Title: Measuring Index Investment in Commodity Futures Markets

Authors: *Dwight R. Sanders** and *Scott H. Irwin***

This version: January 9, 2013

Forthcoming: *The Energy Journal*

Abstract: The "Masters Hypothesis" is the claim that unprecedented buying pressure from new index investment created a massive bubble in commodity futures prices. Due to data limitations, some recent studies of the impact of index investment in the WTI crude oil futures market impute index positions. We investigate the accuracy of the algorithm popularized by Masters (2008) to estimate index positions. The estimates generated by the Masters algorithm deviate substantially from the positions reported in the U.S. Commodity Futures Trading Commission's (CFTC) *Index Investment Data* (IID) report—the agency's best data on index positions. The Masters' algorithm over-estimates the gross WTI crude oil position by an average of 142,000 contracts. Importantly, the deviation in the first half of 2008, the period of greatest concern about the market impact of index investment, is directionally wrong. These results suggest empirical tests of market impact based on mapping algorithms in WTI crude oil futures should be viewed with considerable caution.

Key words: commodity, crude oil, futures markets, index investment, Masters Hypothesis, speculation

*Department of Agribusiness Economics, Southern Illinois University-Carbondale, 226E Agriculture Building, 1205 Lincoln Drive, Carbondale, Illinois 62901. Phone: 618-453-1711; Email: dwights@siu.edu.

**Corresponding author. Department of Agricultural and Consumer Economics, 344 Mumford Hall, 1301 W. Gregory Drive, University of Illinois at Urbana-Champaign, Urbana, Illinois, 61801. Phone: 217-333-6087; Email: sirwin@illinois.edu.

We would like to thank Bahattin Buyuksahin, John Parsons and Michel Robe for invaluable discussions about CFTC data on index investment.

1. Introduction

Commodity futures prices increased rapidly during 2007-2008, led by an increase in crude oil futures prices to a new (nominal) all-time high of $145 per barrel. As the spike developed, concerns emerged that the increase was being driven to a significant degree by inflows into new commodity index investments.[1, 2] Hedge fund manager Michael W. Masters played a highly visible role in raising these concerns, testifying numerous times before the U.S. Congress and Commodity Futures Trading Commission (CFTC) with variations of the following argument:

> "Institutional Investors, with nearly $30 trillion in assets under management, have decided en masse to embrace commodities futures as an investable asset class. In the last five years, they have poured hundreds of billions of dollars into the commodities futures markets, a large fraction of which has gone into energy futures. While individually these Investors are trying to do the right thing for their portfolios (and stakeholders), they are unaware that collectively they are having a massive impact on the futures markets that makes the Hunt brothers pale in comparison. In the last 4½, years assets allocated to commodity index replication trading strategies have grown from $13 billion in 2003 to $317 billion in July 2008. At the same time, the prices for the 25 commodities that make up these indices have risen by an average of over 200%. Today's commodities futures markets are excessively speculative, and the speculative position limits designed to protect the markets have been raised, or in some cases, eliminated. Congress must act to re-establish hard and fast position limits across all markets." (Masters and White, 2008, p. 1).

In essence, Masters argues that unprecedented buying pressure from index investors created a massive bubble in commodity futures prices and this bubble was transmitted to spot prices through arbitrage linkages between futures and spot prices. The end result was that commodity

---

[1] Commodity index investments are packaged in a variety forms but share a common goal—provide investors with long-only exposure to returns from an index of commodity prices. Investors 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) also have been developed that track commodity indexes. See Engelke and Yuen (2008), Stoll and Whaley (2010) and Irwin and Sanders (2011) for further details on commodity index investments.

[2] See USS/PSI (2009), Irwin, Sanders, and Merrin (2009), and Pirrong (2010) for detailed discussions of the controversy surrounding the role of index investment in the 2007-2008 commodity price spike.

prices, and crude oil in particular, far exceeded fundamental values. Irwin and Sanders (2012) use the term "Masters Hypothesis" as a short-hand label for this argument. If index fund investment was indeed responsible for a massive bubble in commodity futures prices, difficult questions are raised about the basic price discovery and risk-shifting functions of these markets and new regulatory limits on speculation may be justified even if costly to some market participants.

Given the stakes involved in the recent controversy about commodity markets and index investment, it is not surprising that the topic has attracted considerable attention on the part of academic researchers. A number of recent studies investigate the empirical relationship between commodity index positions and price movements in commodity futures markets. Some studies find evidence of a positive relationship (e.g., Gilbert, 2010; Tang and Xiong, 2010; Singleton, 2011) but most do not (e.g., Stoll and Whaley, 2010; Sanders and Irwin, 2011; Buyuksahin and Harris, 2011; Brunetti, Buyuksahin and Harris, 2012; Irwin and Sanders, 2012; Hamilton and Wu, 2012; Buyuksahin and Robe, 2012).[3] With a few notable exceptions, these studies rely on data collected by the CFTC; in particular, a weekly snapshot of market positions provided through the various *Commitments of Traders* (COT) reports. Unfortunately, the public COT data are lacking along several dimensions such as reporting frequency, trader categories reported, and markets covered. Most important, the limitations are most severe for key markets such as WTI crude oil futures. This has led some researchers (Gilbert, 2010; Stoll and Whaley, 2010; Singleton, 2011; Hamilton and Wu, 2012) to use mapping algorithms to impute index positions held in the WTI crude oil futures market based on positions reported by the CFTC in other futures markets.

[3] Irwin and Sanders (2011) and Fattouh, Kilian, and Mahadeva (2012) provide surveys of this rapidly expanding literature.

In this article, we investigate the accuracy of the algorithm presented by Masters (2008) to estimate commodity index positions, especially those held in the WTI crude oil futures market. Buyuksahin and Robe (2012) and Irwin and Sanders (2012) previously noted potential inaccuracies in the algorithm estimates. Here, the algorithm calculations and potential sources of error are examined in more detail. First, trader position data provided by the CFTC through COT reports are briefly reviewed. Then, the calculation of index trader positions for futures markets using the Masters algorithm is presented with a focus on WTI crude oil futures. Finally, the positions calculated using the algorithm are compared to those collected by the CFTC's on-going special call and reported in the *Index Investment Data* (IID) report.

We show that index position estimates generated by the Masters algorithm deviate substantially from those provided by the IID report—the best available data from the CFTC. The deviations are especially notable in WTI crude oil futures, where the Masters algorithm over-estimates the gross WTI crude oil position by an average of 142,000 contracts. Importantly, the deviation in the first half of 2008, the period of greatest concern about the market impact of index investment, is directionally wrong. The Masters algorithm estimates that index positions in WTI crude oil increased by 152,000 contracts, while the IID report shows that index positions fell by 47,000 contracts. So, the Masters algorithm produces an error of 232,000 contracts near the 2008 peak of crude oil prices.

Collecting accurate data on trader positions is a difficult task. Index and other speculative positions are not held just in the futures market. For example, over-the-counter positions can be masked by internal netting procedures. The severity of these issues varies across markets. As a result, certain CFTC data sets are more appropriate than others for measuring index investment in different commodity futures markets. For agricultural markets, the CFTC *Supplemental Commitments of Traders* (SCOT) and *Disaggreated Commitments of Traders* (DCOT) data provide reasonably accurate measures of index investment. The IID report is the only accurate measure of index investment that is currently publically-available for the energy and metals futures markets. Unfortunately, it is reported only for a relatively short time period, and until recently, only at quarterly intervals.

2. CFTC's *Commitments of Traders* Data

The CFTC has long collected position data on reportable traders—those traders whose positions exceed some threshold—through their Large Trader Reporting System (LTRS). The LTRS positions have traditionally been revealed to the public through the legacy *Commitments of Traders* (COT) report. The traditional or legacy COT has been criticized for having overly broad trader categories limited to reporting commercials, reporting non-commercials, and non-reporting traders. These categories likely contain traders with a mixture of trading motives such as speculating versus hedging (Ederington and Lee, 2002; Sanders, Boris, and Manfredo, 2004). For instance, swap dealers positions are often classified as commercial hedging positions even though swap dealer customers may be speculating. These issues are resolved to some degree in the CFTC's *Disaggregated Commitments of Traders* (DCOT) report, which breaks down reporting commercial traders into processors/merchants and swap dealers. Also, the DCOT segregates the legacy non-commercial traders into managed money and "other" reportable traders. While this helps to solve part of the data problem, commodity index positions are still contained within three trader categories (swap dealers, managed money, and other reportables).

Starting in 2007, the CFTC began releasing the *Supplemental* (SCOT) report (sometimes referred to as the commodity index trader or CIT report), which specifically breaks out the positions of index traders in12 agricultural markets. Index traders are identified by reviewing the CFTC's Form 40 and through confidential interviews with traders known to be index traders or who exhibit trading patterns consistent with indexing (CFTC (2012a)). The CFTC does not divide up a trader's position in SCOT reports. So, if a trader is identified as an index trader, then all of their positions are counted as index positions.

Most commodity index investing is done in the over-the-counter market (OTC) where a customer enters a swap position with a financial institution (Stoll and Whaley, 2010; Sanders, Irwin, and Merrin, 2010). The swap dealer will then go to the futures market to off-set their risk emanating from the swaps market. It is common for swap dealers to internally net customer positions prior to placing hedges in the futures market. For example, if one customer is long $2 million in crude oil swaps and another customer is short $1 million in crude oil swaps, the swap dealer only needs to hedge the net $1 million long exposure in the futures market. Because of internal netting only a fraction of the underlying positions in the swap market may ultimately make it to the futures market, and therefore, be included in the CFTC's COT reports. Therefore, using the COT data to measure total commodity index investments may be plagued with measurement error.

The CFTC did find that swap dealers operating in agricultural markets conduct a limited amount of non-index long or short swap transactions (CFTC, 2008). Therefore, there is little error in attributing the net long futures position of swap dealers in these markets to index funds. In contrast, the CFTC found that only 41 percent of long swap dealer positions in crude oil futures markets were linked to long-only index fund positions. That is, swap dealers in energy futures markets conduct a substantial amount of non-index swap business that creates considerable uncertainty with regard to how well their futures positions reflect investments linked to commodity indexes. As a result, the CFTC consciously excluded non-agricultural commodities from the SCOT reports. Left with this data vacuum, algorithms were developed whereby index positions in the non-agricultural markets are imputed from the SCOT index trader positions reported for agricultural commodity futures markets.

3. The Masters Algorithm

Masters (2008) popularized a method of imputing index positions for individual commodity futures markets (e.g., energy and metals) that are not included in the SCOT report. This is accomplished by taking an SCOT market that is unique to a particular index and using the notional value of index trader positions in that market (as reported in the SCOT) to estimate total investment in a particular index. Then, any non-SCOT market is simply assigned a notional value according to its weight in the index.

A crucial assumption of the Masters (2008) algorithm is that the bulk of long-only commodity index investment is designed to track either the Standard and Poors-Goldman Sachs Commodity Index™ (S&P-GSCI) or the Dow Jones-UBS Commodity Index™ (DJ-UBS). The DJ-UBS index has a unique component—soybean oil. Likewise, the S&P-GSCI has two unique components— Kansas City Board of Trade (KCBT) wheat and feeder cattle. The unique markets allow Masters to assume that all of the index money in that particular market (e.g., soybean oil) represents investments in the entire index (e.g., DJ-UBS). The unique market investment can then simply be scaled up to infer the total index investment. Once the total index investment is known, it can be allocated to the non-SCOT markets (e.g., WTI crude oil) by the weights of the non-SCOT markets in the respective index.

The following expressions illustrate the calculations for imputing the notional value of long-only index funds held in WTI crude oil futures using the Masters algorithm. Notional values are simply the position size in contracts times the contract size times the price for the nearby futures contract:

$$\text{DJ-UBS WTI Notional} = \left\{\frac{\text{SCOT Soybean Oil Index Trader Notional}}{\text{Weight on Soybean Oil}}\right\} \text{ X Weight on WTI Crude}$$

$$\text{S\&P-GSCI WTI Notional\#1} = \left\{\frac{\text{SCOT Feeder Cattle Index Trader Notional}}{\text{Weight on Feeder Cattle}}\right\} \text{ X Weight on WTI Crude}$$

$$\text{S\&P-GSCI WTI Notional\#2} = \left\{\frac{\text{SCOT KCBT Wheat Index Trader Notional}}{\text{Weight on KCBT Wheat}}\right\} \text{ X Weight on WTI Crude}$$

$$\text{Total WTI Notional} = \text{DJ-UBS WTI Notional} + \frac{S\&P-GSCI\ WTI\ Notional\#1 + S\&P-GSCI\ WTI\ Notional\#2}{2}.$$

To assure that we are correctly applying the algorithm, the following example replicates as closely as possible the WTI crude oil calculations shown in Masters and White (2008, p.50) for SCOT data reported on January 17, 2006:

$$\text{DJ-UBS WTI Notional} = \left\{\frac{\text{59,264 contracts x \$0.2122 per lb. x 60,0000 lbs.}}{0.0277}\right\} \text{ X } 0.1280 = \$3{,}487 \text{ millon}$$

$$\text{S\&P-GSCI WTI Notional\#1} = \left\{\frac{\text{5,613 contracts x \$1.12275 per lb. x 50,000 lbs.}}{0.0068}\right\} \text{ X } 0.3130 =$$

$$\$14{,}504 \text{ million}$$

$$\text{S\&P-GSCI WTI Notional\#2} = \left\{\frac{\text{21,366 contracts x \$3.7525 per bu. x 5,000 bu.}}{0.0082}\right\} \text{ X } 0.3130 =$$

$$\$15{,}302 \text{ million}$$

$$\text{Total WTI Notional} = \$3{,}487 + \frac{\$14{,}504 + \$15{,}302}{2} = \$18{,}390 \text{ million.}$$

With a crude oil price of $66.31 per barrel and a contract value of $66,310 (1,000 barrels per contract), the result is an estimated 277,334 WTI crude oil futures contracts held by index funds according to the Masters algorithm. In Masters and White (2008), the authors report an estimate of 277,036 contracts. The difference (298 contracts or 0.1%) between the calculation above and that reported in Masters and White (2008) is likely due to rounding.[4]

It should also be noted that Masters and White (2008, p. 50) use the price of the January feeder cattle contract ($1.12275 per pound) and the February WTI crude oil futures ($66.31 per barrel) in the above example even though the date is January 17, 2006 for the reported positions. Managers of the index funds replicating the S&P GSCI and DJ-UBS indices would not be likely to hold these contracts so close to their delivery months. While the contract prices used are unlikely to impact longer-term trends in the algorithm's calculated positions, for any single observation it could make a meaningful difference depending on the term structure of that particular futures market (contango or backwardation).

4. Index Investment Data (IID)

Due to concerns associated with the COT data, the CFTC in June 2008 began issuing an on-going "special call" of all swap dealers and index funds known to be significant users of U.S. futures markets. In this special call, the CFTC collects the total notional value of a firm's commodity index business and the equivalent number of futures contracts (CFTC (2012b)). Each firm's entire book related to commodity index investments is reported, not just the netted amount that may be managed ultimately in the futures markets. The *Index Investment Data* (IID) is cross-checked by comparing it to the positions reported through the CFTC's larger trader reporting system and by engaging the firms in extensive discussions.

As pointed out by the CFTC (2012b), because the special call corrects for swap dealer netting, the IID is more precise than either the DCOT or SCOT in representing index investment.

[4] Masters and White (2008) show a rounded weight of 0.3130 for crude oil in the S&P GSCI, when the true value in the underlying spreadsheet is likely more precise.

Moreover, because the netting effect that plagues the COT data is corrected in the IID, data are more comprehensive in terms of markets covered. The IID is available for the 12 agricultural markets in the SCOT report plus 7 major energy and metals markets.

The original call in June 2008 gathered data from 43 entities engaging in index activities in commodity markets. These entities included index funds, swap dealers, pension funds, hedge funds, mutual funds, exchange traded funds (ETFs), and exchange traded notes (ETNs). Since the call included the financial institutions known to be the largest swap dealers in the world and all entities granted exemptions from Federal position limits or "no action" letters, the coverage of the special call is the most comprehensive to date in terms of commodity index activity (CFTC, 2008 2012b). The accuracy of the IID data has been independently verified by a well-known private firm that has been tracking such investments for more than a decade (Norrish, 2010). In addition, our own communication with staff at investment banks and the CFTC indicates a high degree of confidence in the integrity and accuracy of the collection and reporting procedures for the IID.

The comprehensive nature of the IID and its precision in measuring index positions makes this data set the best measure of total index activity in futures and OTC markets. In the words of the CFTC, "The index investment data represents the Commission's best effort to provide a one-day snapshot of the positions of swap dealers and index funds" (CFTC, 2012b). However, up until June of 2010, the report was only issued on a quarterly basis—limiting the number of observations for empirical studies. Still, with 15 quarterly observations, the IID provides a suitable benchmark to evaluate the accuracy of Masters algorithm estimates.[5]

[5] The IID report was issued quarterly from December 2007 through June 2010 and monthly thereafter. Soybean meal and platinum were added to the IID report in January 2011.

5. Evaluation of Algorithm Estimates

The IID are collected at the end of each quarter from December 31, 2007 through June 30, 2011 (15 quarter-end observations). To calculate the Master's algorithm estimates, the SCOT data are also collected for the same dates or the dates nearest to the IID quarter-end dates. Four of the fifteen release dates of the SCOT reports coincide precisely with quarter ending dates for the IID data. The other 11 COT dates are within two days of the IID compilation dates. For calculating the notional values in the algorithm, the futures prices are collected for those contracts that are closest to maturity but have not entered the delivery month (e.g., July futures on June 30).[6] S&P-GSCI weights reflect those reported in Goldman Sach's "Commodity Attributes" report at the end of each quarter. DJ-UBS weights are the target weights announced at the beginning of each year.

While the mapping algorithm can produce minor deviations based on data nuances—such as the choice of nearby futures prices or the use of changing market weights versus fixed target weights—these variations are rather minor and are unlikely to materially impact trends or time-series behavior of the resulting position estimates. More importantly, the Masters algorithm can produce results that are quite different from actual positions for three primary reasons. First, it is assumed that gross long positions reported in the SCOT are the appropriate starting point for measuring long-only index funds presence in the markets. Second, it is assumed there is a perfect positive (unitary) correlation between SCOT index positions in minor markets (e.g., feeder cattle) and index positions held in non-SCOT markets (e.g., crude oil). Third, the algorithm assumes there are just two widely-tracked commodity price indexes (S&P-GSCI and DJ-UBS). This last assumption is the basis for "scaling up" the unique markets to obtain a total

[6] The prices used undoubtedly do not precisely match those contracts held by the DJ-UBS and S&P GSCI indices which have very precisely defined contract switching rules. However, they should mirror the contract prices (nearby) used by Masters (2008) reasonably closely.

index investment estimate and for redistributing that investment among the other markets. Thus, the weight assumptions could generate an error in either step of the calculation. The impact of each of these assumptions is discussed and analyzed below.

5.1 Gross Long Positions versus Net Long Positions

Masters (2008 2009) and Masters and White (2008) take a rather unconventional approach and use the gross long positions found in the SCOT report as the basis for calculations. As an example, the SCOT report on June 30, 2009 for soybean oil shows 66,227 long index trader positions and 5,565 short index trader positions for a net long position of 60,662. The short index trader positions stem from a combination of short commodity index exchange traded funds (ETFs), spread positions between index products, and portfolio rebalancing. In nearly all studies of price pressure impacts the focus on is on net positions held by a trader group (e.g., DeRoon, Nijman and Veld (2001), Bryant, Bessler and Haigh (2006) and Buyuksahin and Harris (2011)). However, the input into the Masters algorithm is the gross long position, ignoring any short positions held by the trader group. Given that Masters is trying to link index funds with price movements, the use of gross positions is inconsistent with the usual concept of price pressure. To the degree that short positions are reported in the SCOT, the Masters algorithm use of gross long positions will generate larger estimates of total index investments.

5.2 Positive Unitary Correlation

A mapping algorithm could provide useful estimates for statistical testing and time-series analysis if there is a reasonably close correlation between the index positions held in the reported SCOT market (e.g., soybean oil) and those markets not reported (e.g., WTI crude oil). The

Masters algorithm implicitly assumes a correlation of +1.0 between positions held in the unique markets (e.g., KCBT wheat) and those held in non-SCOT markets (e.g., natural gas).

Table 1 shows the simple correlation between quarterly growth rates in SCOT gross positions for the three unique SCOT markets and the growth rates in gross long IID positions for seven non-SCOT markets at the end of each quarter between December 31, 2007 and June 30, 2011. Of the 21 correlations calculated, only 5 are statistically significant at the 10% level (two-tailed t-test). Most noticeable, the correlation between the three unique SCOT markets and WTI crude oil is negative. It is not clear why this negative correlation exists. It may arise from ETFs dedicated to investments in crude oil that do not hold positions in other commodities (e.g., the U.S. Oil Fund). Regardless, the data in Table 1 suggest that the mapping algorithm –which imposes a correlation of unity—could generate positions that are negatively correlated with actual non-netted gross index positions in WTI crude oil futures. In the other markets, the correlations are not uniform and suggest that imputed positions are unlikely to consistently track the IID positions.

5.3 Investments Follow Two Weighting Schemes

Masters (2008) asserts that,"95% of dollars indexed to commodities are replicating either the S&P-GSCI or DJ-AIG (UBS)." This assumption is the foundation for scaling up the unique markets to obtain a total index investment estimate. While there may only be 5% invested in other indices, this 5% becomes crucial when scaling up the positions in the unique markets (e.g., soybean oil). As pointed out by Singleton (2011), the measurement error using this mapping procedure will be amplified by the process of scaling minor market positions (such as feeder cattle) up to major market positions (such as WTI crude oil). For instance, in the example above, feeder cattle had a weight of 0.68% in the S&P-GSCI which creates a scaling factor of 147 (1/0.0068). So, any error in the SCOT feeder cattle position for index traders is increased by nearly 150 times in computing total index investment under the Masters algorithm. In fact, the data generated using the Masters algorithm suggests that the level of error in these mapping procedures is likely to be quite large. In the example presented in Masters and White (2008, p. 50), the errors are often of a relatively large magnitude even within the SCOT markets themselves, with the mapping algorithm under-estimating cocoa index positions by 35% and corn by 25%. If errors for markets within the SCOT report are that large, then it is likely that the errors for non-SCOT markets, like energy and metals, are even larger.

5.4 Evaluation of Tracking Errors

The Masters algorithm is first used to compute the positions in all of the IID markets on a common date—June 30, 2009. The results are presented in Table 2 for comparison with both gross and net long IID positions. On this particular date, the Masters algorithm under-estimated the IID gross long positions by an average of 23% and over-estimated the net positions by an average of 14%. Some of the errors are remarkably large, exceeding 50%. So, assuming that the IID represent the best available data on non-netted index investments, the Masters algorithm can produce material deviations from this benchmark both in estimating gross and net index positions.

To further demonstrate the potential errors, the method proposed by Masters (2008) is used to calculate total index investment at the end of each quarter between December 31, 2007 and June 30, 2011.[7] Gross total investment in index funds as reported by the IID and calculated

[7] The Masters (2008) procedure was followed as closely as possible. The weights for the S&P GSCI markets were those reported at the end of each quarter (1-2 days within the SCOT report dates). The DJ-UBS weights were not

using the Masters' algorithm are shown in Figure 1 and Table 3. By chance or design, the Masters' algorithm seems to provide a reasonably good estimate of the gross long index positions reported in the IID with an average over-estimate of just \$4.4 billion or 2.1%. Conversely, the Master's algorithm provides an average over-estimate of net long IID positions by \$57.8 billion (36%). The difference between the algorithm estimates and the net long IID is driven by the short positions held by index traders. This difference has become progressively larger since early 2009, when it was roughly \$30 million, to early 2011 when the short positions exceed \$90 million. Based on these data, the algorithm estimates of total index investment are reasonably accurate for gross IID positions; but, they materially over-estimate the net long IID positions.

Since the Masters algorithm estimates have also been used to examine price pressure in specific markets, it is important to evaluate the positions imputed for the non-SCOT markets, especially WTI crude oil. The average estimated positions (1,000s of contracts) for WTI crude oil futures are shown in Figure 2 and Table 4. The Masters' algorithm over-estimates the gross WTI crude oil position from the IID by an average of 142,000 contracts (statistically significant at 1% level, paired t-test) and the mean absolute percentage error (MAPE) is 26%. The errors in certain time periods are in excess of 200,000 contracts. Moreover, the growth rates in Masters algorithm and IID positions in WTI crude oil have a statistically insignificant 0.02 correlation coefficient—the positions do not move together. Importantly, one of the periods where they deviate is the first half of 2008, the period of greatest concern about the market impact of index funds.

---

available on those specific dates, so the target weights reported for each year were utilized. While the raw data used by Masters (2008) were not available, we compared our estimates where possible to estimates presented graphically in Masters (2008, 2009), Masters and White (2008) and Singleton (2011). Our estimates appear to track these other estimates fairly closely.

Nearby crude oil futures prices increased from $95.98 to $140.47 per barrel from December 31, 2007 to July 1, 2008. Over that same interval, the Masters algorithm estimates that index positions increased by 152,000 contracts, from 522,000 contracts to 674,000 contracts. This is a key justification for the Masters Hypothesis, i.e., index speculators pushed up crude oil prices well beyond fundamental values. In stark contrast, the CFTC's IID show that gross index investment in WTI crude oil over that same period fell by 47,000 contracts, from 489,000 contracts to 442,000 contracts. So, the Masters algorithm produces an error of 232,000 contracts near the 2008 peak of crude oil prices. More importantly, the Masters algorithm is directionally incorrect, showing that index funds expanded their holdings in the first half of 2008; when, in fact, they were net sellers.

Table 4 also presents the positions calculated by the Masters algorithm for the other six non-SCOT markets and the corresponding gross IID positions. As previously discussed, the imputed WTI positions clearly deviate from the gross IID positions with large errors and no correlation in growth rates. Across the other markets, MAPE ranges from a low of 17% (natural gas) to a high of 86% (copper). The correlations in growth rates range from +0.76 (silver) to -0.31 (copper). The lack of uniformity in the algorithm's estimates compared to the gross IID is consistent with the data in Table 1. Any imputed positions using the Masters algorithm have to be used cautiously.

Figure 3 and Table 5 provide analogous data comparing the positions imputed with the Masters algorithm to the net IID positions—arguably the most applicable measurewhen testing price pressure effects. Not surprisingly, the errors between the algorithm estimates and the net IID positions are larger than those found with the gross IID positions. The average difference between the algorithm estimates and the net IID position in WTI crude oil is 284,000 contracts.

The difference exceeds 300,000 contracts in mid-2008 when the crude oil market peaked and exceeded 400,000 through all of 2010. The correlation in growth rates is 0.06 and not statistically different from zero. If the net position held by index funds is the key measure of market price pressure, then the Masters algorithm falls woefully short in estimating this measure in WTI crude oil futures.

Among other markets, the estimation of net IID positions (Table 5) versus gross IID positions (Table 4) results in bigger absolute errors in the energy markets and copper. The estimates are actually more accurate in silver and gold. Generally, the correlations for growth rates in the algorithm estimates with the net IID positions are lower (in absolute terms) than those for the gross IID positions with the exception of gold. The copper market stands out with the largest MAPE (143%) and a negative correlation. Clearly, the use of the Masters algorithm to estimate index positions in copper is ill advised. Indeed, caution is warranted in all markets, especially if statements about the absolute level of index investment are required.

5.5 Potential Sources of Tracking Errors

Clearly, there is a serious tracking error between the index position estimates produced by the Masters algorithm and those found in the IID reports. The error is among the most pronounced in the futures market for which the algorithm is most often applied—WTI crude oil. At its root, the Masters algorithm relies on an implicit correlation between index positions held in soybean oil, feeder cattle, and KCBT wheat and those held in WTI crude oil futures. The algorithm's imposition of positive unitary correlations among these positions likely explains much of the over-estimates observed in the WTI crude positions. As shown in Table 1, the correlations are not unity. An inspection of the data shows that the combined notional gross value held by SCOT index funds in feeder cattle, KCBT wheat, and soybean oil increased by 234% from December 2008 to December 2010. Over those same two years, the notional value of all IID positions increased by a much smaller 152% and the notional value of IID WTI crude oil positions increased by just 133%. More pointedly, the number of gross long IID WTI contracts increased by just 21%; whereas, the Master's algorithm estimates increased by 68% (see Figure 2). Hence, the increase in the Master's algorithm estimates isfueled by the increases in the feeder cattle, KCBT, and soybean oil SCOT positions because the algorithm assumes a positive correlation when no such correlation exists.

While the lack of correlation between the SCOT index positions and the IID WTI crude oil positions is the statistical source of error in the Masters algorithm, the reason for lack of correlation is more difficult to determine. The first and most obvious potential source of error is in the actual versus theoretical tracking and rebalancing used by index funds. While both the S&P-GSCI and the DJ-UBS are specific in regards to periodic rebalancing and market allocations, index fund managers may or may not allocate across markets as precisely or rebalance as frequently as the theoretical indices. A second potential source of error is the reliance on only two investment indexes. The Masters algorithm assumes that any index investment held in the unique markets (e.g., soybean oil) is representative of the total investment in a particular index (e.g., DJ-UBS). However, there are commodity indices other than the S&P-GSCI and the DJ-UBS. These alternative indices may represent a relatively small portion of total index investments, but the scaling-up process inherent to the algorithm magnifies their impact.

Another likely source of the errors is the rise of ETF's that are focused on single agricultural markets or narrowly defined sub-indices or baskets of agricultural markets. An exchange traded fund data base (*ETFdb.com*) lists a total of 27 ETFs that are focused in this manner (see Table 6), with a combined notional value of nearly $4 billion. Most notably, the Powershares DB Agricultural Fund (symbol DBA) is an actively traded ETF, and as of June 30, 2011, DBA had shareholder equity of $3.1 billion with base allocations of 6.25% to KCBT wheat and 4.17% to feeder cattle. At these weights the notional amounts (contracts) held in KCBT wheat and feeder cattle are $192 (5,575) and $128 (1,854) million, respectively. Using the scaling-up process implicit in the Masters algorithm, these ETF positions would create an imaginary $27.3 billion invested in the S&P-GSCI with $8.9 billion allocated to WTI crude oil positions, or 87,107 long contracts. These positions do not exist. Indeed, on that date, the Masters algorithm generated an over-estimate of the gross IID data by 149,000 contracts (see Table 4). The positions wrongly extrapolated from the DBA fund would account for over 60% of that error. The Masters algorithm is highly sensitive to slight deviations in index positions held in the unique futures markets. With 27 ETFs dedicated to agricultural commodity futures investments, it is easy to see how multiple errors can be incorporated into the algorithm's estimates. Consequently, any empirical work using these imputed positions must be viewed with considerable caution.

6. Summary and Conclusions

The "Masters Hypothesis" is the claim that unprecedented buying pressure from new index investment created a massive bubble in commodity futures prices. A number of recent studies investigate the empirical relationship between commodity index positions and price movements in commodity futures markets. Some studies find evidence of a positive relationship (e.g., Gilbert, 2010; Tang and Xiong, 2010; Singleton, 2011) but most do not (e.g., Stoll and

Whaley, 2010; Sanders and Irwin, 2011; Buyuksahin and Harris, 2011; Brunetti, Buyuksahin and Harris, 2012; Irwin and Sanders, 2012; Hamilton and Wu, 2012; Buyuksahin and Robe, 2012). With a few notable exceptions, these studies rely on data collected by the U.S. Commodity Futures Trading Commission (CFTC). Unfortunately, the public CFTC data are lacking along several dimensions such as reporting frequency, trader categories reported, and markets covered. These limitations are most severe for key markets such as WTI crude oil futures, which has led some researchers (Gilbert, 2010; Stoll and Whaley, 2010; Singleton, 2011; Hamilton and Wu, 2012) to use mapping algorithms to impute index positions held in the WTI crude oil futures market based on positions reported by the CFTC in other futures markets.

We investigate the accuracy of the algorithm popularized by Masters (2008) to estimate commodity index positions, especially those held in the WTI crude oil futures market. The Masters algorithm is used to generate estimates of quarterly commodity index fund positions from December 2007 through June 2011. The estimates generated by the Masters algorithm are shown to deviate substantially from the positions reported in the U.S. Commodity Futures Trading Commission's (CFTC) *Index Investment Data* (IID) report—the agency's best data on index positions. The deviations are especially notable in WTI crude oil futures. The Masters' algorithm over-estimates the gross WTI crude oil position by an average of 142,000 contracts and the mean absolute percentage error (MAPE) is 26%. Moreover, the correlation of growth rates for Masters algorithm and IID WTI positions is a statistically insignificant 0.02—the positions do not move together. Importantly, the deviation in the first half of 2008, the period of greatest concern about the market impact of index investment, is directionally wrong. The Masters algorithm estimates that index positions in WTI crude oil increased by 152,000 contracts, while the IID show that index positions fell by 47,000 contracts. So, the Masters algorithm produces an error of 232,000 contracts near the 2008 peak of crude oil prices.

The inescapable conclusion from this analysis is that mapping algorithms—such as that developed by Masters (2008)—generate suspect data, especially for WTI crude oil futures. The imputed data not only may contain large absolute errors but also a lack of correlation with the best available estimate of actual positions from the IID report. Consequently, empirical results for WTI crude oil futures based on mapping algorithm data should be viewed with considerable caution (Gilbert, 2010; Stoll and Whaley, 2010; Singleton, 2011; Hamilton and Wu, 2012).

Testing for the impact of index investment on commodity prices is challenging—even with good data. Collecting accurate data on trader positions is a difficult task. Index and other speculative positions are not held just in the futures market. Over-the-counter (OTC) positions can be masked by internal netting procedures. The severity of these issues varies across markets. As a result, certain CFTC data sets are more appropriate than others for measuring index investment in different commodity futures markets. Irwin and Sanders (2012) show that the average correlation between quarterly index positions from the *Supplemental Commitments of Traders* (SCOT) report and the IID for 12 agricultural markets is 0.81, suggesting that the SCOT positions provide a reasonably accurate measure of index investment in agricultural markets covered by this report. Irwin and Sanders report that average correlation between quarterly index positions from the *Disaggregated Commitments of Traders* (DCOT) report and the IID is lower (0.71) for the same 12 agricultural markets, but still high enough to have reasonable confidence that the positions from the DCOT also provide a reasonably accurate measure of index investment in agricultural markets. The principal reason the two reports provide relatively accurate measurements is that the non-index swap trade in agricultural markets is relatively minor. By contrast, there is a very active non-index swap trade and internal netting of positions by swap dealers in the energy and metals markets and it not surprising that Irwin and Sanders find DCOT swap dealer positions are a poor proxy for total index positions in these markets (average correlation = 0.19). Moreover, as we show in the this article, using algorithmic transformations of the SCOT data to infer index investments in the energy markets does not yield accurate measurements.

Across all markets, the IID report is the preferred measure of total index positions. Importantly, for the energy and metals futures markets it is the only accurate measure of index investment that is currently in the public domain. Unfortunately, the IID is reported only for a relatively short time period, and until recently, only at quarterly intervals. There is a clear need for the development of higher frequency IID-type data in energy markets.

References

Bryant, H., D.A. Bessler and M.S. Haigh (2006). "Causality in Futures Markets." *Journal of Futures Markets,* 26(11): 1039-1057.

Buyuksahin, B. and J.H. Harris (2011). "Do Speculators Drive Crude Oil Futures Prices?" *Energy Journal,* 32(2): 167-202.

Buyuksahin, B. and M.A. Robe (2012). "Speculators, Commodities, and Cross-Market Linkages." American University. Accessed at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1707103.

Commodity Futures Trading Commission (CFTC) (2008). "Staff Report on Commodity Swap Dealers & Index Traders with Commission Recommendations." Accessed at http://www.loe.org/images/content/080919/cftcstaffreportonswapdealers09.pdf.

Commodity Futures Trading Commission (CFTC) (2012a). "Commitments of Traders: Explanatory Notes." Accessed at http://www.cftc.gov/MarketReports/CommitmentsofTraders/ExplanatoryNotes/index.htm

Commodity Futures Trading Commission (CFTC) (2012b). "Index Investment Data: Explanatory Notes." Accessed at http://www.cftc.gov/MarketReports/IndexInvestmentData/ExplanatoryNotes/index.htm.

De Roon, F.A., T.E. Nijman and C. Veld (2000). "Hedging Pressure Effects in Futures Markets." *Journal of Finance,* 55(3): 1437-1456.

Deutsche Bank (2011). "PowerShares DB Agriculture Fund: Fact Sheet." June 30. Accessed at http://dbfunds.db.com/Dba/Pdfs/DBA_Fact_Sheet.pdf.

Ederington, L.H. and J.H. Lee (2002). "Who Trades Futures and How: Evidence from the Heating Oil Market." *Journal of Business,* 75(2): 353-373.

Engelke, L. and J.C. Yuen (2008). "Types of Commodity Investments," in *The Handbook of Commodity Investing*, F.J. Fabozzi, R. Fuss, and D. Kaiser eds., Hoboken, NJ: John Wiley and Sons, pp. 549-69.

Exchange Traded Funds Database. Accessed at http://etfdb.com/etfdb-category/agricultural-commodities/.

Fattouh, B., L. Kilian and L. Mahadeva (2012). "The Role of Speculation in Oil Markets: What Have We Learned So Far? Oxford Institute for Energy Studies. Accessed at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2034134.

Gilbert, C.L. (2010). "Speculative Influences on Commodity Futures Prices, 2006-2008." Discusion Paper No. 197, United Nations Conference on Trade and Development. Accessed at http://archive.unctad.org/en/docs/osgdp20101_en.pdf.

Goldman Sachs, Inc. "Commodities Market Attributes." Investment Report, various issues, 2006-2011.

Hamilton, J.D. and J.C. Wu. (2012). "Effects of Index-Fund Investing on Commodity Futures Prices." University of Chicago. Accessed at http://faculty.chicagobooth.edu/JING.WU/research/pdf/commodity_index.pdf.

Irwin, S.H., D.R. Sanders and R.P. Merrin (2009). "Devil or Angel? The Role of Speculation in the Recent Commodity Price Boom (and Bust)." *Journal of Agricultural and Applied Economics,* 41(2): 393-402.

Irwin, S.H. and D.R. Sanders (2011). "Index Funds, Financialization, and Commodity Futures Markets." *Applied Economic Perspectives and Policy,* 33(1): 1-31.

Irwin, S.H. and D.R. Sanders (2012). "Testing the 'Masters Hypothesis' in Commodity Futures Markets." *Energy Economics,* 34(1): 256-269.

Masters, M.W. (2008). "Testimony before the Committee on Homeland Security and Governmental Affairs, United States Senate." May 20. Accessed at http://hsgac.senate.gov/public/_files/052008Masters.pdf.

Masters, M.W. (2009). "Testimony before the Commodity Futures Trading Commission." August 5. Accessed at http://www.cftc.gov/ucm/groups/public/@newsroom/documents/file/hearing080509_masters.pdf.

Masters, M.W. and A.K. White (2008). "The Accidental Hunt Brothers: How Institutional Investors are Driving Up Food and Energy Prices." Special Report. Accessed at http://www.loe.org/images/content/080919/Act1.pdf.

Norrish, K. (2010). "Prepared Statement for the Record before the U.S. Commodity Futures Trading Commission." March 25. Accessed at http://www.cftc.gov/ucm/groups/public/@newsroom/documents/file/metalmarkets032510_norrish.pdf.

Pirrong, C. (2010). "No Theory? No Evidence? No Problem!" *Regulation,* 33(Summer): 38-44.

Sanders, D.R., K. Boris and M. Manfredo (2004). "Hedgers, Funds, and Small Speculators in the Energy Futures Markets: An Analysis of the CFTC's Commitments of Traders Reports." *Energy Economics* 26(3): 425-445.

Sanders, D.R. and S.H. Irwin (2011). "The Impact of Index Funds in Commodity Futures Markets: A Systems Approach." *Journal of Alternative Investments,* 14(1): 40-49.

Sanders, D.R., S.H. Irwin and R.P. Merrin (2010). "The Adequacy of Speculation in Agricultural Futures Markets: Too Much of a Good Thing?" *Applied Economics Perspectives and Policy,* 32(1): 77-94**.**

Singleton, K.J. (2011). "Investor Flows and the 2008 Boom/Bust in Oil Prices." Stanford University. Accessed at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1793449.

Stoll, H.R. and R.E. Whaley (2010). "Commodity Index Investing and Commodity Futures Prices." *Journal of Applied Finance,* 20(1): 7-46.

Tang, K. and W. Xiong (2010). "Index Investing and the Financialization of Commodities." Working Paper No. 16385, National Bureau of Economic Research. Accessed at http://www.nber.org/papers/w16385.

United States Senate, Permanent Subcommittee on Investigations (USS/PSI) (2009). *Excessive Speculation in the Wheat Market*. U.S. Government Printing Office: Washington, D.C.

Table 1. Cross-Market Correlations of Growth Rates in Index Investment Gross Long Positions, Quarterly, December 31, 2007 – June 30, 2011

	IID Market						
SCOT Market	WTI Crude Oil	RBOB Gasoline	Heating Oil	Natural Gas	Gold	Silver	Copper
Soybean Oil	-0.50	-0.09	0.34	0.57	0.55	0.62	0.15
Wheat, KCBT	0.22	0.50	0.58	0.04	-0.17	0.19	0.41
Feeder Cattle	-0.23	0.45	0.55	0.18	0.37	0.49	0.20
Average	-0.17	0.29	0.49	0.26	0.25	0.44	0.25

Note: Simple Pearson correlation coefficients are calculated between the log-relative growth rates in gross trader positions reported in the *Supplemental Commitments of Traders* (SCOT) and the *Index Investment Data* (IID) reports. The data are based on end-of-quarter positions.

Table 2. Comparison of Commodity Index Fund Positions based on the Masters Algorithm and *Index Investment Data* (IID) Report as of June 30, 2009

Commodity Futures Market	Masters Algorithm (thousand contracts)	Gross IID (thousand contracts)	Difference of Algorithm from IID	Net IID (thousand contracts)	Difference of Algorithm from IID
Corn	325	455	-29%	298	9%
Soybeans	96	183	-48%	122	-22%
Soybean Oil	66	84	-21%	62	7%
Wheat, CBOT	212	285	-26%	171	24%
Wheat, KCBT	23	32	-27%	24	-3%
Cotton	73	104	-30%	53	37%
Live Cattle	129	143	-9%	97	33%
Feeder Cattle	9	12	-23%	7	31%
Lean Hogs	101	101	0%	62	63%
Coffee	47	60	-22%	36	30%
Sugar	174	322	-46%	237	-27%
Cocoa	11	26	-56%	18	-37%
WTI Crude Oil	579	637	-9%	430	35%
RBOB Gasoline	76	87	-13%	66	15%
Heating Oil	74	83	-11%	59	25%
Natural Gas	240	306	-22%	233	3%
Gold	66	101	-34%	73	-9%
Silver	24	36	-32%	27	-9%
Copper	106	88	21%	63	69%

Table 3. Total Index Investment in Commodity Futures Markets based on the Masters Algorithm and *Index Investment Data* (IID) Report, Quarterly, December 31, 2007 – June 30, 2011

Date	Algorithm Total Investment	Gross IID Total Investment	Algorithm Over/(Under) Estimate	Net IID Total Investment	Algorithm Over/(Under) Estimate
	------- $ billions-------			------- $ billions-------	
December 31, 2007	183.2	175.6	7.6	147.1	36.1
April 1, 2008	233.4	209.9	23.5	168.9	64.5
July 1, 2008	306.6	255.9	50.7	201.5	105.1
September 30, 2008	173.3	175.6	(2.3)	131.4	41.9
December 30, 2008	84.8	112.4	(27.6)	82.2	2.6
March 31, 2009	97.2	120.8	(23.6)	86.5	10.7
June 30, 2009	134.2	163.0	(28.8)	117.2	17.0
September 29, 2009	147.2	178.5	(31.3)	134.5	12.7
December 29, 2009	215.5	211.2	4.3	159.9	55.6
March 30, 2010	253.4	215.9	37.5	161.2	92.2
June 29, 2010	235.7	212.3	23.4	160.6	75.1
September 28, 2010	259.0	241.5	17.5	181.7	77.3
December 28, 2010	314.7	283.7	31.0	211.1	103.6
March 29, 2011	321.4	336.0	(14.6)	242.6	78.8
June 28, 2011	321.3	321.9	(0.6)	227.7	93.6
Average	218.7	214.3	4.4	160.9	57.8

Table 4. Index Investment Positions in Commodity Futures Markets based on the Masters Algorithm and Gross Long Positions from the *Index Investment Data* (IID) Report, Quarterly, December 31, 2007 – June 30, 2011

Date	Algorithm WTI Crude	Gross IID WTI Crude	Algorithm RBOB	Gross IID RBOB	Algorithm Heating Oil	Gross IID Heating Oil	Algorithm Natural Gas	Gross IID Natural Gas	Algorithm Copper	Gross IID Copper	Algorithm Silver	Gross IID Silver	Algorithm Gold	Gross IID Gold
							---thousand contracts---							
December 31, 2007	522	489	41	49	84	90	216	169	115	36	36	27	99	103
April 1, 2008	683	483	86	66	88	83	216	164	113	57	32	32	102	112
July 1, 2008	674	442	87	66	87	88	208	168	131	53	39	35	119	124
September 30, 2008	502	428	68	58	67	65	197	183	109	54	38	34	86	115
December 30, 2008	537	516	74	60	67	63	137	160	110	41	21	28	50	102
March 31, 2009	534	586	70	77	68	69	193	162	96	65	19	29	53	91
June 30, 2009	579	594	76	84	74	76	240	304	106	83	24	38	66	113
September 29, 2009	674	637	90	87	84	83	218	306	102	88	22	36	67	101
December 29, 2009	863	626	110	96	103	83	255	322	122	98	26	39	82	98
March 30, 2010	895	612	115	93	118	90	409	387	148	82	40	43	113	126
June 29, 2010	881	619	115	91	115	92	362	337	161	85	37	45	103	125
September 28, 2010	926	642	125	89	123	89	420	375	151	84	36	46	107	137
December 28, 2010	900	622	124	94	122	89	491	393	161	92	34	47	123	135
March 29, 2011	796	694	110	100	110	95	464	484	150	98	29	44	128	157
June 28, 2011	838	689	124	102	123	94	423	470	157	101	28	47	114	166
Average	720	579	94	81	96	83	297	292	129	74	31	38	94	120
Average Error	142		14		12		4		54		-7		-26	
MAPE	26%		21%		16%		17%		86%		25%		22%	
Correlation	0.02		0.65		0.60		0.49		-0.31		0.76		0.61	

Table 5. Index Investment Positions in Commodity Futures Markets based on the Masters Algorithm and Net Long Positions from the *Index Investment Data* (IID*)* Report, Quarterly, December 31, 2007 – June 30, 2011

Date	Algorithm WTI Crude	Net IID WTI Crude	Algorithm RBOB	Net IID RBOB	Algorithm Heating Oil	Net IID Heating Oil	Algorithm Natural Gas	Net IID Natural Gas	Algorithm Copper	Net IID Copper	Algorithm Silver	Net IID Silver	Algorithm Gold	Net IID Gold
							---thousand contracts---							
December 31, 2007	522	413	41	41	84	72	216	145	115	31	36	23	99	87
April 1, 2008	683	405	86	55	88	62	216	132	113	45	32	26	102	89
July 1, 2008	674	366	87	54	87	65	208	132	131	40	39	25	119	102
September 30, 2008	502	351	68	48	67	53	197	135	109	38	38	25	86	86
December 30, 2008	537	422	74	47	67	46	137	120	110	31	21	20	50	70
March 31, 2009	534	448	70	63	68	51	193	111	96	45	19	22	53	61
June 30, 2009	579	430	76	66	74	59	240	233	106	63	24	27	66	73
September 29, 2009	674	464	90	72	84	62	218	249	102	69	22	30	67	79
December 29, 2009	863	451	110	82	103	64	255	261	122	76	26	33	82	77
March 30, 2010	895	432	115	81	118	72	409	300	148	62	40	35	113	93
June 29, 2010	881	462	115	77	115	72	362	271	161	65	37	37	103	100
September 28, 2010	926	470	125	75	123	69	420	309	151	66	36	39	107	101
December 28, 2010	900	451	124	81	122	73	491	329	161	72	34	40	123	105
March 29, 2011	796	482	110	81	110	77	464	375	150	72	29	35	128	118
June 28, 2011	838	492	124	82	123	72	423	357	157	70	28	35	114	123
Average	720	436	94	67	96	65	297	231	129	56	31	30	94	91
Average Error	284		27		31		66		72		1		3	
MAPE	65%		40%		47%		35%		143%		22%		12%	
Correlation	0.06		0.62		0.43		0.40		-0.24		0.64		0.75	

Table 6. Exchange Traded Funds (ETFs) focused on Agricultural Markets as of September 23, 2011

Symbol	Name	Assets (thousand $)	Volume (shares)
DBA	PowerShares DB Agriculture Fund	2,768,220	1,972,861
JJG	iPath Exchange Traded Notes Dow Jones - AIG Grains Total Return Sub-Index ETN Series A	253,191	176,384
JJA	iPath Exchange Traded Notes Dow Jones - AIG Agriculture Total Return Sub-Index ETN Series A	179,913	53,359
CORN	Teucrium Corn Fund	112,164	161,142
BAL	iPath Dow Jones-AIG Cotton Total Return Sub-Index ETN	79,202	96,470
COW	Dow Jones-UBS Livestock Subindex Total Return	70,438	55,807
SGG	iPath Dow Jones-AIG Sugar Total Return Sub-Index ETN	65,074	67,232
RJA	Elements Exchange Traded Notes Rogers International Commodity Index - Agriculture Total Return	49,814	669,720
FUD	UBS E-TRACS CMCI Food Total Return ETN	44,708	10,985
JJS	iPath Dow Jones-AIG Softs Total Return Sub-Index ETN	34,642	10,185
JO	iPath Dow Jones-AIG Coffee Total Return Sub-Index ETN	32,114	53,675
GRU	ELEMENTS Exchange Traded Notes MLCX Grains Index-Total Return	19,302	86,881
NIB	iPath Dow Jones-AIG Cocoa Total Return Sub-Index ETN	14,446	21,481
UAG	UBS E-TRACS CMCI Agriculture Total Return ETN	14,030	7,278
AGF	DB Agriculture Long ETN	10,983	9,109
SGAR	iPath Pure Beta Sugar	10,566	6,624
WEET	iPath Pure Beta Grains	6,382	2,498
CAFE	iPath Pure Beta Coffee	6,174	2,633
GRWN	iPath Pure Beta Softs	5,962	2,614
CTNN	iPath Pure Beta Cotton	5,679	2,133
DIRT	iPath Pure Beta Agriculture	5,614	1,652
LSTK	iPath Pure Beta Livestock	5,059	945
UBC	UBS E-TRACS CMCI Livestock Total Return ETN	4,913	1,138
CHOC	iPath Pure Beta Cocoa	4,576	2,008
SOYB	Teucrium Soybean Fund	2,437	n.a.
CANE	Teucrium Sugar Fund	2,372	n.a.
WEAT	Teucrium Wheat Fund	2,298	n.a.
	Total	**3,810,273**	

Figure 1. Total Index Investment in Commodity Futures Markets based on the Masters Algorithm and the *Index Investment Data* (IID*)* Report, Quarterly, December 31, 2007 – June 30, 2011

Figure 2. Index Investment Positions in the WTI Crude Oil Futures Market based on the Masters Algorithm and Gross Long Positions from the *Index Investment Data* (IID*)* Report, Quarterly, December 31, 2007 – June 30, 2011

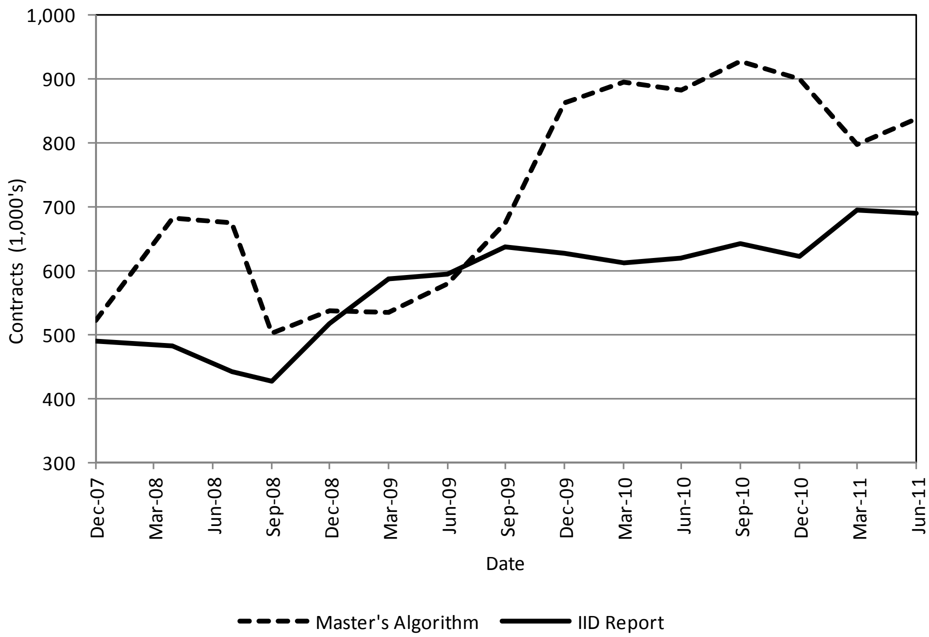

Figure 3. Index Investment Positions in the WTI Crude Oil Futures Market based on the Masters Algorithm and Net Long Positions from the *Index Investment Data* (IID*)* Report, Quarterly, December 31, 2007 – June 30, 2011