Rising and Volatile Food Prices: Are Index Fund Investors to Blame?*

Marcel Prokopczuk[†,‡] Lazaros Symeonidis[§] and Timo Verlaat[¶]

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Abstract

The recent sharp increase in the prices of primary food commodities has raised serious concerns of policy makers on the role of index funds in these food markets. In this paper, we employ a dataset on trading positions of index fund investors from the US Commodity Futures Trading Commission (CFTC), and analyze the relationship between index fund activity and food prices and their volatility. We focus on three major and liquid agricultural markets: corn, soybeans and wheat. We find little evidence that the positions of index fund investors can help explain changes in food prices. Instead, causality from food price changes to position changes appears to be much stronger. Furthermore, our findings suggest that index trader positions bear some predictive ability for volatility. This relationship is mainly concentrated on the 2006–2009 period that includes the recent financial crisis. Finally, we find that volatility decreases with the positions of index fund traders.

JEL classification: G10, G13, G28, Q14, Q18

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*Contact emails: marcel.prokopczuk@zu.de (Marcel Prokopczuk), lazaros.symeonidis@stir.ac.uk (Lazaros Symeonidis) and t.verlaat@zeppelin-university.de (Timo Verlaat).

†Zeppelin University, Am Seemooser Horn 20, 88045, Friedrichshafen, Germany.

‡ICMA Centre, Henley Business School, University of Reading, RG6 6BA, UK

§University of Stirling, FK9 4LA, Stirling, UK.

¶Zeppelin University, Am Seemooser Horn 20, 88045, Friedrichshafen, Germany.

1. Introduction

Over the last decade, and especially in the 2006–2008 period, the prices of major food commodities have increased sharply. The FAO Food Price Index, which measures the monthly change in the prices of a group of food commodities, more than doubled between the years 2004 and 2008 (see Figure 1). After the 2008 peak, food prices began to fall, but since 2011 a second period of sharp price rises has started. These developments raise major concerns for food security of poorer nations that are heavily dependent on the imports of agricultural goods. Additionally, they pose a significant challenge for economic policy makers in their effort to control inflation.

The period of food price escalations has coincided with the increased participation of index funds in commodity markets.[1] This type of investor follows a strategy of buying and holding a futures contract, then selling the expiring contract shortly before maturity and buying the next to maturity contract. Several studies have shown that these long-only trading strategies can lead to substantial returns (Bodie and Rosansky, 1980; Gorton and Rouwenhorst, 2006). Moreover, the popularity of these kind of investment strategies also stems from the view that commodities are good diversification instruments (Jensen et al., 2000; Chong and Miffre, 2010).

Among the various explanations for the observed food price boom – such as the increased usage of biofuels, increasing demand from emerging markets, and high energy prices – the role of index investors is regarded as most critical. More specifically, several studies argue that index fund activity has made a substantial contribution to the sharp increase in the prices and volatility of agricultural commodities (Gilbert, 2010a), or even led to a bubble (e.g. Masters, 2009; Gilbert, 2010b). By contrast, other researchers find little support for the above argument (Stoll and Whaley, 2010; Irwin and Sanders, 2010; Hamilton and Wu, 2012).[2]

Drawing upon these considerations, in this paper we conduct a compre-

[1] For example, Barclays Capital estimates that commodity index-linked investments increased from approximately US$90bn in 2006 to more than US$200bn in mid-2008, reaching a peak of more than US$250bn in 2011.

[2] See also Fattouh et al. (2012) for a very comprehensive review.

hensive econometric analysis of the relationship between index fund activity and food prices and their volatility. In particular, we attempt to answer the following two questions: First, does index fund activity Granger-cause returns of agricultural food commodities and vice versa? Second, is the increased volatility of agricultural futures returns related to the increased activity by index fund investors? The answers to these questions are of crucial importance for a large number of stakeholders. Policy makers need to know the reasons for increased food prices when discussing market regulations. Besides, for market professionals it is crucial to understand the main determinants of prices and volatility when making asset allocation, hedging or risk management decisions.

We make the following contributions to the existing literature. First, we study the question of whether index investors are responsible for the sharp increase in agricultural food prices over a sample period that includes the second and most recent boom cycle in agricultural futures prices. Most existing studies have focused on a shorter time period, only focusing on the pre-2008 boom period and, thus, not including the recent bust. Second, the lead-lag relationships between agricultural commodity returns and index fund flows are analyzed by employing several measures of index fund activity. In this way we provide a unifying framework across studies that employ different ways of measuring the impact of index fund investing on commodity prices. Third, our study is one of the very few that analyzes the effect of index fund investments on the volatility of food prices, which is another major concern in the market.

To quantify index fund flows we employ the weekly positions of various types of traders from the Disaggregated Commitments of Traders reports as well as the Supplemental reports published by the US Commodity Futures Trading Commission (CFTC). These reports are available since 2006, therefore our empirical application is conducted in the six-year period from September 2006 to October 2012. This dataset is the best publicly available data source to date. We focus our attention on three of the most important and liquid agricultural food markets, namely: corn, soybeans and wheat.

We first analyze the contemporaneous association between excess agricultural futures returns and the net positions of two types of traders: index investors and swap dealers. We find that the changes in the net long positions of index fund investors are positively related to excess futures returns. This first finding is similar to the results for the crude oil market reported by Singleton (2013). The net position changes are measured in three different horizons, namely: 1-week, 4-weeks and 13-weeks. In the next step of our analysis, we perform Granger causality tests to investigate the lead-lag relationships between excess returns on commodity futures and changes in the net positions separately for the two types of traders. We implement our analysis for the entire sample period as well as for two sub-samples of almost equal length, that is: September 2006 to September 2009 and October 2009 to October 2012.

Our results provide very little support for the hypothesis that changes in the net position of index fund investors can explain subsequent returns on agricultural futures prices. In contrast, the evidence rather points in the direction that excess futures returns Granger-cause the net position index investors. Therefore, it seems that index fund investors tend to follow price signals when taking their investment positions. This result is consistent with the idea of time series momentum discussed by Moskowitz et al. (2012). Our findings cast doubt on the presumption that speculation and index fund investment have increased food commodity prices.

We also analyze the impact of net trader positions on food price volatility. Our results show a modest predictive ability of index fund flows for volatility, which varies across the three markets. For instance, it is entirely absent for corn, but much stronger for wheat. Most of this predictability appears to be concentrated in the first sub-period from 2006 to 2009. In non-reported results we also find that the sign of the majority of significant coefficients for the changes in net trader positions is negative. This means that long-only index investors do not seem to destabilize the agricultural futures market, but rather provide liquidity.

This paper contributes to the fast-growing literature on the impact of speculation and index fund investment on commodity prices. Thus far, the evidence in this literature is fairly mixed; that is, while some studies find supporting evidence that commodity index investment significantly affects futures prices (Gilbert, 2010b,a; Lagi et al., 2011), others contradict this conjecture (Brunetti and Büyüksahin, 2011; Irwin and Sanders, 2010; Stoll and Whaley, 2010; Büyüksahin and Harris, 2011; Sanders and Irwin, 2011; Hamilton and Wu, 2012; Irwin and Sanders, 2012b).[3]

Our paper is also related to the literature on "financialization" of commodities, according to which the recent flow of funds from index investors has led to an accelerating process of integration of commodities to the other asset markets. For example, Tang and Xiong (2012) find that the presence of commodity index investors has a greater impact on the prices of indexed compared to non-indexed commodities. In a recent paper, Basak and Pavlova (2013) present a theoretical model and reach a number of interesting conclusions. For instance, they show that supply and demand shocks for an indexed commodity can spill-over to the rest of the commodities in the index. This is not the case for non-indexed commodities. Moreover, in their model the prices and volatility increase more for indexed than non-indexed commodities. In contrast, another group of studies such as Kilian and Murphy (2013) and Fattouh et al. (2012) identifies fundamentals rather than speculation or index fund activity as the main driving force of the recent rise in the prices of major commodities. Lastly, Miffre and Brooks (2013) argue that long-short strategies of speculators in commodity markets have no significant impact on commodity volatility and correlations with other asset classes.

The remainder of the paper is organized as follows. Section 2 provides a detailed description of index fund investing and the related literature. Section 3 states the main hypothesis, describes the data and variables employed for our analysis and outlines the methodology. Section 4 presents our empirical results and discusses their implications. Section 5 concludes.

[3]For other reviews of the literature the reader can refer to Irwin (2012) or Irwin and Sanders (2011).

2. Index fund investment

Since early 2000, commodity futures markets have experienced some major structural reforms, which led to increased trading activity and to participation of new types of investors. Examples include the regulatory changes under the Commodity Futures Modernization Act (CFMA), or the Dodd–Frank Act. Another important, and related, influence was the inception of electronic trading, which has substantially reduced trading costs and increased market accessibility (Irwin and Sanders, 2012a). Following these developments a large number of institutional investors, such as pension funds, have increased their exposure to commodities.

Part of this interest in commodity markets can be attributed to a number of academic studies that highlight the benefits of commodities as an asset class (Gorton and Rouwenhorst, 2006; Erb and Harvey, 2006, and others). According to the evidence of these studies, commodities can improve the risk-return profile of existing portfolios by shifting the efficient frontier upwards; they also offer equity-like returns to investors. Moreover, due to their positive correlation with inflation they constitute an effective hedge against unexpected changes in inflation. This triggered a massive inflow of funds from long-only commodity index investors. To this end, a broad range of new products, like exchange traded funds (ETFs) and exchange traded notes (ETNs) were offered in order to help individual investors gain exposure to commodities (Stoll and Whaley, 2010).

One of the most popular ways of investing in commodities is to buy commodities in a similar manner to a known commodity futures index. The two most popular and most heavily traded commodity futures indices are: the *S&P-Goldman Sachs Commodity Index* (S&P-GSCI) and the *Dow Jones-UBS Commodity Index (DJ-UBS*, previously the DJ-AIG Commodity Index). The weights of the S&P-GSCI are calculated based on world production and the index contains futures on the major commodities. Currently it consists of 24 commodities and is over-weighed by the energy sector (energy 69%, industrial metals 6.9%, agriculture 15.6%, livestock 5% and precious metals 3.6% as of December 31, 2012). The DJ-UBS currently includes 20 commodity futures contracts, whose weights are based on liquidity data of the futures contracts, combined with dollar-adjusted production data. It is a well-diversified index, which allocates weights as follows: energy 37.6%, industrial metals 16%, agriculture 28.6%, precious metals 11.9% and livestock 5.83% as of November 2013.

Individual investors can synthetically create an exposure to commodity indices either by purchasing futures contracts that replicate a traded index or through alternative investment vehicles, e.g. ETFs. The latter way is by far the most popular. On the other hand, institutional investors mainly use managed funds and OTC commodity-swaps, commonly referred to as "commodity index swaps", in which the swap dealer promises to pay the return on a traded commodity index and is therefore implicitly short in OTC futures (Hamilton and Wu, 2012). In order to hedge their risk associated with fluctuations of the underlying index, they have to take long positions in the underlying futures market. Sanders et al. (2010) point out that in agricultural markets, approximately 85% of commodity index trading is related to positions held by swap dealers.

According to the CFTC, market participants, who "*seek exposure to commodities through passive long-term investment in commodity indexes, and swap dealers, who seek to hedge price risk resulting from their over-the-counter (OTC) activity*" (CFTC, 2008) are referred to as *commodity index traders*. As stated above, one issue that still remains is whether commodity index traders should be regarded as a separate investment group or as speculators. Based on the Keynesian view of the futures market (Keynes, 1930) index fund investors should be defined as speculators. However, Stoll and Whaley (2010) argue that commodity index fund investors are not speculators, first, because speculators are not long-only but can be either short or long, and, second, because index traders are passive buy-and-hold investors motivated by portfolio diversification considerations rather than by speculative gains. Nevertheless, the distinction in the literature is still quite unclear.

3. Empirical design

3.1 Main hypotheses

Our main purpose is to examine the impact of index fund investments on agricultural futures returns. Before analyzing causal relationships, a natural starting point is to examine contemporaneous relationships between the variables of interest. To this end a correlation analysis is performed for each market between position changes of index traders and swap dealers, respectively, and excess futures returns. Correlation analysis indicates whether the two variables co-move, but has nothing to do with causal relationships.

For this reason, we proceed by performing a series of Granger causality tests between net position changes and excess futures returns. In particular, we analyze the following causal relationships:

- Changes in the net positions of index fund investors (swap dealers) Granger-cause futures returns and vice versa.
- Changes in the net positions of index traders (swap dealers) Granger-cause volatility of future returns and vice versa.

We measure net position changes over various horizons. The section that follows provides extensive details on this.[4]

3.2 Data

(a) Position data

We collect weekly data on the positions of various types of traders from the CFTC. The CFTC is the most reliable public source for position data on

[4] A bivariate Granger causality framework may be subject to endogeneity bias if variables that are significant are omitted from the analysis. Unless these variables are orthogonal to the regression residuals, the coefficient estimates may be biased and inconsistent. To account for this possibility, we examine the effect of index fund flows on agricultural futures returns, including a number of control variables in our analysis that are shown to be significant predictors for futures returns (e.g. Hong and Yogo, 2012), such as the short rate (T-bill), the futures basis, foreign exchange rates, open interest and the price of oil. Our subsequent results remained qualitatively similar.

commodity futures.[5] In general, the CFTC publishes three reports for trader positions: (i) the Commitments of Traders (COT) report, (ii) the Supplemental to the COT report (S-COT) and (iii) the Disaggregated Commitments of Traders (D-COT) report.

More specifically, the CFTC releases every Friday the COT report which provides a breakdown of each Tuesday's open interest. To collect this information, the CFTC requires the participating entities to report on a daily basis their positions in futures and options that exceed a certain threshold set by the CFTC. Then the daily positions are aggregated across days and contract maturities to create the weekly report. The COT report consists of two sub-reports: (i) the *Futures-only* report and (ii) the *Options-and-Futures-Combined* report. In the latter case, option positions are converted into futures-equivalent positions by adjusting the previous day's open interest in options by the appropriate option delta. For instance 5 positions in options with a delta of 0.4 are equivalent to 2 positions in futures (see also, Irwin and Sanders, 2012a). Short delta exposures, such as long call and short put options are converted into long futures, whereas short delta exposures, that is short calls and long puts, are converted into short futures positions.

The COT report classifies trading entities into commercial and non-commercial, respectively.[6] Commercial traders are those identified by the CFTC as hedgers. This category mainly includes producers and manufacturers that seek to hedge their exposure to the underlying commodity. Non-commercial traders, generally regarded as speculators, include hedge funds, floor traders, pension funds, etc. Needless to say, the classification in different types of traders is not free of problems and concerns (e.g. Stoll and

[5] First established in 1974 by the US Congress, the CFTC is "*an independent agency with the mandate to regulate commodity futures and option markets in the United States.*" Its primary mission is to provide more transparency to market participants and prevent cases of fraud and market manipulation. To this end, it regularly disseminates information to market participants and to the public regarding trading activity in the futures and option markets.

[6] Note that trading entities are classified as a whole and not by individual transactions. A single entity cannot be classified as both a commercial and non-commercial trader at the same time. The same principle applies to all CFTC reports.

Whaley, 2010; Büyüksahin and Harris, 2011).

In 2006 the CFTC started publishing a supplemental report (S-COT) based on the information contained in the Options-and-Futures-Combined report. Specifically, the new report introduces a new category of long-only investors called *Commodity Index Traders (CIT).* This new category consists of investors that undertake buy-and-hold strategies in the individual futures contracts that underlie a commodity index. This type of investor can belong either to the commercial or to the non-commercial category. The commercial group is further sub-divided into traditional hedgers and commodity index traders, while the non-commercial group is sub-divided into index traders and speculators (for illustration see Figure I-2, page 16 in Stoll and Whaley, 2010). In the S-COT, similarly to the original COT report, long and short positions are reported.

As an initiative for providing more market transparency, the CFTC started in 2009 to publish an additional report, the Disaggregated Commitments of Traders report (D-COT). The D-COT report classifies commercial traders into: (a) *Producer/Merchant/Processor/User* and (b) *Swap Dealers* and non-commercial traders into: (c) *Managed Money* and (d) *Other Reportables.* Swap dealers are defined as trading entities whose activity is focused on hedging their short OTC exposure on commodity index futures. They usually sell index-based futures in the OTC market and then hedge their exposure by taking long positions on the same index in the organized futures market. In the agricultural futures market the main trading activity by swap dealers concerns commodity index funds (Hamilton and Wu, 2012).[7] Hence, swap dealer positions for the three agricultural futures markets considered are mainly linked to long index investment activity.[8] Similar to the COT report, futures-only, as well as options-and-futures-combined data are reported for long, short and spread positions, respectively.

Our dataset consists of trader positions for each of the three agricultural

[7]This is not the case in other markets. For example, in the energy market swap dealers may appear in any side of the market and therefore long-only positions are not necessarily indicative of index fund investment activity.

[8]For an illustration of the structure of the CFTC reports with respect to the different types of traders see figure 1, pp. 259 in Sanders and Irwin (2011).

futures markets considered. It is compiled from the S-COT and D-COT Futures-and-Options Combined reports. The data from the S-COT report begin on April 4, 2006, while those from the D-COT only start on September 12, 2006. To achieve consistency and comparability of results, we consider a common sample period from September 12, 2006 to October 16, 2012, a total of 319 weekly observations.

(b) Futures price data

We collect weekly closing prices for the three agricultural futures contracts considered, namely: corn, soybeans and wheat. The dataset was obtained from Bloomberg for the period from September 12, 2006 to October 16, 2012. We use Tuesday prices to make our series consistent with the positions data described above. The futures prices obtained refer to the nearest and second-nearest to maturity futures contracts.

3.3 Variables

We consider the following variables for our analysis:

For the index fund activity in the three agricultural futures markets, we consider two trader groups: (a) *index traders* in case the of the S-COT report and (b) *swap dealers* in the case of the D-COT report. These two groups of traders are similar, but not exactly the same in the two different reports.[9] Using these datasets we construct the following variables:

(i) Changes in the net long positions of index traders and swap dealers: This variable is computed by subtracting the number of short

[9]As already mentioned above, the vast majority of swap dealers in the agricultural market represent index investors. For example, Sanders et al. (2010) show that in agricultural futures markets approximately 85% of index related positions are held by swap dealers. Moreover, the CFTC notes that in such markets, swap dealers are involved in comparatively little non-index business. However, minor differences exist, like for example that the D-COT report contains some swap dealers that are not involved in index trading and so are not included in the S-COT report. In addition, the S-COT includes some "index traders" that trade directly in the futures market and through the swap dealers. This type of traders are classified as "managed money" based on the D-COT report. Thus, we decide to separately consider data from both reports, for our analysis.

positions from the number of long positions for the corresponding group of traders (index trader or swap dealer). We therefore obtain two variables for each one of the three markets. We denote these period-by-period net position changes $IT1WKCH$ and $SD1WKCH$ for index traders and swap dealers, respectively.

Singleton (2013) argues that it is of greater interest for investors to assess the impact of investment flows on commodity returns (or risk premiums) over longer horizons of weeks or months, rather than days. Using positions of index investors for crude oil, the author confirms his conjecture. A similar argument is made by Sanders and Irwin (2011), who stress that index trader positions may evolve in waves that build up slowly and thus shorter horizons of days may fail to capture the relationship between the variables. Therefore, we incorporate in our analysis the position changes over 4 and 13 weeks, and for each category of trader. This way we obtain four additional variables. These variables are denoted *ITiWKCH* for index traders and *SDiWKCH* for swap dealers, where: $i = 4$, 13, respectively.

(ii) Percentage net long positions: We also consider the percentage net long positions of index traders and swap dealers, respectively. These variables are calculated by dividing traders' net long positions by the total number of positions. This variables can be regarded as a measure of growth in index fund flows. We indicate these variables as *ITP* for index traders and *SDP* for swap dealers.

(iii) Excess futures returns: We construct continuous series of excess futures returns based on the data mentioned above. We compute excess futures returns following Singleton (2013). The excess futures returns are based on a strategy according to which investors take a long position on the nearest to maturity futures contract and close out this position on the day preceding delivery, when they open a new long position to the next nearest to maturity futures contract. Further details on the calculation of excess futures returns are provided in the appendix. We label futures returns FRET.

3.4 Granger causality tests

To analyze the lead-lag relationships between index fund flows and agricultural food prices, we perform a series of Granger causality tests (Granger, 1969). Our analysis concerns pairwise causality tests based on a bivariate Vector Autoregressive model of order p, VAR(p). The general representation of this system is as follows:

$$\begin{bmatrix} R_t \\ X_t \end{bmatrix} = \begin{bmatrix} \alpha_{1,0} \\ \alpha_{2,0} \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \beta_{1,i} & \gamma_{1,i} \\ \beta_{2,i} & \gamma_{2,i} \end{bmatrix} \begin{bmatrix} R_{t-i} \\ X_{t-i} \end{bmatrix} + \begin{bmatrix} u_{1,t} \\ u_{2,t} \end{bmatrix} \tag{1}$$

where: R_t corresponds to the futures return of a specific commodity, while X_t is one of the position variables for the same market as described above. According to the standard form of a Granger causality test, variable R does not Granger-cause variable X if the coefficients of the lagged terms of variable R in the equation of variable X are jointly insignificant. The joint significance of the coefficients is tested using a standard Wald-type test (F-test). For instance, to test the null hypothesis that the changes in the positions of traders (X) do not Granger-cause futures returns (F), we test the following hypothesis: $H_0 : \gamma_{1,1} = \gamma_{1,2} = ... = \gamma_{1,p} = 0$. Rejection of the null is interpreted as evidence of causality with a given confidence level. The optimal number of lags p in the system is chosen based on the Akaike Information Criterion (AIC).

The VAR estimation requires variables to be stationary (I(0) series). For this reason, we perform the following unit root tests on the variables involved in the estimations: a) Augmented Dickey–Fuller (ADF), b) Phillips–Perron (PP) and c) Dickey–Fuller GLS (Elliott-Rothenberg-Stock, DFGLS). Table 1 presents the test statistics from these tests. Our analysis is mainly focused on differenced series, such as the changes in the positions of traders as well as futures return series. Apart from ensuring stationarity, it is also important to make sure that we do not over-difference our variables. To this end, we also test for a unit root the series of futures prices and net long positions (long minus short open interest).

Based on the unit root test results, we fail to reject the null of a unit root for the futures price and for net long positions (NL). However, the weekly changes in net long positions (IT1WKCH) as well as futures returns (FRET) are both stationary for all markets. Moreover, we reject the null of non-stationarity for the percentage net long positions (net long positions/total number of positions) in most cases. Therefore, we choose to work with the percentage instead of the level of net trader positions. Finally, the null of a unit root is rejected for the changes in net positions over longer horizons of 4 and 13 weeks, respectively. The only exception is soybeans, where the 13-week change in index trader positions appear to be weakly stationary according to the ADF and PP tests.[10]

4. Empirical results

4.1 Descriptive statistics

Table 2 contains descriptive statistics for the position data. From the table we see that the average of net long positions (number of long minus number of short positions) is much higher for corn compared to soybeans and wheat for both groups of traders. If we consider the percentage net long positions – i.e., net long positions divided by the total number of positions for a particular trader group – we observe that its average ranges from 12.5% (10.13%) for corn to 20.4% (16.46%) for wheat in the case of index traders (swap dealers). Furthermore, the table shows summary statistics for the proportion of long open interest held by each group of investors in each market (row named Long %). We see that this proportion varies across markets. For instance, in the soybean market swap dealers hold on average approximately 45% of the total

[10] Also as a robustness check, we work with the notional value of trader positions similar to Hamilton and Wu (2012). This is computed as:

$$\tilde{x}_t = 100\,[ln(X_t) + ln(F_t)]$$

where: $\tilde{x}_t$ is the notional exposure of index trader (swap dealer) in week t, X_t is the number of long contracts for index traders (swap dealers) in week t and F_t is the weekly futures price at t. As noted by Hamilton and Wu (2012) the appropriate definition should also multiply the futures price by the number of units of the commodity per contract (e.g. 5,000 bushels). However, this is just a constant that would not affect the significance of the estimates in the later estimations. Our final results did not qualitatively change by following this different approach of measuring index fund flows.

long positions. Instead, in the corn market this proportion is much lower, close to 22%. On the other hand, the corresponding percentage of total long open interest held by index traders is on average lower and varies less across markets compared to that of swap dealers (from 21% for soybeans to 28% for wheat).

Table 2 also provides summary statistics for changes in the net long positions over 1, 4 and 13 weeks, respectively. The average changes are all negative in the three markets, yet the median is much less negative or even positive for soybeans. This observation suggests that the negative mean is driven by some large negative changes in the net long positions, especially during the large price fall in food prices in 2009. In Figure 2 we illustrate the notional exposure of index traders and swap dealers for each market computed as the number of long positions multiplied by the price of the first nearby futures contract of the specific commodity. From the figure it is evident that long-only commodity index investments trended upwards between 2006 and mid-2008 and then started falling until the beginning of 2009 when they gradually started recovering. Moreover, we observe some commonality in the behaviour of the three series in the sense that they seem to rise and fall together.

In Figure 3, we plot the percentage of long open interest held by index traders and swap dealers. This is computed as the number of long positions of each type of index fund investor and for each market over the total number of long positions in the particular market. We see that although commodity index fund investments grew substantially during our sample period, the relative fraction of the total trading activity attributed to index investors did not exhibit such a sharp increase. More specifically, from the plot we observe that the percentage of long open interest held by commodity index funds is persistent and moves between a relatively narrow band. The pattern in the three markets shows an increase during 2009 followed by a downward trend towards the end of our sample, especially after 2011. The observed increase from 2008 onwards is probably due to the increased flow from new types of index investors, such as hedge funds and pension funds. On the other hand, the gradual decrease after 2010 may be attributed to portfolio rebalancing by institutional investors following the big drop in commodity prices in 2008 or the effort to decrease over-exposure in commodities. Finally, Table 3 presents summary statistics for excess futures returns for the three markets analyzed. From the table we see that returns exhibit a substantial amount of weekly variation that ranges from 4.08% for soybeans to 5.35% for wheat. In addition, their empirical distribution appears to be platykurtic with a skewness close to zero, value that corresponds to a normal distribution.

4.2 Contemporaneous relationships

We begin our analysis by investigating contemporaneous relationships between index fund investment and futures returns. Figures 4 and 5 plot the closing price of the nearest to maturity futures contract against the net long positions of index traders and swap dealers, respectively, for each market over the period from September 12, 2006 to October 10, 2012. From the plot we observe that there are periods during which futures prices and the net positions of traders co-move, but there are also times when they diverge. For instance, the flows from index investors appear to co-move with the prices of corn in the period before 2008, but afterwards they mainly move in opposite directions. In the most recent period after 2009 the series seem to evolve in opposite directions. In our subsequent analysis, we shed more light in the relationship between food prices and the positions of traders by examining sub-periods of the entire sample.

In order to quantify the degree of association of the two quantities of interest, namely futures returns and index fund flows, we perform a correlation analysis. More specifically, for each market we compute pairwise correlation coefficients between futures returns and each of the index trader positions variables considered. Table 4 contains the correlation coefficients between futures returns and index flow variables. We report correlations for the entire sample period as well as two sub-periods of almost equal length: from 12/09/2006 to 30/09/2009 and from 01/10/2009 to 16/10/2012. These two sub–periods are quite important for the food market from an economic perspective. The 2006–2009 period covers the financial crisis as well as the first major boom in the prices of agricultural commodities and their subsequent fall. The 2010–2012 period includes the second period of sharp increase in agricultural food prices. Overall, the correlation table shows that index fund flows are positively correlated with excess futures returns in the three agricultural markets analyzed. Nevertheless, most of these coefficients are not statistically different from zero.

Looking at the reported correlations in more detail we observe that in the entire sample (2006–2012), the correlation between excess futures returns and 1-week changes in index fund flows are positive and significant for all markets and highest in magnitude for soybeans. Also, for soybeans the net long position changes measured over longer periods of 4 and 13 weeks are both significant although smaller in size compared to 1-week changes. The analysis over sub-samples provides further insights. A look at the correlations of the two sub-samples reveals that the observed association between futures returns and position changes is driven by the first sub-period (2006–2009). In particular, both for index funds and swap dealers the correlations of excess futures returns with 1-week changes in net long positions is positive and significant and higher than the corresponding correlation coefficient for the entire sample. The only exception is wheat where the aforementioned correlation coefficient is only significant for swap dealers but not for index traders. Instead, in the second sub-period (2009–2012) most coefficients are statistically insignificant.

The evidence presented supports the picture shown in Figures 4 and 5, where it is evident that futures prices and positions of traders share common trends in the first half of the sample, but afterward they depart from each other. In Figure 6 we present scatter plots of the excess futures returns against the 1-week changes in the net positions of swap dealers. In the plots we fit a regression line. We clearly see that the regression line is upward sloping in all the three markets.

In sum, the preceding correlation analysis shows that index fund activity and futures prices are positively associated with each other, since there seems to be a positive contemporaneous relation between the two (although often quite weak). This relationship is mainly observed during the first sub-period that coincides with the financial crisis and the first major food price boom. However, the more important question is whether there is a causal relationship between the two variables. The following section elaborates on this.

4.3 Granger causality test results

We perform Granger causality tests between excess futures returns and positions of the two types of index fund investors considered, namely index traders and swap dealers. For our estimations we employ the whole sample from September 12, 2006 to October 16, 2012 as well as two sub-periods of almost equal length: from September 12, 2006 to September 30, 2009 and from October 1, 2009 to October 16, 2012. The tests are conducted separately for index traders and swap dealers. This gives a total of 24 bi-directional tests. Tables 5 to 7 contain the estimation results. These tables report the optimal number of lags used for each VAR model estimated, based on the AIC. In addition, each table contains the F-statistic along with the associated p-values for the null hypothesis (H_0) that the coefficients of the lagged values of one variable in the equation of the other are jointly equal to zero.

Overall, based on our results, we fail to reject the null hypothesis of no Granger causality from net positions and net position changes to excess futures returns for most markets, trader groups and sample periods. Instead, there is much stronger evidence that futures returns predict the net positions of traders. We elaborate more on this finding below.

Looking at the results across markets, we see that for corn there is evidence of causality from the positions of traders to futures returns at the 5% level only for the 1-week changes in the net long positions. Similarly, for the two sub-samples considered, the null of no Granger causality is rejected only for the percentage net long positions in the corn market. In contrast, for swap dealers we find evidence that commodity returns predict position changes regardless of the horizon at which these position changes are measured. The latter is also the case for the 1-week position changes for the 2006–2009 sub-sample.

The results for soybeans show more evidence that positions of traders can help to predict excess futures returns. More specifically, the null that trader positions Granger-cause commodity returns is rejected at the 5% level, when the 13-week changes in the net positions of index traders (swap dealers) are considered as a measure of index fund flows similar to Singleton (2013). The aforementioned causal link is also observed for the 4-week changes in the net long positions of index traders but not for those of swap dealers. Interestingly, the sub-sample analysis suggests that the causal impact of index fund flows on soybean returns is mainly observed during the first sub–period between 2006 and 2009, but vanishes afterwards. Regarding the null of causality of the opposite direction, that is from soybean futures returns to net position changes, we find that this can be rejected in many cases, mostly in the second half of the full sample (2009–2012).

Finally, wheat exhibits the weakest evidence of causality to either direction among all the three markets analyzed. In particular, the null hypothesis of no causality from net position changes to wheat futures returns is never rejected, whereas the hypothesis of causality of the opposite direction is rejected in few cases in the entire sample period, but in several cases in the second half of the entire sample.

In sum, we find causality from positions of traders to excess returns of agricultural food prices to be relatively weak, at least in two of the three markets. In contrast, there is more evidence that futures returns have predictive ability for index fund and swap dealer positions. The latter result is in line with the main findings of Büyüksahin and Harris (2011) for the crude oil market. Moreover, the finding that price changes lead position changes indicates that index fund investors are trend followers, consistent with the idea of time series momentum in Moskowitz et al. (2012). In other words, investors undertake futures positions based on current futures prices and this creates the lead-lag relationship observed between excess futures returns and position changes. Extensive empirical evidence has shown that momentum strategies involving commodity futures can be profitable (Miffre and Rallis, 2007; Shen et al., 2007; Fuertes et al., 2010, and others).

4.4 Impact on volatility

We now investigate the relationship between index fund flows and realized futures return volatility. Given that volatility is unobservable, we first need to obtain estimates of weekly volatility for each market. There are several alternative ways to do this, such as GARCH, range-based estimators, etc. We choose to work with the range volatility estimator of Yang and Zhang (2000) that is unbiased, robust to the presence of opening jumps, and much more efficient compared to GARCH volatility estimators. This estimator is computed as the sum of three components:

$$\sigma_{YZ}^2 = \sigma_0^2 + \kappa\sigma_c^2 + (1-k)\sigma_{RS}^2 \tag{2}$$

To explain the notation above let H_t, L_t, O_t, and C_t be the high, low, open and close prices observed on trading day t. Also: $c_t = lnC_t - lnO_t$, the normalized close price, $o_t = lnO_t - lnC_{t-1}$, the normalized open price, $u_t = lnH_t - lnO_t$, the normalized high price, and $d_t = lnL_t - lnO_t$, the normalized low price. Then in the above expression:

$$\sigma_c^2 = \frac{1}{n-1}\sum_{t=1}^{n}\left[(o_t + c_t) - (\overline{o+c})\right]^2 \tag{3}$$

where: $\overline{o+c} = \frac{1}{n}\sum_{t=1}^{n}(o_t + c_t)$, and n the number of trading days over which the volatility estimator is computed (n=5 here). The last equation is simply the volatility of the sum of open and close prices over n days. Moreover, σ_0 is the standard deviation of o_t, that is:

$$\sigma_0^2 = \frac{1}{n-1}\sum_{t=1}^{n} o_t^2 \tag{4}$$

Finally, the third component of Equation (2) is the Rogers–Satchell range-based variance estimator (Rogers and Satchell, 1991), given by:

$$\sigma_{RS}^2 = \frac{1}{n}\sum_{t=1}^{n}\left[u_t(u_t - c_t) + d_t(d_t - c_t)\right] \tag{5}$$

The constant k is set to:

$$\kappa = \frac{0.34}{1.34 + \frac{\alpha+1}{\alpha-1}} \tag{6}$$

The estimator achieves maximum efficiency for $\alpha = 2$ (Yang and Zhang, 2000). Therefore, we set α equal to 2. We further take the square root of variance computed from Equation (2) to obtain estimates for volatility. Figure 7 shows the weekly volatility estimates for the three food markets.

The next step is to perform causality tests between the volatility and the positions of traders for each of the three agricultural markets considered. The results from these tests are presented in Tables 8 to 10. Overall, the results show that causality from the net positions of traders to return volatility is not very strong, but stronger compared to the results for returns presented above. Looking at the three markets in isolation, we see that the aforementioned causal link is almost totally absent in the corn market. In the soybean market, we find predictability from the 1-week and 4-week changes in the net positions of index traders (swap dealers) to volatility, which is mainly driven by the first sub-period of 2006–2009. For the wheat market, we reject the null of no causality in several cases. For example, in the full sample the null of no Granger causality is rejected at the 5% level for the 4-week and 13-week changes in the net long positions of index traders. Again, this predictive link seems to be determined by the first half of our sample (2006–2009), but vanishes in the 2009–2012 sub-sample period. Moreover, the evidence for swap dealers is slightly weaker compared to index traders.

Although not presented in the table, the sign of the net position variables is negative, meaning that higher investment flow from index traders leads to lower volatility. This is in contrast to the idea that index fund activity increases volatility, yet consistent with the idea that speculation does not destabilize the commodity futures market (Brunetti and Büyüksahin, 2011).

5. Conclusion

The recent upsurge in the prices of major food commodities during 2007/2008, the subsequent fall and the new increase after 2010 has raised awareness on the role of long-only index funds in these developments. This is an issue of paramount importance not only for investors, but also for policy makers. For example, there is a widespread debate on whether there should be additional regulation for the participation of index funds in the (agricultural) futures market. Moreover, for economic policy makers knowing the determinants of agricultural price increases is rather important in their effort to control inflation and provide food security for poorer nations.

Motivated by the aforementioned considerations, in this paper we perform a comprehensive analysis of the relationship between index fund trading activity and agricultural futures prices and their volatility. Our empirical investigation is based on three of the most liquid and economically important food futures contracts traded at the Chicago Board of Trade (CBOT), namely corn, soybeans and wheat. On the basis of the financialization argument for commodity markets, increased investment flow by index traders or swap dealers should affect the commodity risk premium and also the volatility of futures returns (Singleton, 2013). We employ the publicly available data on the positions of index traders and swap dealers, published in the D-COT and S-COT reports by the CFTC, and measure index fund activity at several horizons.

First, we analyze contemporaneous relationships between changes in the net long positions of index fund investors/swap dealers and excess futures returns. We find a positive and significant correlation between the two quantities of interest, which is mainly concentrated in the first half of the sample, namely between 2006 and 2009. Nevertheless, this contemporaneous association does not necessarily mean that the two variables have a causal relationship. It could be the case that both are related to one or more common factors. The latter idea is supported by Fattouh et al. (2012).

The extensive Granger causality tests we perform show very little evidence that trader positions have an impact on subsequent food commodity returns. Instead, we document a stronger causality from futures returns to net position changes. This finding supports the idea that index fund investors are trend followers, i.e. they follow momentum strategies (Büyüksahin and Harris, 2011;

Moskowitz et al., 2012). Our findings contradict the popular view that index fund investors have caused the recent escalations of agricultural food prices.

We further analyze the impact of positions of index investors on the return volatility of each market. To obtain volatility proxies we employ the efficient and unbiased range-based estimator of Yang and Zhang (2000). Overall, net position changes seem to bear some predictive power for futures returns. For example, for soybeans and wheat, the null of no causality from position changes to volatility is rejected in several cases. Unreported results show that the coefficient of index investor positions are negative, which means that volatility decreases with the net positions of index investors and swap dealers.

With regard to the policy dimension of the problem it is necessary to further discuss the issue of tighter futures market regulation. This is crucial, since recent evidence suggests that index investors do not destabilize futures markets (Brunetti and Büyüksahin, 2011; Kim, 2013). Our results from volatility analysis seem to provide further support for this conjecture. Furthermore, findings in the literature show that speculators provide liquidity and enhance market efficiency Kilian and Murphy (2013). Therefore, a decreased participation by index investors following tighter regulation might prove harmful at the end. Thus the issue of further regulation should be carefully addressed.

Appendix

Calculation of futures returns

To calculate weekly futures returns we apply the methodology used by Singleton (2013). Let $F_t^{T_i(t)}$ be the price of the futures contract with expiration at $T_i(t)$. Also let $D(s) > s$ be the time when investor switches from the nearest to maturity to the next nearest to maturity futures contract. For all the three markets considered $D(s)$ is the business day prior to the 15th calendar day of the delivery month. From the above it follows that:

$$T_{i+1}(D(s)) = T_i(D(s) + 1)$$

Futures returns are calculated under the assumption that investor holds a long position in the i-month nearby futures contract, and liquidates this position on the last trading day before expiry, $D(s)$, when he switches to the second nearest to maturity futures contract, which by definition will be the i-month contract one day later. This strategy is followed from s to t.

Thus, the return on the i-month nearby futures contract is given by:

$$\begin{aligned} &\frac{F_t^{T_i(t)}}{F_t^{T_i(s)}} && \text{if } t < D(s) \\ &\frac{F_{D(s)}^{T_i(D(s))}}{F_s^{T_i(s)}} \cdot \frac{F_t^{T_i(t)}}{F_{D(s)}^{T_{i+1}D(s)}} - 1 && \text{if } t > D(s) \end{aligned}$$

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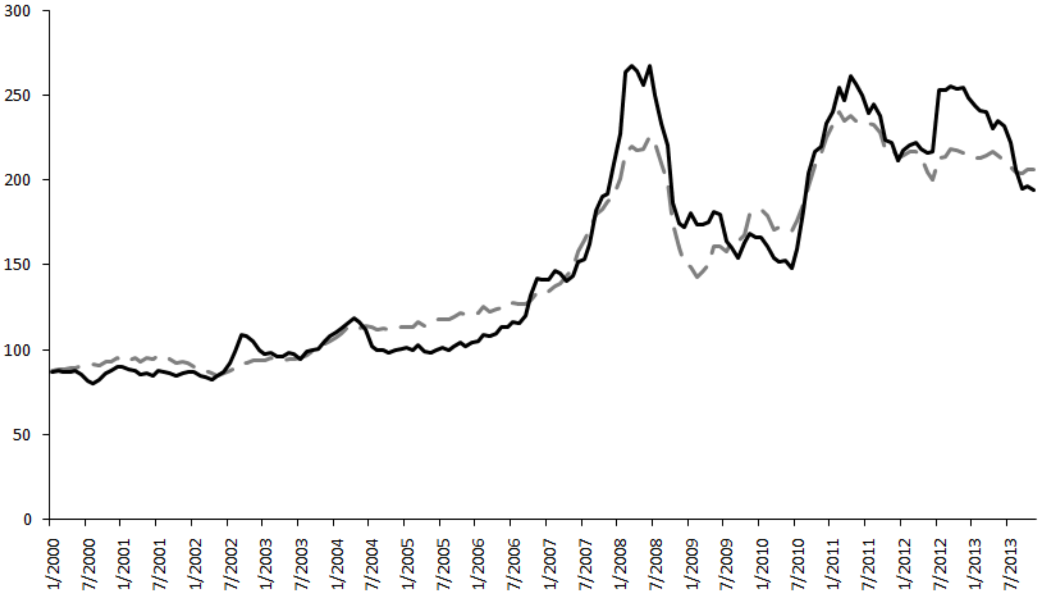

Figure 1: **Food price indices**

This figure plots the time series of monthly prices of the FAO Food Price Index (dashed line) and the corresponding index for cereals (solid line) for the period 2000–2012.

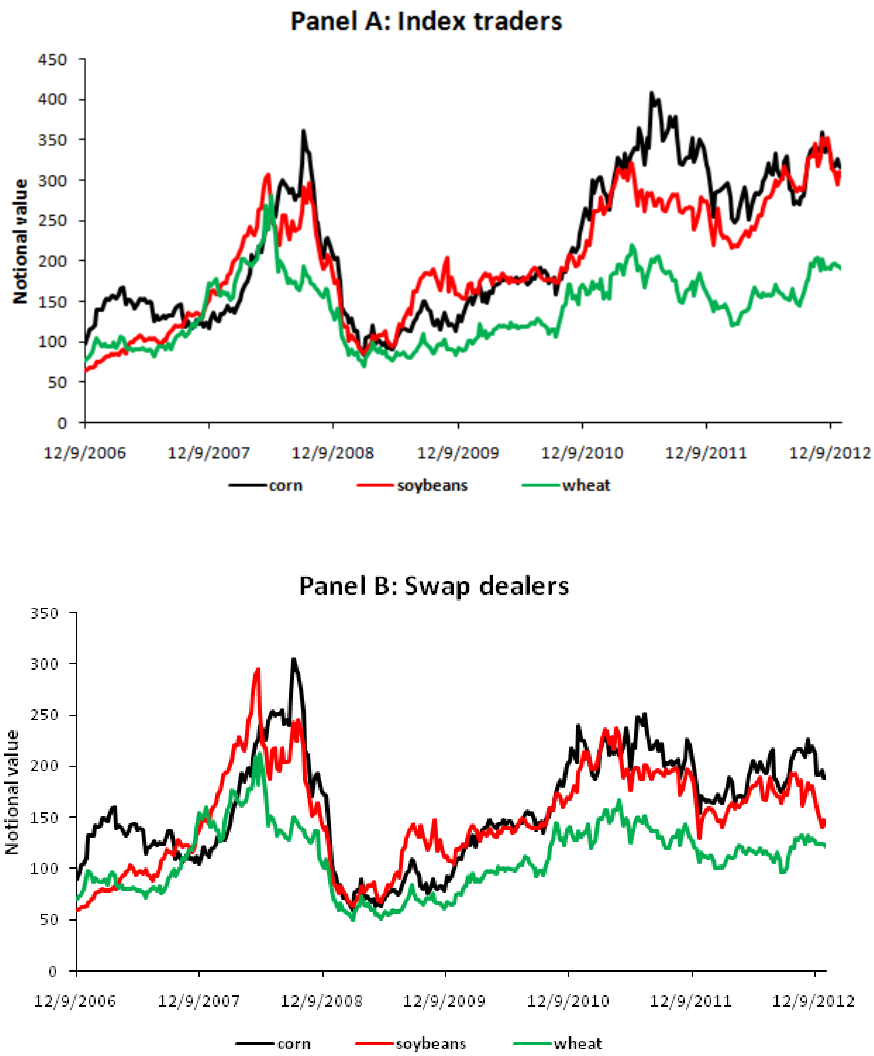

Figure 2: **Notional exposure of traders (in mil. dollars)**

This plot displays index traders' and swap dealers' notional exposure in the three agricultural markets, considered: corn, soybeans and wheat. The sample period is from September 12, 2009 to October 16, 2012. The notional exposure for each market is computed as the product of the number of contracts times the price of the nearby futures contract for a given week. The red line corresponds to the swap dealers and the black line to index traders, respectively.

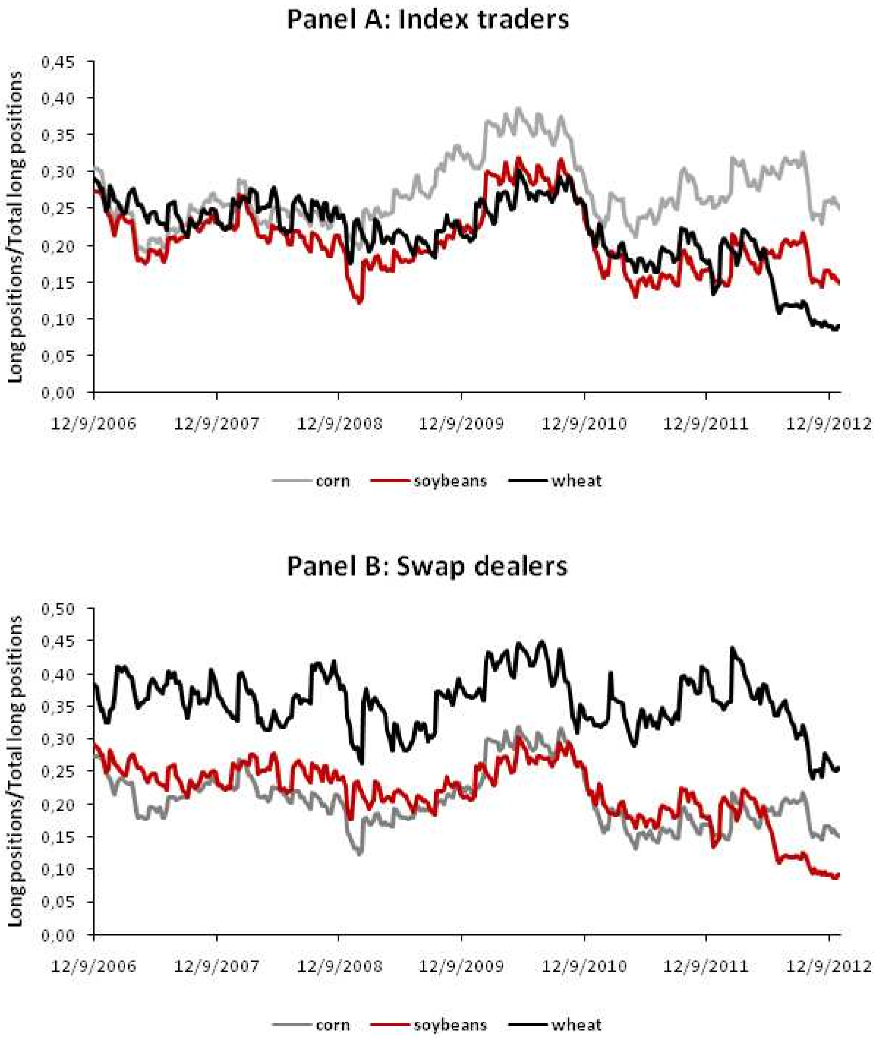

Figure 3: **Proportion of long open interest held by index funds**

This figure plots the percentage of long open interest held by commodity index funds. The proportion is computed as the number of long positions held by index investors over the total number of long positions in each market. The sample period is from September 12, 2009 to October 16, 2012.

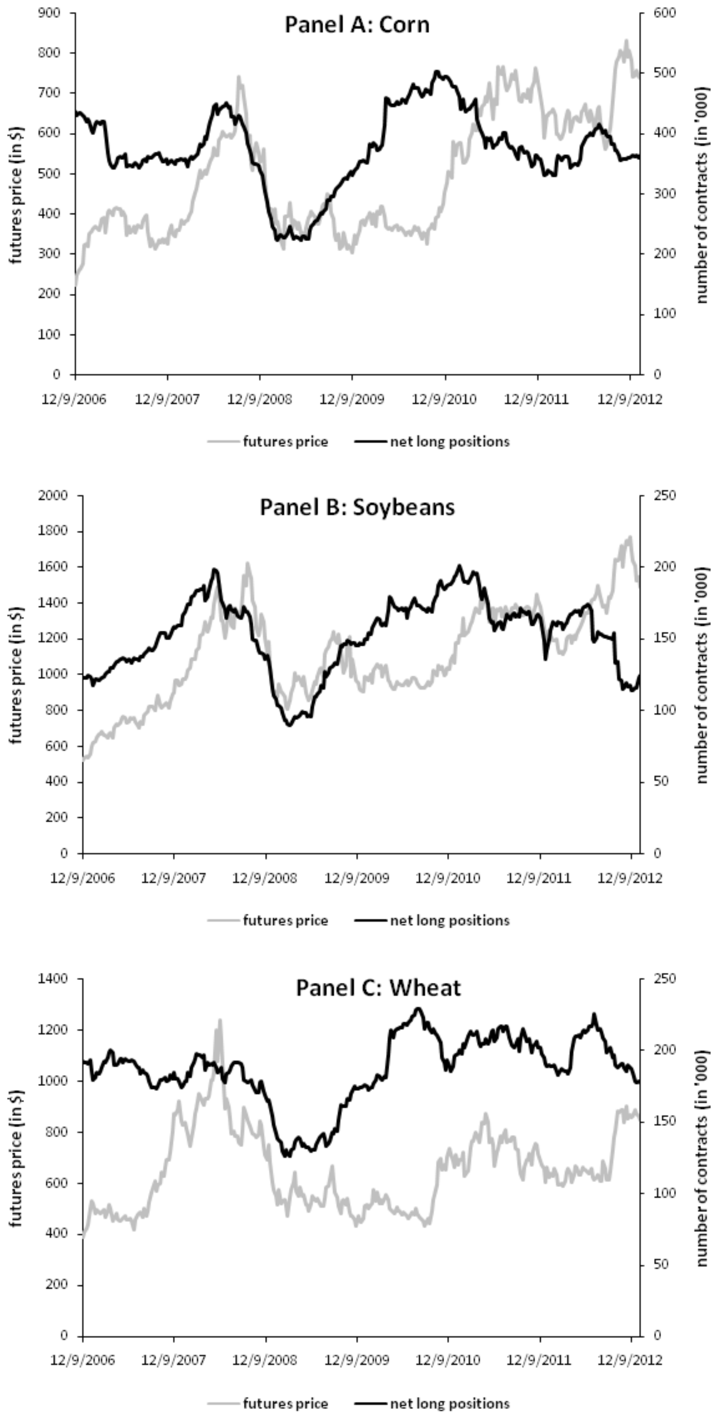

Figure 4: **Net long open interest vs nearby futures price (index traders)**

This figure plots the net open interest of index traders (long - short positions) against the price of the nearest to expiry futures contract. The left vertical axis measures futures price in dollars, whereas the right vertical axis corresponds to number contracts in thousands. The price data are from Bloomberg and the position data from the CFTC.

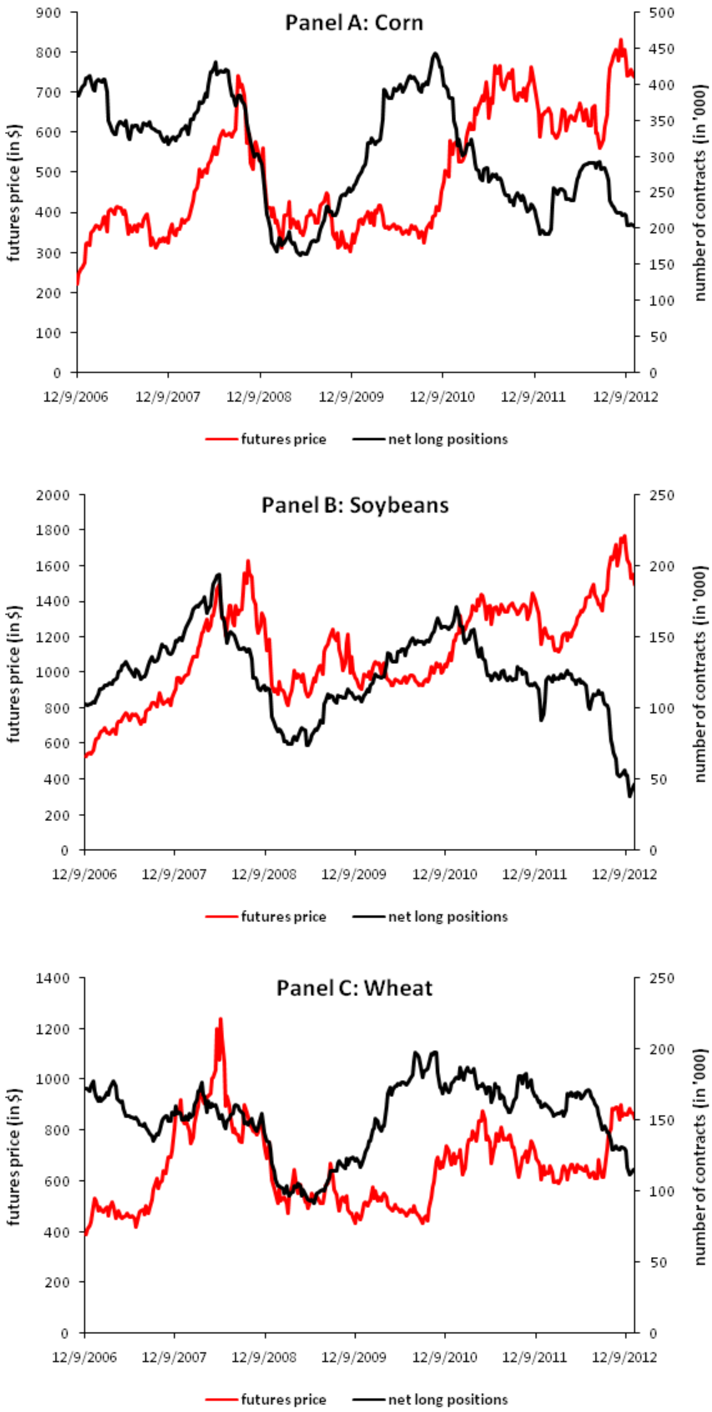

Figure 5: **Net long open interest vs nearby futures price (swap dealers)**

This figure plots the net open interest of swap dealers (long - short positions) against the price of the nearest to expiry futures contract. The left vertical axis measures futures price in dollars, whereas the right vertical axis corresponds to number contracts in thousands. The price data are from Bloomberg and the position data from the CFTC.

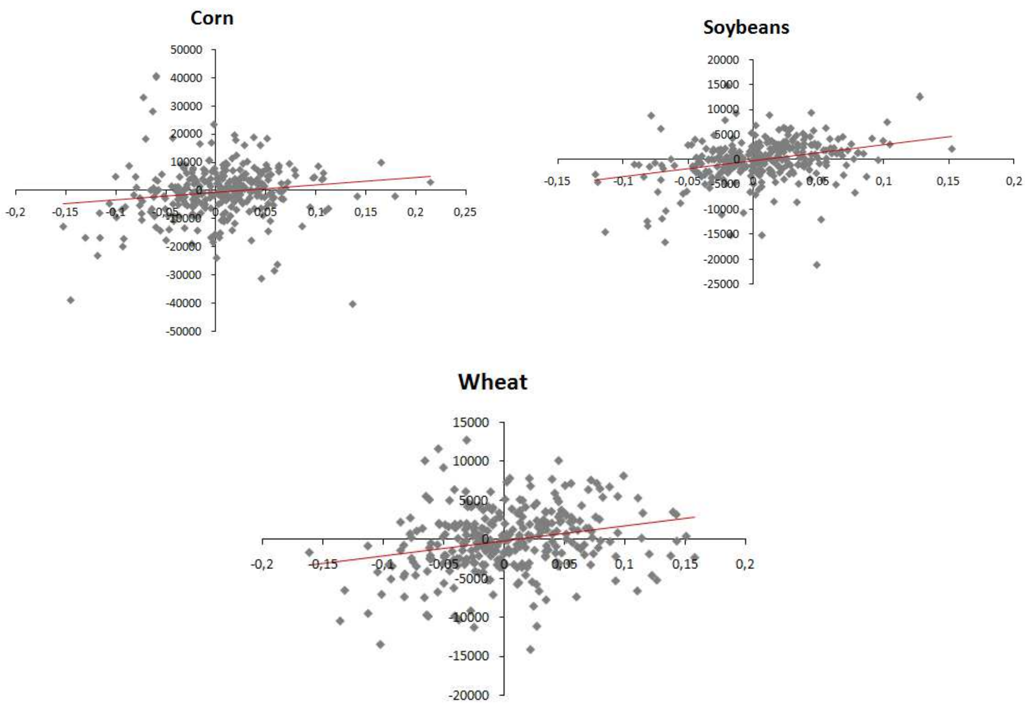

Figure 6: **Scatter plots: Futures returns vs weekly changes in net positions of swap dealers**

The scatter plots illustrate the relationship between excess futures returns and the 1-week changes in the net positions of swap dealers. The sample period is 12/9/2006 – 16/10/2012.

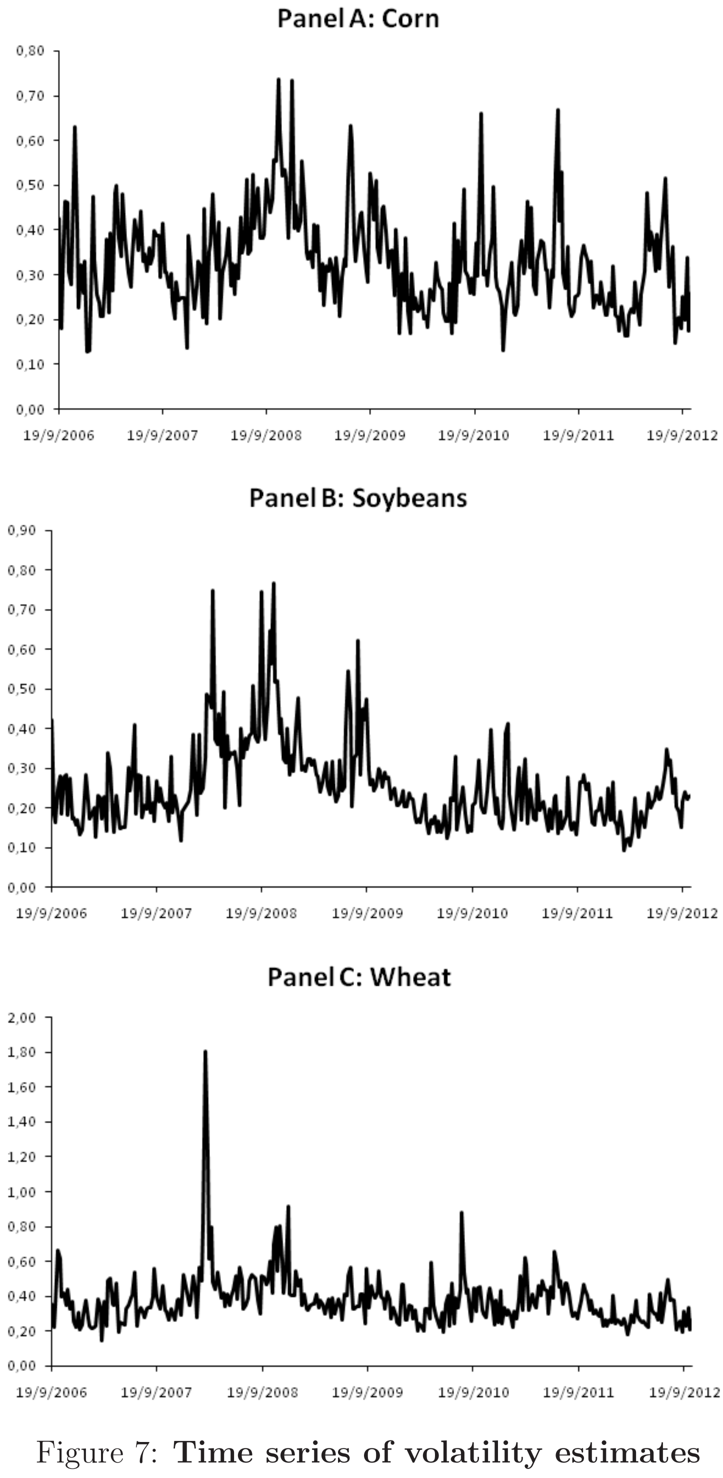

Figure 7: **Time series of volatility estimates**

This figure plots the time series of weekly volatility estimates for the three agricultural food commodities under consideration. Weekly estimates of volatility are obtained using the range-based estimator of Yang and Zhang (2000) described in the text. The sample period is from September 12, 2006 to December 31, 2012.

Table 1: **Unit root tests**

*This table presents results from performing Augmented Dickey–Fuller (ADF), Phillips–Perron (PP) and Dickey–Fuller GLS (Elliott–Rothenberg-Stock, ERS) unit root tests on the price and position data. The critical values of the ADF and PP tests at 1%, 5% and 10% significance levels are: -3.45, -2.87 and -2.57, while for the ERS test: -2.572, -1.942, -1.616. *, **, and *** indicate rejection of the null of a unit root at the 10%, 5%, 1% levels of significance, respectively. Lag lengths for the tests were determined based on the Schwarz Bayesian Criterion.*

Corn				Soybeans		
	ADF	**PP**	**ERS**	**ADF**	**PP**	**ERS**
A. Index traders						
Price	-1.64	-1.68	0.04	-2.11	-2.09	0.01
Return (FRET)	-19.19***	-19.15***	-6.82***	-18.50***	-18.65***	-4.89***
Net Long (NL)	-1.65	-1.86	-1.08	-1.71	-1.65	-1.19
Net Long % (ITP)	-2.89**	-2.67*	-1.76*	-1.53	-1.83	-0.41
NL - 1-week change (IT1WKCH)	-13.68***	-14.12***	-8.20***	-14.58***	-14.64***	-13.89***
NL - 4-week change (IT4WKCH)	-3.58**	-4.71***	-2.63***	-3.42**	-3.81***	-2.90***
NL - 13-week change (IT13WKCH)	-3.11**	-2.57**	-2.95***	-2.75*	-2.91*	-2.48**
B. Swap dealers						
Net Long (NL)	-1.42	-1.54	-0.50	-0.83	-0.08	-1.00
Net Long % (SDP)	-2.32	-2.10	-1.05	-0.67	-0.72	0.32
NL - 1-week change (SD1WKCH)	-12.66***	-12.90***	-12.67***	-13.55***	-13.52***	-13.57***
NL - 4-week change (SD4WKCH)	-4.14***	-4.36***	-3.63***	-4.29***	-3.80***	-3.86***
NL - 13-week change (SD13WKCH)	-2.73*	-2.68*	-2.39**	-2.40	-2.81*	-2.22**

Wheat			
	ADF	**PP**	**ERS**
A. Index traders			
Price	-2.29	-2.29	-0.78
Return (FRET)	-17.79***	-17.81***	-16.97***
Net Long (NL)	-1.62	-1.78	-1.56
Net Long % (ITP)	-4.36***	-4.33***	-4.07***
NL - 1-week change (IT1WKCH)	-15.34***	-15.58***	-3.35***
NL - 4-week change (IT4WKCH)	-3.93***	-4.93***	-2.48**
NL - 13-week change (IT13WKCH)	-2.77*	-3.46**	-2.26**
B. Swap dealers			
Net Long (NL)	-1.42	-1.47	-0.55
Net Long % (SDP)	-3.54**	-3.66**	-2.05**
NL - 1-week change (SD1WKCH)	-15.62***	-15.65***	-14.92***
NL - 4-week change (SD4WKCH)	-3.88***	-5.13***	-3.37***
NL - 13-week change (SD13WKCH)	-3.26**	-3.29**	-2.65***

Table 2: **Descriptive statistics: Positions of traders**

This table presents summary statistics for the positions of traders in the three agricultural futures markets considered. Panel A reports statistics for index traders (S-COT report), while Panel B presents the same statistics for swap dealers (D-COT report). The variables reported are: the net long positions of traders (Net Long) computed as long minus short positions, the percentage of net long positions over the total number of positions (Net Long (%)), the percentage of long positions over the total number of long positions (Long %), and the changes in the net long positions over i weeks (ITiWCH), where: i = 1, 4, 13.

Variable	***Market***	**Mean**	**Median**	**Std. Dev.**	**Skew.**	**Kurt.**
Index traders						
Net long	Corn	375,143.10	367,720.00	64,459.32	-0.41	3.07
	Soybeans	152,679.30	158,969.00	26,049.68	-0.50	2.57
	Wheat	187,293.10	189,493.00	23,881.85	-0.82	3.26
Net long (%)	Corn	12.53	11.95	2.61	0.89	3.20
	Soybeans	12.89	13.35	2.80	-0.76	3.70
	Wheat	20.38	20.57	2.20	-0.24	2.14
Long (%)	Corn	27.25	26.09	4.52	0.68	2.77
	Soybeans	20.75	20.27	4.45	0.64	2.79
	Wheat	28.14	28.13	4.26	-0.31	3.13
IT1WKCH	Corn	-243.22	115.00	8,574.83	0.23	6.78
	Soybeans	0.72	100.00	3,985.78	-1.27	8.15
	Wheat	-59.06	19.00	3,770.03	0.14	4.26
IT4WKCH	Corn	-904.30	859.00	21,331.42	-0.15	4.90
	Soybeans	-15.00	1,601.00	9,423.31	-0.91	4.35
	Wheat	-257.38	-195.00	8,521.58	0.38	4.05
IT13WKCH	Corn	-2,879.72	-997.00	47,686.51	-0.39	3.00
	Soybeans	-25.27	4,421.00	19,417.05	-0.70	2.74
	Wheat	-670.52	-552.00	17,791.21	0.07	2.92
Swap dealers						
Net long	Corn	303,261.50	305,326.00	75,790.59	-0.06	1.85
	Soybeans	123,249.60	122,212.00	28,357.97	-0.35	3.37
	Wheat	151,812.90	155,429.00	25,236.56	-0.67	2.66
Net long (%)	Corn	10.13	9.79	2.80	0.45	2.49
	Soybeans	10.55	11.09	2.90	-1.03	3.84
	Wheat	16.46	16.67	2.08	-0.60	3.37
Long (%)	Corn	21.80	22.41	4.82	-0.92	3.51
	Soybeans	45.47	45.47	4.44	-0.09	2.01
	Wheat	35.62	35.73	4.37	-0.29	2.89
IT1WKCH	Corn	-586.94	-288.00	9,213.53	-0.26	6.66
	Soybeans	-174.18	97.00	4,238.35	-1.01	7.01
	Wheat	-185.03	-139.00	4,075.89	-0.21	3.91
IT4WKCH	Corn	-2,268.81	-145.00	24,193.29	-0.40	4.19
	Soybeans	-727.89	421.00	10,271.83	-0.77	4.49
	Wheat	-775.81	-786.00	9,178.11	0.05	3.36
IT13WKCH	Corn	-6,702.01	-1,218.00	53,355.86	-0.50	2.79
	Soybeans	-1,917.70	3,446.00	20,637.91	-0.81	3.03
	Wheat	-2,336.73	-2,851.00	17,484.10	-0.07	2.75

Table 3: **Descriptive statistics: Food commodity returns**

This table presents summary statistics for excess futures returns on the three agricultural food markets considered: corn, soybeans and wheat. The returns are expressed as percentages by multiplying by 100. The sample period is September 12, 2006 to October 10, 2012.

Commodity	**Mean**	**Median**	**Min**	**Max**	**St. Dev.**	**Skew**	**Kurt**
Corn	0.32	0.54	-15.20	21.45	5.09	0.19	1.48
Soybeans	0.49	0.47	-12.14	15.24	4.08	-0.04	0.77
Wheat	0.19	-0.15	-16.16	15.78	5.35	0.21	0.29

Table 4: **Correlation table**

	Whole sample 2006 – 2012			First half 2006 – 2009			Second half 2009 – 2012		
	Corn	**Soybeans**	**Wheat**	**Corn**	**Soybeans**	**Wheat**	**Corn**	**Soybeans**	**Wheat**
Panel A: Index traders									
Net Long	0.11*	0.07	0.06	0.13	0.07	0.09	0.07	0.11	-0.01
Net Long (%)	0.03	0.02	-0.03	0.10	0.06	-0.03	-0.03	0.01	-0.03
IT1WKCH	0.13**	0.33***	0.12**	0.24***	0.46***	0.11	0.00	0.22**	0.13
IT4WKCH	0.01	0.17***	-0.02	0.12	0.32***	0.03	-0.14	-0.01	-0.07
IT13WKCH	0.04	0.14**	-0.04	0.11	0.16**	-0.02	-0.09	0.10	-0.06
Panel B: Swap dealers									
Net Long	0.10*	0.09	0.08	0.14	0.09	0.12	0.06	0.09	0.02
Net Long (%)	0.04	0.05	0.02	0.16*	0.12	0.06	-0.01	0.02	-0.01
SD1WKCH	0.14**	0.31***	0.25***	0.31***	0.49***	0.28***	-0.04	0.11	0.22**
SD4WKCH	0.05	0.15**	0.07	0.18**	0.32***	0.11	-0.11	-0.08	0.02
SD13WKCH	0.07	0.11**	0.04	0.16**	0.15*	0.07	-0.06	0.04	-0.01

Table 5: **Granger causality tests for corn**

*The table shows Granger causality test results between excess futures returns and the positions of index traders (Panel A) and swap dealers (Panel B). We test the null hypothesis that corn futures returns (FRET) do not Granger-cause positions of traders and vice versa. The following four variables are employed for the positions of traders: the proportion of net long positions over the total number of positions (NLP), the 1-week, 4-week and 13-week change in the net long positions (*iWKCH*, where* i= *1,4,12). We report F-statistics from the tests along with their associated p-values. The optimal lag length for the VAR model is based on the Akaike Information Criterion. We test causality in the full sample (2006–2012) as well as two sub-samples of almost equal length: 12/9/2006–30/9/2009 and 1/10/2009–16/10/2012. *, ** and *** indicate rejection of the null at the 10%, 5% and 1% significance levels, respectively.*

	Entire sample 2006–2012			*Sub-sample 1 2006–2009*			*Sub-sample 2 2009–2012*		
	Lags	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**
Panel A: Index traders									
H_0: FRET $\nrightarrow$ NLP	14	0.68	0.79	2	0.25	0.78	7	2.14**	0.04
H_0: NLP $\nrightarrow$ FRET	14	0.96	0.50	2	6.99***	0.00	7	0.31	0.95
H_0: FRET $\nrightarrow$ IT1WKCH	1	1.18	0.28	2	1.69	0.19	1	0.03	0.87
H_0: IT1WKCH $\nrightarrow$ FRET	1	4.39**	0.04	2	2.33	0.10	1	4.02*	0.05
H_0: FRET $\nrightarrow$ IT4WKCH	14	0.71	0.76	5	0.95	0.45	10	0.80	0.63
H_0: IT4WKCH $\nrightarrow$ FRET	14	1.42	0.14	5	0.81	0.55	10	1.37	0.20
H_0: FRET $\nrightarrow$ IT13WKCH	15	1.42	0.14	15	1.28	0.23	15	0.91	0.55
H_0: IT13WKCH $\nrightarrow$ FRET	15	0.97	0.48	15	1.39	0.16	15	0.99	0.47
Panel B: Swap dealers									
H_0: FRET $\nrightarrow$ NLP	3	0.47	0.70	2	1.16	0.32	2	2.04	0.13
H_0: NLP $\nrightarrow$ FRET	3	1.02	0.38	2	6.63***	0.00	2	0.50	0.61
H_0: FRET $\nrightarrow$ SD1WKCH	2	3.17**	0.04	1	7.68**	0.01	1	0.33	0.56
H_0: SD1WKCH $\nrightarrow$ FRET	2	3.18**	0.04	1	0.31	0.58	1	3.83*	0.05
H_0: FRET $\nrightarrow$ SD4WKCH	6	2.54**	0.02	6	1.18	0.32	5	2.20*	0.06
H_0: SD4WKCH $\nrightarrow$ FRET	6	2.02*	0.06	6	2.01*	0.07	5	1.51	0.19
H_0: FRET $\nrightarrow$ SD13WKCH	15	1.79**	0.04	15	1.25	0.25	15	1.90**	0.03
H_0: SD13WKCH $\nrightarrow$ FRET	15	0.97	0.49	15	1.42	0.15	15	0.63	0.85

Table 6: **Granger causality tests for soybeans**

*The table shows Granger causality test results between excess futures returns and the positions of index traders (Panel A) and swap dealers (Panel B). We test the null hypothesis that soybean futures returns (FRET) do not Granger-cause positions of traders and vice versa. The following four variables are employed for the positions of traders: the proportion of net long positions over the total number of positions (NLP), the 1-week, 4-week and 13-week change in the net long positions (*iWKCH*, where* i= *1,4,12). We report F-statistics from the tests along with their associated p-values. The optimal lag length for the VAR model is based on the Akaike Information Criterion. We test causality in the full sample (2006–2012) as well as two sub-samples of almost equal length: 12/9/2006–30/9/2009 and 1/10/2009–16/10/2012. *, ** and *** indicate rejection of the null at the 10%, 5% and 1% significance levels, respectively.*

	Entire sample 2006–2012			*Sub-sample 1 2006–2009*			*Sub-sample 2 2009–2012*		
	Lags	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**
Panel A: Index traders									
H_0: FRET $\nrightarrow$ NLP	10	2.59**	0.01	11	2.50**	0.01	7	4.06***	0.00
H_0: NLP $\nrightarrow$ FRET	10	1.61	0.10	11	1.14	0.34	7	1.41	0.21
H_0: FRET $\nrightarrow$ IT1WKCH	1	0.07	0.79	2	2.87*	0.06	1	0.46	0.50
H_0: IT1WKCH $\nrightarrow$ FRET	1	0.77	0.38	2	3.58**	0.03	1	0.07	0.79
H_0: FRET $\nrightarrow$ IT4WKCH	9	1.33	0.22	9	0.99	0.45	7	2.71**	0.01
H_0: IT4WCH $\nrightarrow$ FRET	9	2.23**	0.02	9	2.46**	0.01	7	2.93**	0.01
H_0: FRET $\nrightarrow$ IT13WKCH	14	1.02	0.43	14	1.20	0.29	15	2.01**	0.02
H_0: IT13WKCH $\nrightarrow$ FRET	14	2.17	0.01	14	3.21***	0.00	15	1.59*	0.09
Panel B: Swap dealers									
H_0: FRET $\nrightarrow$ NLP	10	2.48**	0.01	8	2.14**	0.04	7	4.37***	0.00
H_0: NLP $\nrightarrow$ FRET	10	1.30	0.23	8	1.47	0.17	7	1.37	0.22
H_0: FRET $\nrightarrow$ SD1WKCH	1	3.34*	0.07	2	4.48**	0.01	1	0.00	0.99
H_0: SD1WKCH $\nrightarrow$ FRET	1	0.80	0.37	2	4.04**	0.02	1	0.36	0.55
H_0: FRET $\nrightarrow$ SD4WKCH	9	2.12**	0.03	5	1.43	0.22	7	2.72**	0.01
H_0: SD4WKCH $\nrightarrow$ FRET	9	0.81	0.61	5	2.74**	0.02	7	1.94*	0.07
H_0: FRET $\nrightarrow$ SD13WKCH	15	1.51	0.10	15	1.46	0.13	15	2.80***	0.00
H_0: SD13WKCH $\nrightarrow$ FRET	15	1.78**	0.04	15	1.45	0.14	15	1.74*	0.05

Table 7: **Granger causality tests for wheat**

*The table shows Granger causality test results between excess futures returns and the positions of index traders (Panel A) and swap dealers (Panel B). We test the null hypothesis that wheat futures returns (FRET) do not Granger-cause positions of traders and vice versa. The following four variables are employed for the positions of traders: the proportion of net long positions over the total number of positions (NLP), the 1-week, 4-week and 13-week change in the net long positions (*iWKCH*, where* i*= 1,4,12). We report F-statistics from the tests along with their associated p-values. The optimal lag length for the VAR model is based on the Akaike Information Criterion. We test causality in the full sample (2006–2012) as well as two sub-samples of almost equal length: 12/9/2006–30/9/2009 and 1/10/2009–16/10/2012. *, ** and *** indicate rejection of the null at the 10%, 5% and 1% significance levels, respectively.*

	Entire sample 2006–2012			*Sub-sample 1* 20062009			*Sub-sample 2* 2009–2012		
	Lags	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**
Panel A: Index traders									
H_0: FRET ↛ NLP	2	3.00*	0.05	1	0.37	0.54	1	0.16	0.69
H_0: NLP ↛ FRET	2	0.24	0.79	1	0.10	0.75	1	0.32	0.57
H_0: FRET ↛ IT1WKCH	1	4.96**	0.03	1	0.80	0.37	1	5.10**	0.03
H_0: IT1WKCH ↛ FRET	1	1.24	0.27	1	0.01	0.90	1	2.02	0.16
H_0: FRET ↛ IT4WKCH	13	1.16	0.31	9	0.73	0.68	5	0.98	0.43
H_0: IT4WKCH ↛ FRET	13	1.49	0.12	9	1.54	0.14	5	1.96*	0.09
H_0: FRET ↛ IT13WKCH	14	1.54	0.10	1	0.68	0.41	14	1.99**	0.02
H_0: IT13WKCH ↛ FRET	14	1.50	0.11	1	0.24	0.62	14	1.27	0.24
Panel B: Swap dealers									
H_0: FRET ↛ NLP	2	1.97	0.14	1	0.06	0.81	2	2.41*	0.09
H_0: NLP ↛ FRET	2	0.35	0.71	1	0.59	0.44	2	0.31	0.73
H_0: FRET ↛ SD1WKCH	1	1.48	0.22	1	0.21	0.65	2	3.50**	0.03
H_0: SD1WKCH ↛ FRET	1	0.95	0.33	1	0.10	0.76	2	0.60	0.55
H0: FRET ↛ SD4WKCH	9	2.17**	0.02	6	0.67	0.68	5	2.39**	0.04
H_0: SD4WKCH ↛ FRET	9	1.20	0.29	6	1.89*	0.09	5	0.62	0.68
H_0: FRET ↛ SD13WKCH	14	1.63*	0.07	1	1.97	0.16	14	2.09**	0.02
H_0: SD13WKCH ↛ FRET	14	1.33	0.19	1	0.01	0.94	14	0.85	0.61

Table 8: **Granger causality tests for corn volatility**

*The table shows results from Granger causality tests between weekly corn futures return volatility and the positions of index traders (Panel A) and swap dealers (Panel B), respectively. We test the null hypothesis that futures return volatility (FVOL) does not Granger-cause the positions of traders and vice versa. The following four variables are employed for the positions of traders: the proportion of net long positions over the total number of positions (NLP), the 1-week, 4-week and 13-week change in the net long positions (*iWKCH*, where* i= *1,4,12). Weekly volatility is computed using the range estimator of Yang and Zhang (2000). We report F-statistics from the tests along with their associated p-values. The optimal lag length for the VAR model is based on the Akaike Information Criterion. We test causality in the full sample (2006–2012) as well as two sub-samples of almost equal length: 12/9/2006–30/9/2009 and 1/10/2009–16/10/2012. *, ** and *** indicate rejection of the null at the 10%, 5% and 1% significance levels, respectively.*

	Entire sample 2006–2012			*Sub-sample 1 2006–2009*			*Sub-sample 2 2009–2012*		
	Lags	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**
Panel A: Index traders							2	0.47	0.63
H_0: FVOL ↛ NLP	14	1.33	0.19	2	0.70	0.50	2	2.97*	0.05
H_0: NLP ↛ FVOL	14	1.21	0.27	2	0.58	0.56			
							1	3.75*	0.05
H_0: FVOL ↛ IT1WKCH	2	1.96	0.14	2	0.13	0.88	1	2.44	0.12
H_0: IT1WKCH ↛ FVOL	2	0.95	0.39	2	0.90	0.41			
							11	1.06	0.40
H_0: FVOL ↛ IT4WKCH	14	0.63	0.84	5	2.80	0.02	11	1.08	0.38
H_0: IT4WKCH ↛ FVOL	14	0.80	0.67	5	0.49	0.78			
							16	1.60*	0.08
H_0: FVOL ↛ IT13WKCH	15	0.63	0.85	16	2.14**	0.01	16	0.92	0.55
H_0: IT13WKCH ↛ FVOL	15	0.81	0.67	16	0.91	0.56			
Panel B: Swap dealers									
H_0: FVOL ↛ NLP	5	0.17	0.97	1	0.62	0.43	2	0.26	0.77
H_0: NLP ↛ FVOL	5	1.75	0.12	1	4.21**	0.04	2	1.65	0.20
H_0: FVOL ↛ SD1WKCH	2	0.37	0.69	4	0.93	0.45	2	0.66	0.52
H_0: SD1WKCH ↛ FVOL	2	2.29	0.10	4	1.89	0.11	2	2.31	0.10
H_0: FVOL ↛ SD4WKCH	5	0.83	0.53	5	1.64	0.15	5	0.34	0.89
H_0: SD4WKCH ↛ FVOL	5	1.59	0.16	5	1.35	0.25	5	1.12	0.35
H_0: FVOL ↛ SD13WKCH	15	0.54	0.92	15	0.82	0.65	2	1.06	0.35
H_0: SD13WKCH ↛ FVOL	15	1.23	0.25	15	1.18	0.29	2	2.38	0.10

Table 9: **Granger causality tests for soybean volatility**

*The table shows results from Granger causality tests between weekly soybean futures return volatility and the positions of index traders (Panel A) and swap dealers (Panel B), respectively. We test the null hypothesis that futures return volatility (FVOL) does not Granger-cause the positions of traders and vice versa. The following four variables are employed for the positions of traders: the proportion of net long positions over the total number of positions (NLP), the 1-week, 4-week and 13-week change in the net long positions (*iWKCH*, where* i= *1,4,12). Weekly volatility is computed using the range estimator of Yang and Zhang (2000). We report F-statistics from the tests along with their associated p-values. The optimal lag length for the VAR model is based on the Akaike Information Criterion. We test causality in the full sample (2006–2012) as well as two sub-samples of almost equal length: 12/9/2006–30/9/2009 and 1/10/2009–16/10/2012. *, ** and *** indicate rejection of the null at the 10%, 5% and 1% significance levels, respectively.*

	Entire sample 2006–2012			*Sub-sample 1 2006–2009*			*Sub-sample 2 2009–2012*		
	Lags	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**
Panel A: Index traders									
H_0: FVOL $\nrightarrow$ NLP	15	1.61*	0.07	5	0.71	0.62	2	3.62**	0.03
H_0: NLP $\nrightarrow$ FVOL	15	1.09	0.37	5	1.12	0.35	2	1.40	0.25
H_0: FVOL $\nrightarrow$ IT1WKCH	4	2.08*	0.08	6	2.29**	0.04	2	2.73*	0.07
H_0: IT1WKCH $\nrightarrow$ FVOL	4	2.98**	0.02	6	3.06**	0.01	2	2.40	0.09
H_0: FVOL $\nrightarrow$ IT4WKCH	9	1.09	0.37	5	0.97	0.44	6	2.10*	0.06
H_0: IT4WKCH $\nrightarrow$ FVOL	9	2.32**	0.02	5	3.44**	0.01	6	1.12	0.36
H_0: FVOL $\nrightarrow$ IT13WKCH	14	1.35	0.18	14	1.59	0.09	2	0.64	0.53
H_0: IT13WKCH $\nrightarrow$ FVOL	14	0.96	0.49	14	1.66*	0.07	2	1.32	0.27
Panel B: Swap dealers									
H_0: FVOL $\nrightarrow$ NLP	15	1.79**	0.04	7	1.03	0.41	2	4.30**	0.02
H_0: NLP $\nrightarrow$ FVOL	15	1.21	0.26	7	0.94	0.48	2	1.14	0.32
H_0: FVOL $\nrightarrow$ SD1WKCH	4	3.05**	0.02	5	3.67***	0.00	2	3.97**	0.02
H_0: SD1WKCH $\nrightarrow$ FVOL	4	2.99**	0.02	5	1.73	0.13	2	2.44*	0.09
H_0: FVOL $\nrightarrow$ SD4WKCH	9	1.35	0.21	5	1.59	0.17	6	1.48	0.19
H_0: SD4WKCH $\nrightarrow$ FVOL	9	2.01**	0.04	5	2.47**	0.04	6	1.30	0.26
H_0: FVOL $\nrightarrow$ SD13WKCH	15	1.74**	0.04	15	1.56	0.10	2	1.95	0.15
H_0: SD13WKCH $\nrightarrow$ FVOL	15	0.77	0.72	15	1.03	0.43	2	1.50	0.23

Table 10: **Granger causality tests for wheat volatility**

*The table shows results from Granger causality tests between weekly wheat futures return volatility and the positions of index traders (Panel A) and swap dealers (Panel B), respectively. We test the null hypothesis that futures return volatility (FVOL) does not Granger-cause the positions of traders and vice versa. The following four variables are employed for the positions of traders: the proportion of net long positions over the total number of positions (NLP), the 1-week, 4-week and 13-week change in the net long positions (*iWKCH*, where* i= *1,4,12). Weekly volatility is computed using the range estimator of Yang and Zhang (2000). We report F-statistics from the tests along with their associated p-values. The optimal lag length for the VAR model is based on the Akaike Information Criterion. We test causality in the full sample (2006–2012) as well as two sub-samples of almost equal length: 12/9/2006–30/9/2009 and 1/10/2009–16/10/2012. *, ** and *** indicate rejection of the null at the 10%, 5% and 1% significance levels, respectively.*

	Entire sample 2006–2012			*Sub-sample 1 2006–2009*			*Sub-sample 2 2009–2012*		
	Lags	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**	**Lags**	**F-stat.**	**p-val.**
Panel A: Index traders									
H_0: FVOL $\nrightarrow$ NLP	6	0.24	0.96	1	0.06	0.81	1	0.32	0.57
H_0: NLP $\nrightarrow$ FVOL	6	3.11**	0.01	1	3.66*	0.06	1	2.09	0.15
H_0: FVOL $\nrightarrow$ IT1WKCH	4	1.27	0.28	7	1.98*	0.06	2	0.51	0.60
H_0: IT1WKCH $\nrightarrow$ FVOL	4	2.22*	0.07	7	3.15***	0.00	2	1.30	0.28
H_0: FVOL $\nrightarrow$ IT4WKCH	14	0.87	0.59	9	2.40**	0.01	15	1.11	0.35
H_0: IT4WKCH $\nrightarrow$ FVOL	14	2.48***	0.00	9	1.75*	0.08	15	1.46	0.13
H_0: FVOL $\nrightarrow$ IT13WKCH	14	0.80	0.67	1	2.72	0.10	2	0.58	0.56
H_0: IT13WKCH $\nrightarrow$ FVOL	14	2.29**	0.01	1	4.37**	0.04	2	3.04*	0.05
Panel B: Swap dealers									
H_0: FVOL $\nrightarrow$ NLP	5	0.47	0.80	1	0.06	0.81	2	1.19	0.31
H_0: NLP $\nrightarrow$ FVOL	5	3.22**	0.01	1	3.48*	0.06	2	0.84	0.43
H_0: FVOL $\nrightarrow$ SD1WKCH	3	0.72	0.54	3	1.18	0.32	2	0.68	0.51
H0: SD1WKCH $\nrightarrow$ FVOL	3	1.54	0.21	3	1.50	0.22	2	0.58	0.56
H_0: FVOL $\nrightarrow$ SD4WKCH	11	1.08	0.38	10	1.75*	0.08	5	2.40**	0.04
H_0: SD4WKCH $\nrightarrow$ FVOL	11	2.82***	0.00	10	1.76*	0.07	5	0.50	0.77
H_0: FVOL $\nrightarrow$ SD13WKCH	14	1.40	0.15	1	3.01*	0.08	2	0.46	0.63
H_0: SD13WKCH $\nrightarrow$ FVOL	14	1.52	0.10	1	2.86*	0.09	2	0.64	0.53