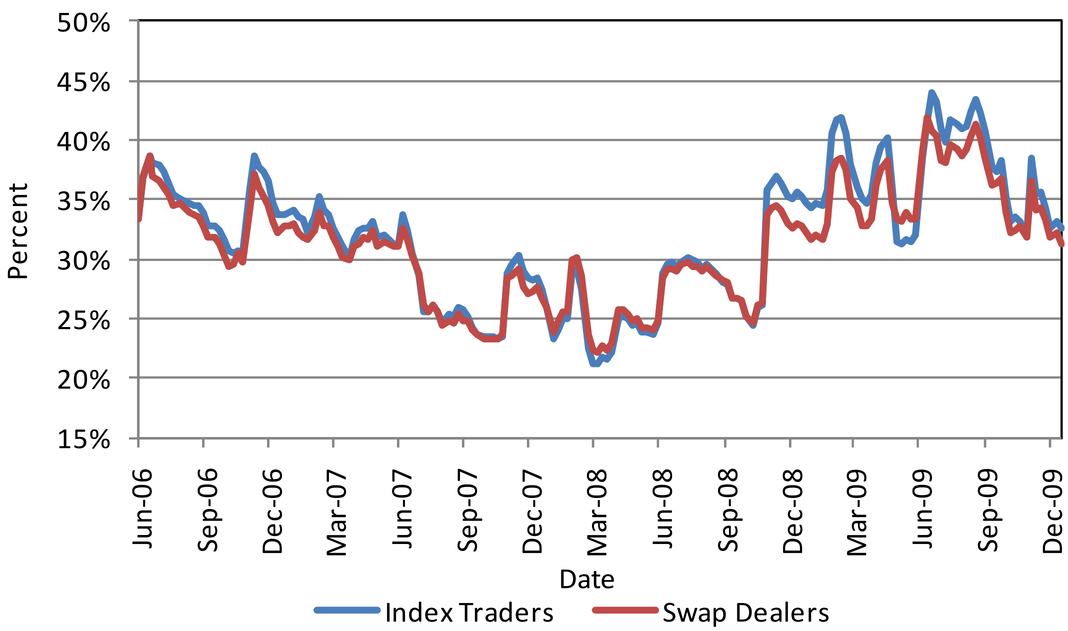


Figure A7. Live Cattle *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

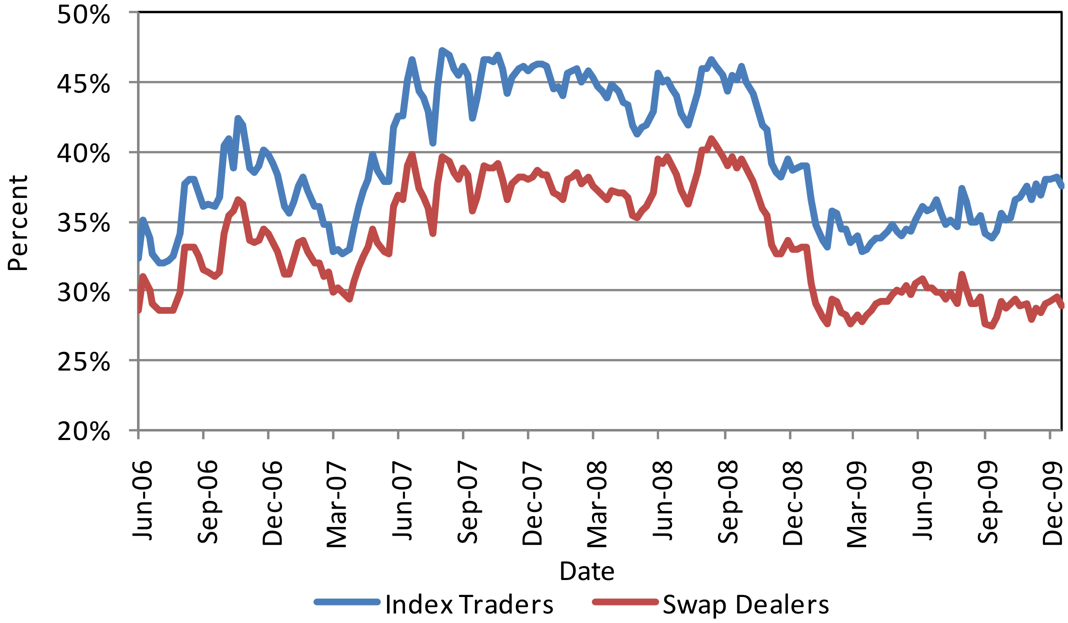


Figure A8. Feeder Cattle *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

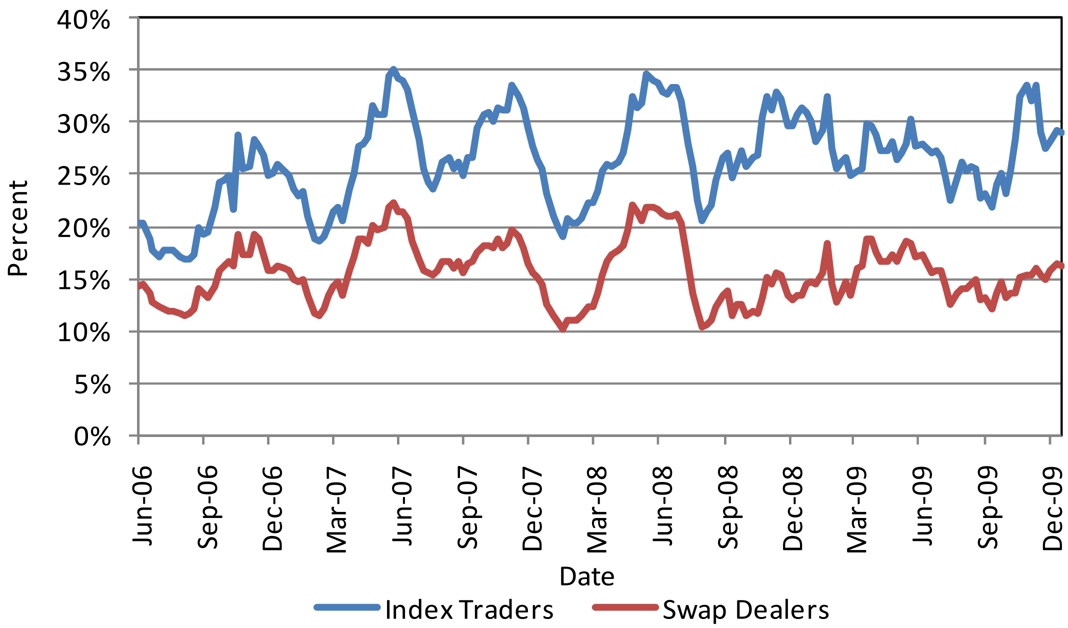


Figure A9. Lean Hogs *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

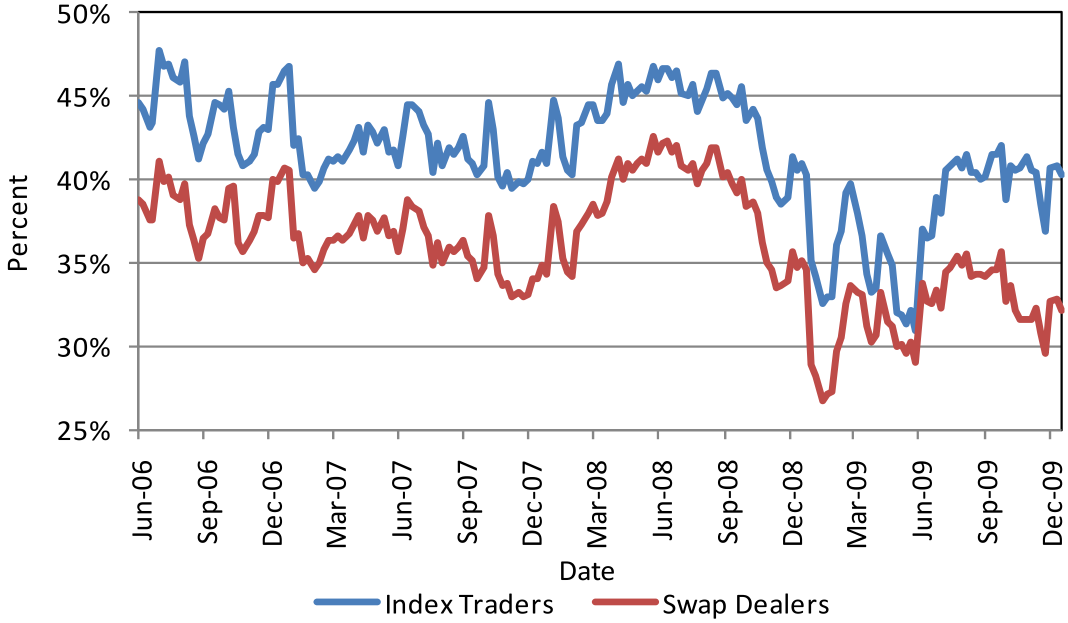


Figure A10. Coffee *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

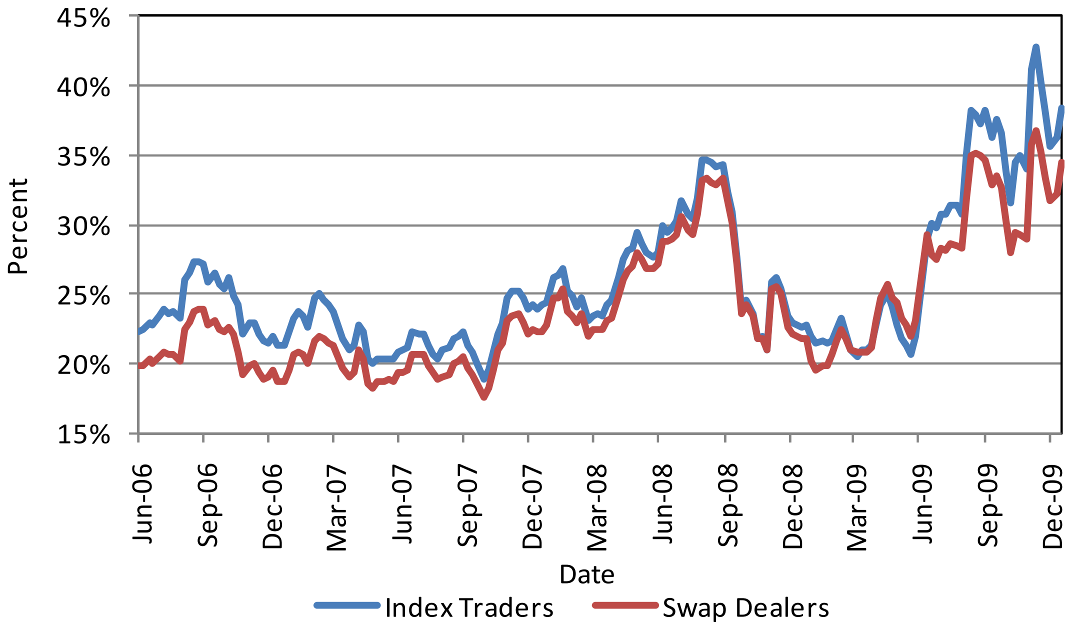


Figure A11. Sugar *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

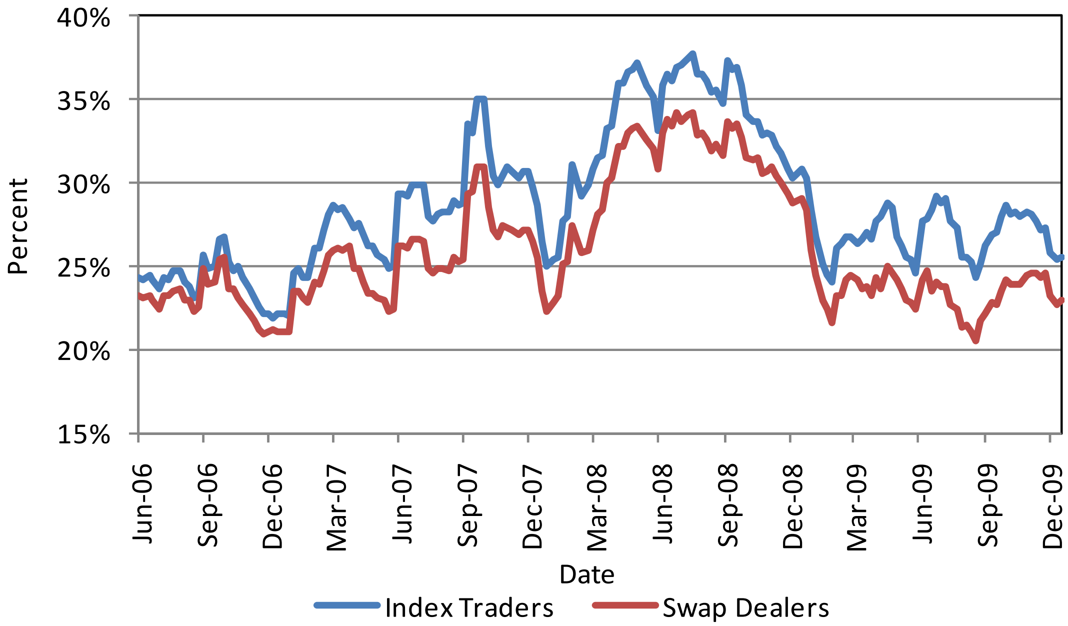


Figure A12. Cocoa *CIT* Index Trader and *DCOT* Swap Dealers' Percent of Long Positions, June 2006-December 2009.

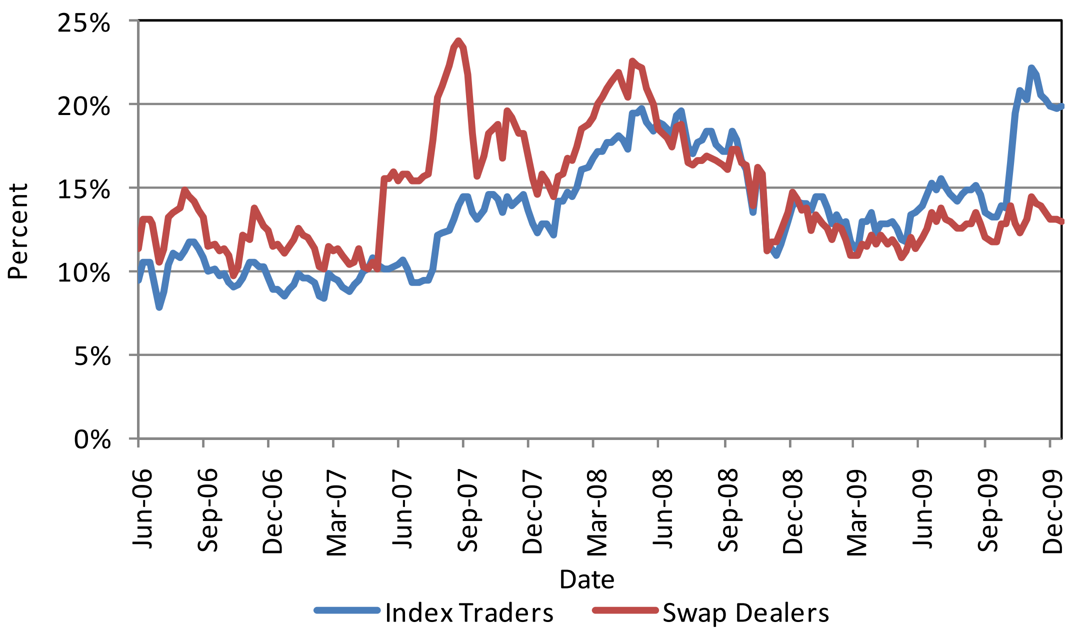


Figure A13. Corn *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

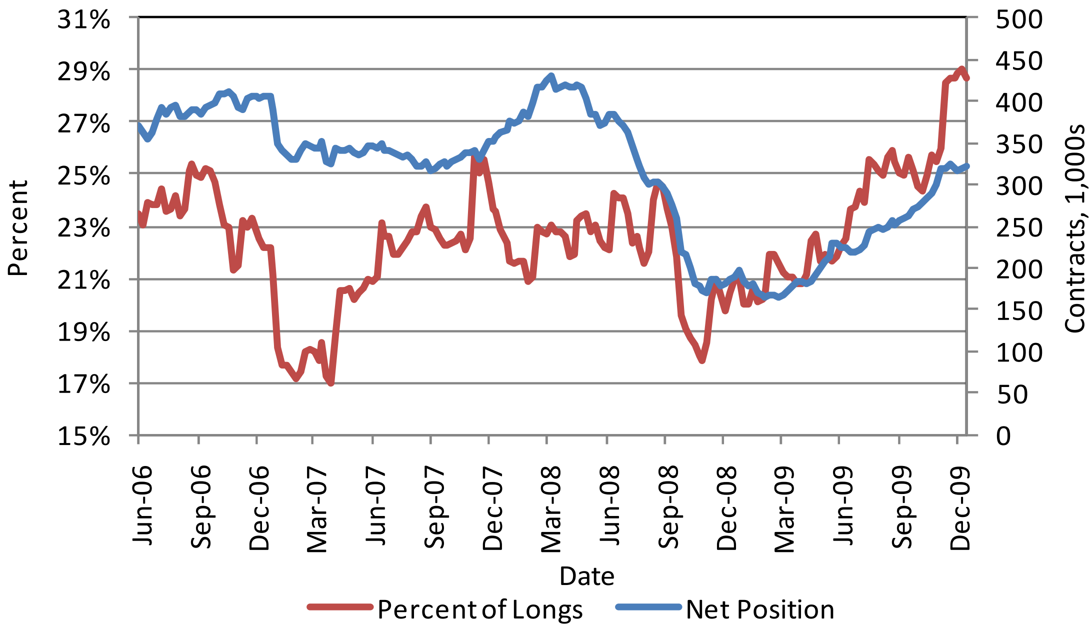


Figure A14. Soybeans *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

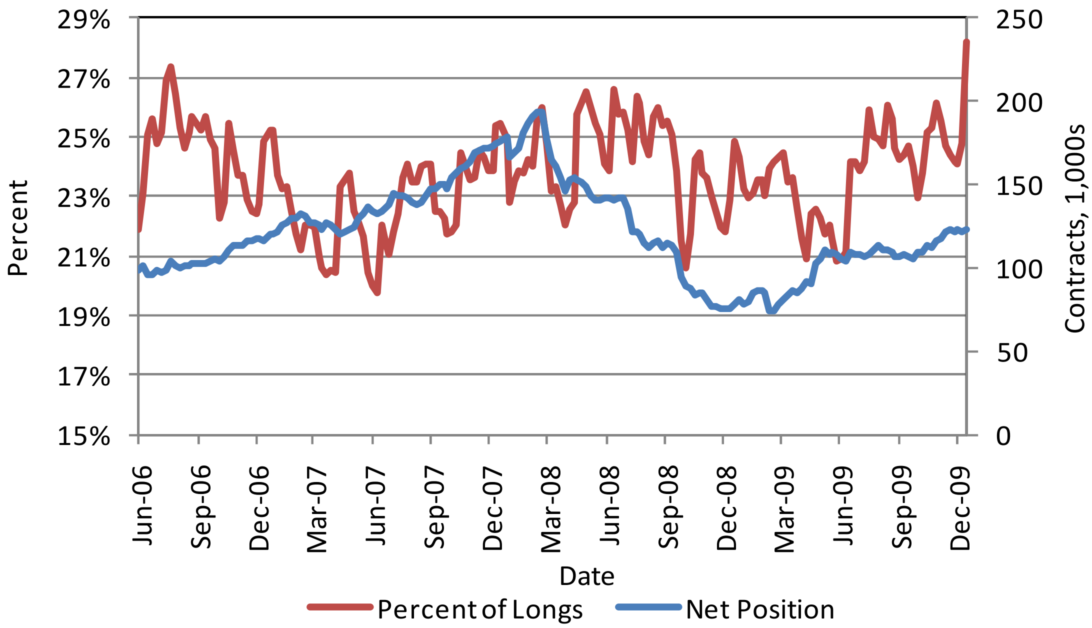


Figure A15. Soybean Oil *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

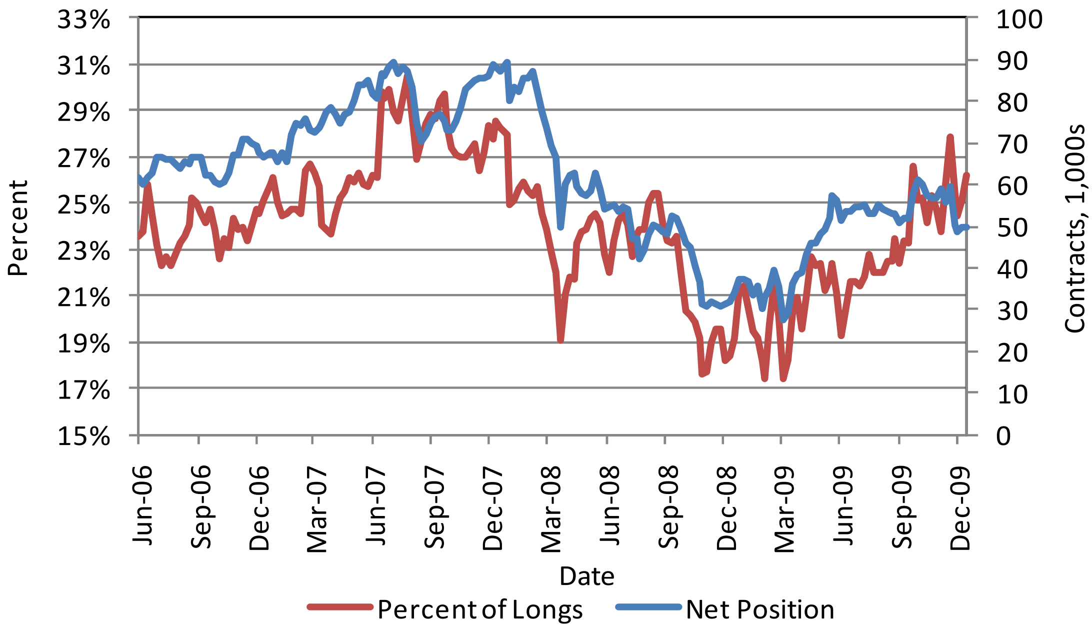


Figure A16. CBOT Wheat *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

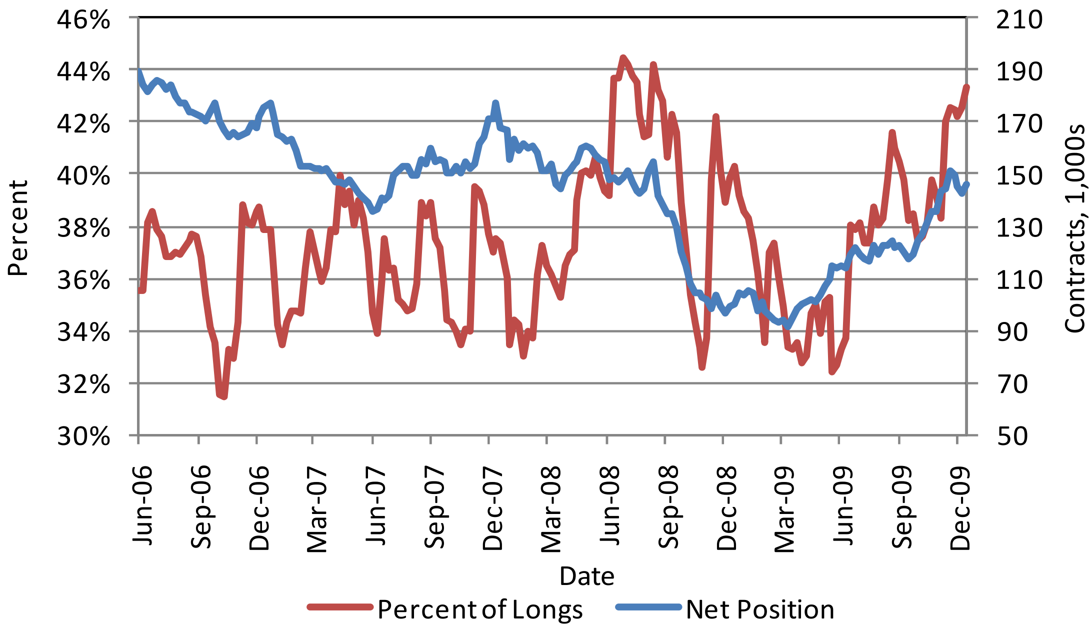


Figure A17. KCBOT Wheat *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

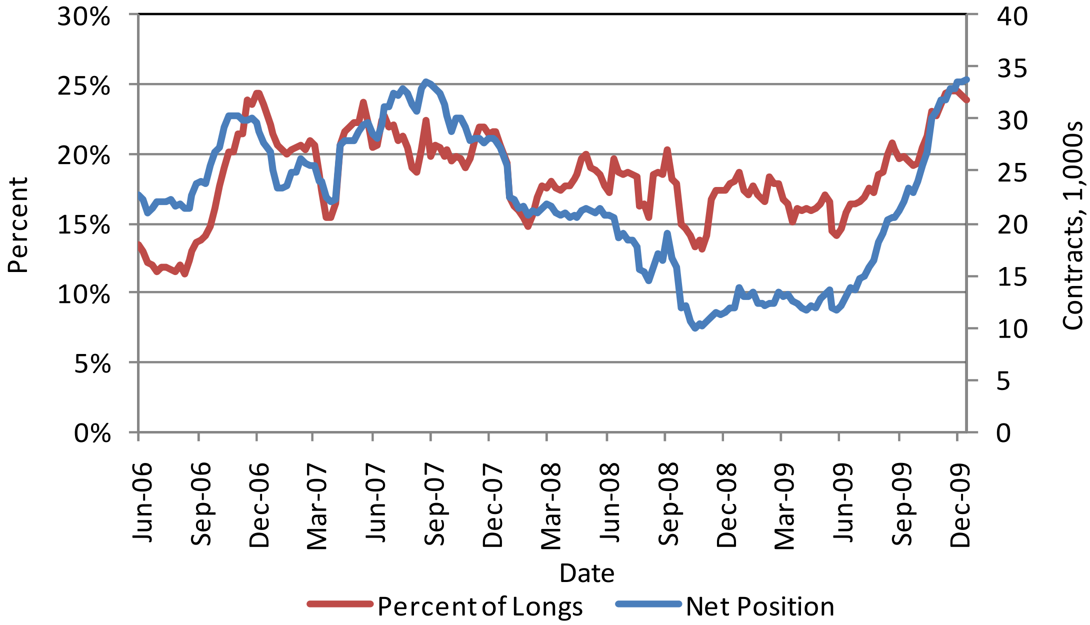


Figure A18. Cotton *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

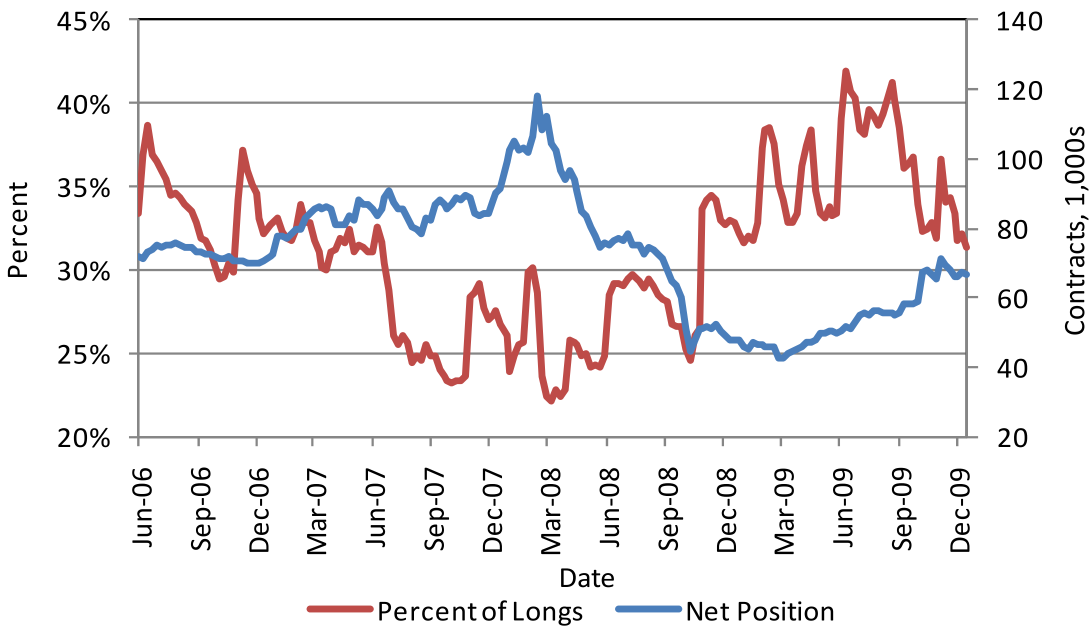


Figure A19. Live Cattle *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

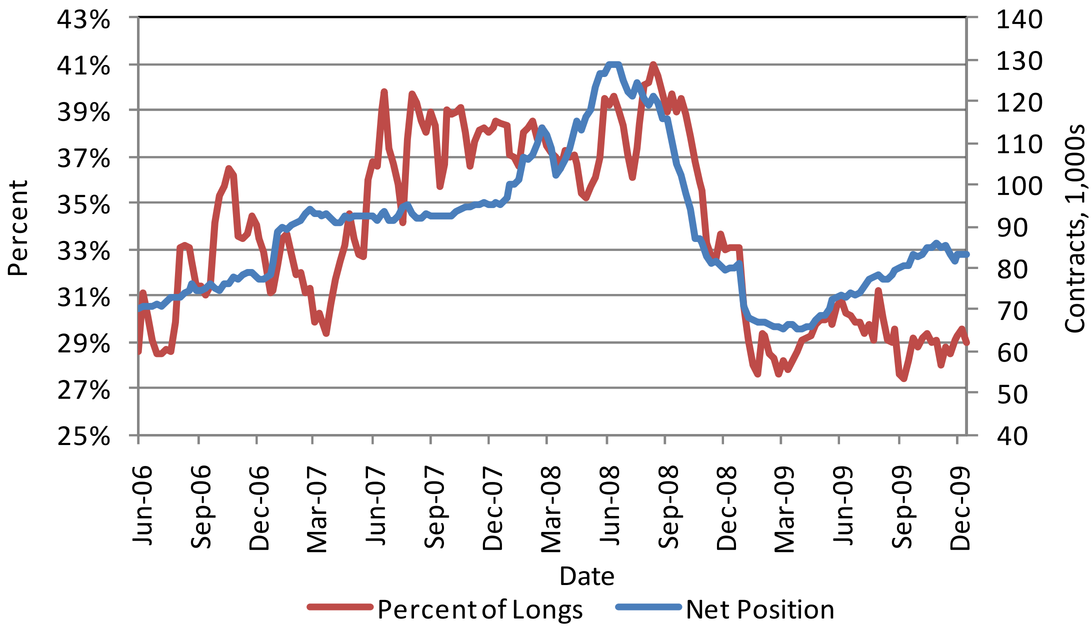


Figure A20. Feeder Cattle *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

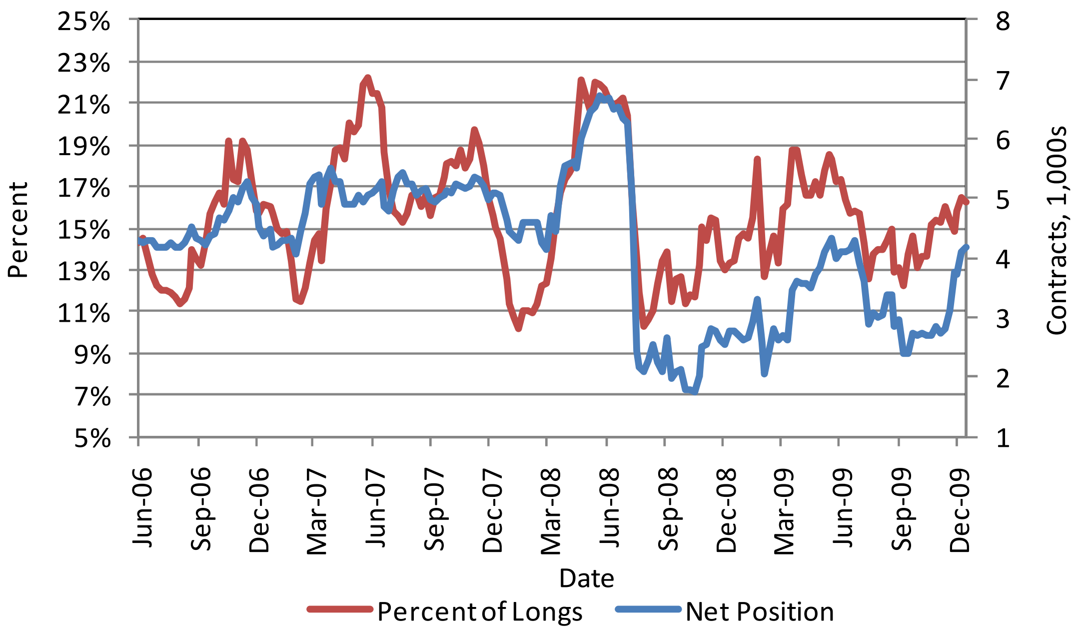


Figure A21. Lean Hogs *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

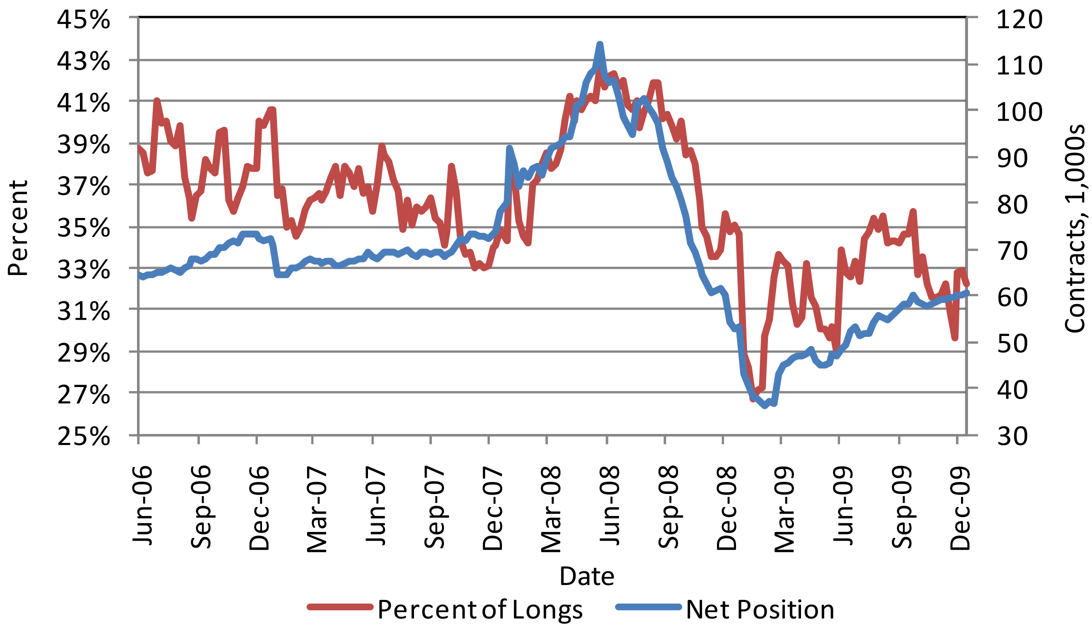


Figure A22. Coffee *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

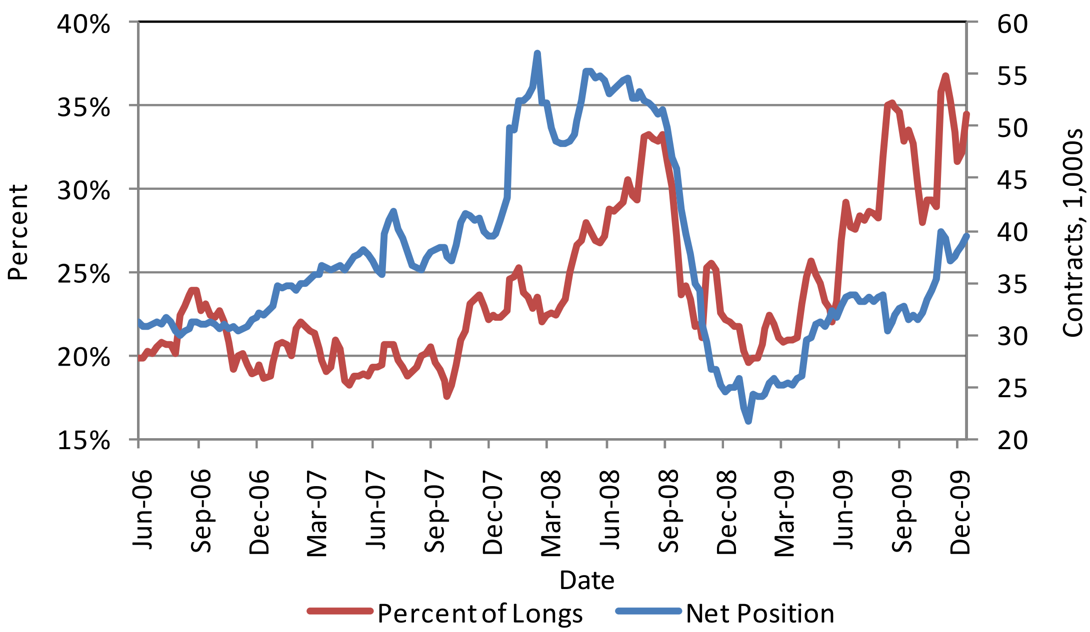


Figure A23. Sugar *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

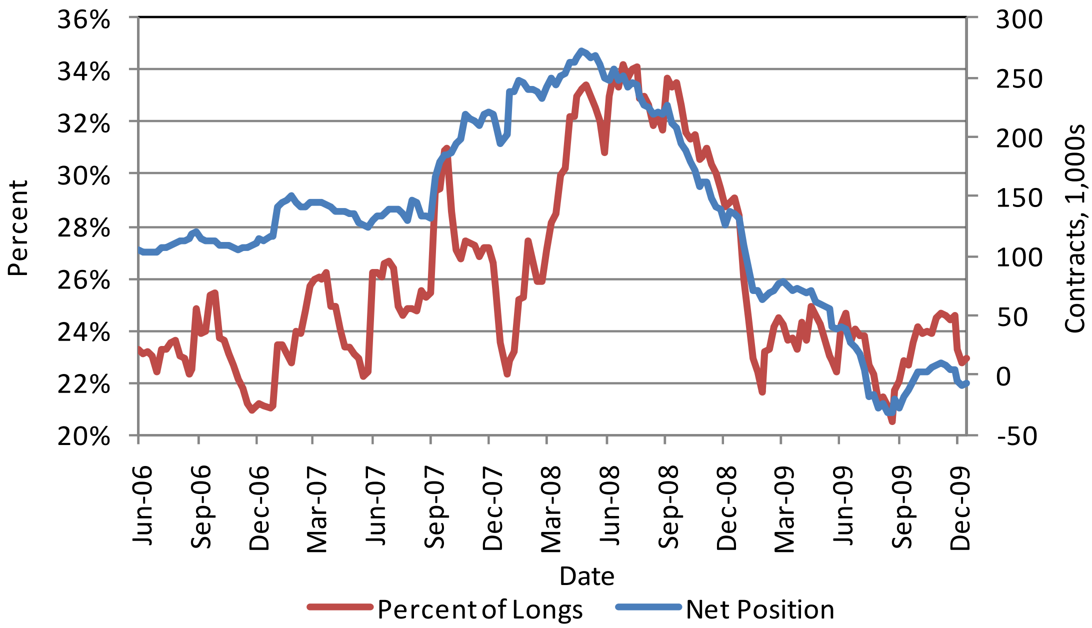


Figure A24. Cocoa *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

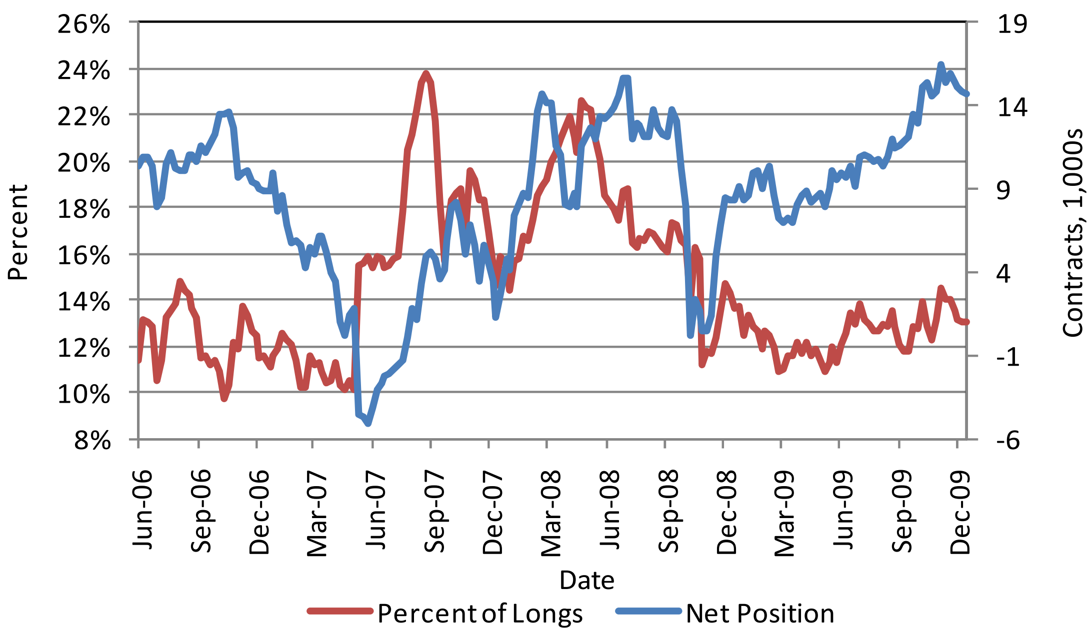


Figure A25. Crude Oil *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.

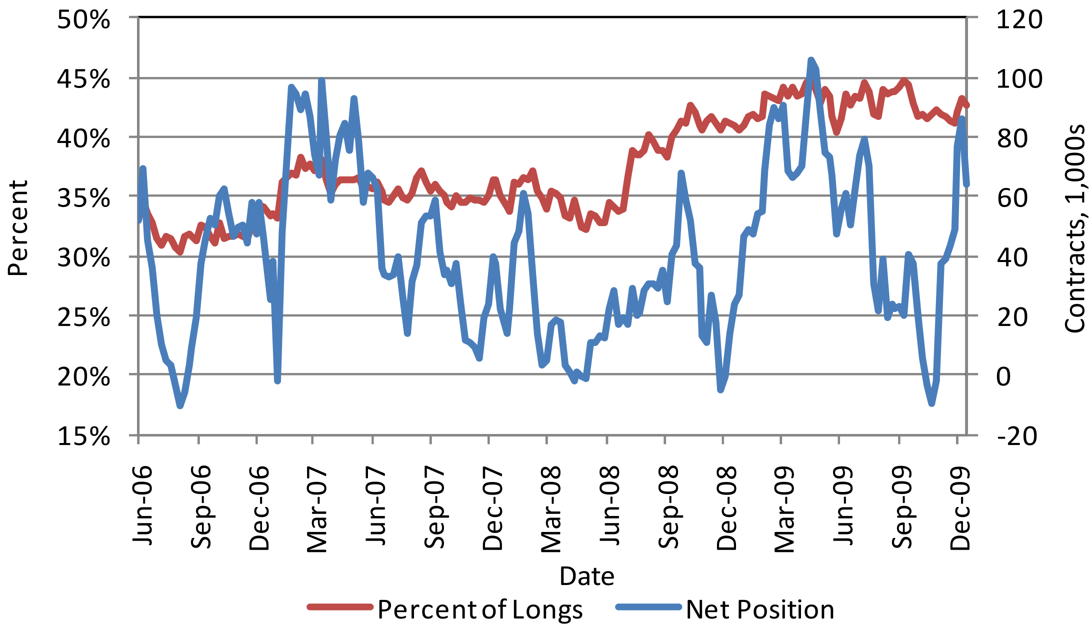


Figure A26. Natural Gas *DCOT* Swap Dealers, Net Position (contracts) and Percent of Long Positions, June 2006-December 2009.