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by
Georg V. Lehecka

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Hedging and Speculative Pressures: An Investigation of the Relationships among Trading Positions and Prices in Commodity Futures Markets

Georg V. Lehecka*

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*Georg V. Lehecka is a doctoral candidate in the Department of Economics and Social Sciences at the University of Natural Resources and Life Sciences, Vienna (georg.lehecka@boku.ac.at). This paper was finalized while the author was visiting the Department of Agricultural and Consumer Economics at the University of Illinois at Urbana-Champaign and he gratefully acknowledges their hospitality.

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This study provides a systematic empirical investigation of lead-lag relationships among trading positions and prices in commodity futures markets. It employs Toda-Yamamoto Granger-causality tests applied on a variety of measurements of hedging, speculative, and index trader position activities and futures prices. Weekly futures market positions from the Commodity Futures Trading Commission (CFTC) and prices are examined for 24 commodities (1995 to 2011) based on Commitments of Traders (COT) reports and twelve commodities (2006 to 2011) based on Commodity Index Trader Supplement (CIT) reports. In particular, this study empirically examines whether pressures on prices due to hedging and speculative activities can be identified, and whether they have changed due to structural changes in commodity futures markets. Results suggest little systematic lead-lag relationship from hedging and speculative activities to prices. In contrast, there is strong evidence that prices tend to lead traders' hedging and speculative activity. These results appear to be generally persistent over commodities, measurements of hedging and speculation, and periods. In summary, hedging and speculative pressures may not be helpful in explaining prices in commodity futures markets; to the contrary, prices may cause traders to change their positions.

Keywords: commitments of traders, commodity futures markets, commodity index traders, hedging pressures, lead–lag relationships, speculative pressures.

Introduction

Since the increase in commodity prices in the mid-2000s, some commentators, policymakers and non-governmental organizations (NGOs) have argued that trading behavior of speculators started to predominate price levels in commodity markets. Commodity futures and options markets began to grow rather rapidly around 2004, both in held positions and traded volume, which is referred to as the "financialization" of commodity markets (Irwin and Sanders 2012b). Even though little evidence for direct influences on price levels from speculative positions and index funds has been found (see Irwin and Sanders 2011; Will et al. 2012; Gilbert and Pfuderer 2013), the public opinion in many countries is still dominated by the assumption that commodity futures prices are characterized by *speculative pressures* driven by futures market participants.[1] In this context, *speculative pressures* occur when (net) demand for long speculation exceeds (net) short hedging needs, which may result in changed price levels.

On the other hand, a number of trading guides present trading strategies that make use of the concept of *hedging pressure* to capture the risk premium in commodity futures markets (e.g., Upperman 2006; Briese 2008; Miffre 2012). *Hedging pressure*, based on the theory of "normal backwardation" of Keynes (1930) and Hicks (1939), tries to explain the price behavior of futures in relation to hedgers' position data. It is hypothesized that if the (net) demand for short hedging exceeds the demand for (net) long speculation, then long speculators will need to be compensated by an additional return risk premium to encourage them to balance the excess demand for short hedging, and this may result in price impacts.

Both concepts of *hedging* and *speculative pressure* assume explicitly or implicitly that movements in futures prices are directly affected by changes in hedgers' or speculators' open interest positions.[2] There have been a number studies on these relationships among traders' positions and prices in commodity futures markets. Based on position data of hedgers or speculators, some previous studies have found some evidence for *hedging pressure* (e.g., Bessembinder 1992; De Roon et al. 2000; Basu and Miffre 2009)[3] or *speculative pressure* (Cooke and Robles 2009; Gilbert 2010a 2010b; Plastina 2010; Singleton 2011). In contrast, other studies (e.g., Wang 2003; Bryant et al. 2006; Sanders et al. 2009)[4] have failed to find any evidence that either hedgers' or speculators' positions lead prices.[5] Nevertheless, the majority of studies report contemporaneous relationships between position data of market participants and prices. These observed contemporaneous relationships may be interpreted as pressure from positions to prices, however, correlations between price changes and net position changes of market participants cannot indicate any causation, and causal linkages are theoretically not obvious.

Given the ongoing debates on *hedging* and *speculative pressures* in commodity futures markets, the purpose of this paper is to address the following three questions: Are prices led by trading position activities of market participants? Are trading positions of groups of market participants led by prices? Have relationships changed due to structural changes in futures markets? By providing a comprehensive and systematic investigation of the lead-lag relationships among traders' positions and prices over a broad range of commodity markets (agricultural, livestock, softs, energy, and metals), this paper contributes to the available literature in the following ways.

To establish findings that are robust to measures of hedging and speculative activities, tests are systematically applied between prices and a variety of position data categories and variables on hedging and speculation. In contrast to previous studies, an augmented Granger-causality test (Toda and Yamamoto 1995) that is robust even if time series variables are non-stationary (or cointegrated) is used in a bivariate vector autoregression (VAR) framework to analyze lead-lag relationships. The testing power of results obtained in previous studies is strengthened by extending the sample period to more recent years, and including more commodities and position report data for consideration. Futures position data considered include data from *Commodity Futures Trading Commission* (CFTC) *Commitments of Traders* (COT), 1995 to 2011, and *Commodity Index Trader Supplement* (CIT) reports, 2006 to 2011. COT reports are issued weekly and list open interest position data of market participants classified into commercial (hedgers), noncommercial (speculators), and non-reportable traders (hold positions less than CFTC reporting levels) while CIT reports also include commodity index trader positions. In addition to Granger-causality, tests on the cumulative directional impacts between prices and position variables are conducted (e.g., Sanders et al. 2009). Furthermore, possible structural changes in the relationships among traders' positions and prices in futures markets are analyzed by examining two subsamples (1995 to 2003, 2004 to 2011) for COT report data. The subsample split is motivated by the growth of commodity futures and options markets that started around 2004 and the emergence of new financial market participants since that time (e.g., Irwin and Sanders 2012b).

Based on the wide range of analyzed commodity markets, a variety of measures of hedging and speculative activities, a newly applied more robust Granger-causality framework, and different

position data categories and sample periods, this study provides conclusive and robust empirical evidence on the effects of systematic *hedging* and *speculative pressures* in commodity futures markets. A better understanding of the mechanisms that drive commodity futures markets is important for a variety of parties interested in the functions of futures markets – hedgers, speculators, exchange officials, and regulators. In particular, policymakers and regulators may find the results useful in their decisions to change regulations of commodity futures markets.

Commitments of Traders (COT) and Commodity Index Trader Supplement (CIT) Reports

Futures positions of market participants are publicly available from CFTC's reports on a weekly basis. The futures market open interest positions of market participants are collected every Tuesday (aggregated across all contract expiration months for a given commodity) and made available to the public the following Friday at 3:30 p.m. EST. In this study, futures price data and position data of the COT reports are collected for eight agricultural (CBOT corn, oats, soybeans, soybean meal, soybean oil, and wheat; KCBT wheat; MGE wheat), three livestock (CME feeder cattle, live cattle, lean/live hogs[6]), five softs (ICE cocoa, coffee, cotton, orange juice, and sugar), four energy (NYMEX crude oil, heating oil, natural gas, and gasoline), and four metal (COMEX copper, gold, and silver; NYMEX platinum) futures markets over 17 years from March 1995 through December 2011.[7]

In COT reports, the CFTC classifies traders based on the size of their positions into reportable and non-reportable (reporting traders hold positions in excess of CFTC reporting levels). Reportable traders constitute the majority of the open interest of any futures market and are further classified as commercial (hedgers) or noncommercial (speculators) traders. A trader's futures position is determined to be commercial if the position is used for hedging purposes as defined by CFTC regulations. Futures positions are otherwise classified as non-commercial. The market's total open interest (TOI) is disaggregated in the following way:

$$\overbrace{\underbrace{[\mathrm{NCL}+\mathrm{NCS}+2\cdot\mathrm{NCSP}]}_{\text{Reporting}}}^{\text{Noncommercial}}+\overbrace{[\mathrm{CL}+\mathrm{CS}]}^{\text{Commercial}}+\underbrace{[\mathrm{NRL}+\mathrm{NRS}]}_{\text{Nonreporting}}=2\cdot\mathrm{TOI}, \tag{1}$$

with NCL, NCS, and NCSP are noncommercial long, short, and spreading positions, respectively. CL (CS) represents commercial long (short) positions, and NRL (NRS) are long (short) positions held by nonreporting traders. Reporting and nonreporting positions must sum to the market's TOI, and the number of long positions must be equal to the number of short positions.[8]

However, while the classification of commercial traders as hedgers and noncommercial as speculators may have never been fully accurate (e.g., Ederington and Lee 2000; Sanders et al. 2004)[9], the experienced structural changes in commodity futures markets and the increased diversity of futures market participants since the mid-2000s may have changed the composition of traders classified as commericals (e.g., Gilbert 2010b; Buyuksahin and Harris 2011; Irwin and Sanders 2012a). In particular, (mostly) long-only commodity index funds may be classified as commercials since their positions are hedged by swap dealers on the futures market (CFTC 2006). The swap dealers' underlying risk may not be a position in the physical commodity market,

rather, the reporting commercials may be financial institutions that hedge their risk of over-the-counter (OTC) derivative positions. Hence, there is uncertainty whether an underlying swap dealer position represents hedging or speculating behavior.

To address the issues of shortcomings in COT classifications, the CFTC started to publish more disaggregated reports. The *Commodity Index Trader Supplement* report (CIT)[10], available since January 2006 for twelve agricultural futures markets[11], add the new category of index traders to commercials and noncommercial positions (both less index traders).[12] In CIT reports, the market's total open interest (TOI) is disaggregated as follows:

$$\overbrace{\overbrace{[\mathrm{NCL}^{\text{-CITL}} + \mathrm{NCS}^{\text{-CITS}} + 2 \cdot \mathrm{NCSP}]}^{\text{Noncommercial}} + \overbrace{[\mathrm{CL}^{\text{-CITL}} + \mathrm{CS}^{\text{-CITS}}]}^{\text{Commercial}} + \overbrace{[\mathrm{CITL} + \mathrm{CITS}]}^{\text{CIT}}}^{\text{Reporting}} + \underbrace{[\mathrm{NRL} + \mathrm{NRS}]}_{\text{Nonreporting}} = 2 \cdot \mathrm{TOI}, \tag{2}$$

with $\mathrm{NCL}^{\text{-CITL}}$ ($\mathrm{NCS}^{\text{-CITS}}$) and $\mathrm{CL}^{\text{-CITL}}$ ($\mathrm{CS}^{\text{-CITS}}$) are noncommercial long (short) and commercial long (short) positions less index trader long (short) positions. CITL (CITS) represents index trader long (short) positions, and NCSP, NRL, and NRS denote noncommercial spreading positions, nonreporting long, and nonreporting short, respectively. As for COT reports, reporting and nonreporting positions must sum to the market's TOI, and the number of long positions must be equal to the number of short positions.

The major drawback of the new reports is, however, that they are not publicly available before the emergence of the new financial market participants and the growth of commodity futures markets that began around 2004, and thus, comparisons on relationships among traders' positions and futures prices are limited. If structural changes in commodity futures markets and futures market participants changed the relationships among traders' positions and prices, then this should also be observable using traditional COT report data. Therefore, possible changes in the relationships among traders' positions and prices in futures markets due to the structural changes in trading and participants in commodity futures markets are analyzed by examining two subsample periods based on weekly COT data (1992 to 2003, 2004 to 2011), split by the emergence of new market participants and the growth of commodity futures markets that started around 2004. Futures prices on Tuesdays' closing prices are matched with COT/CIT report releases. The nearby futures contract is used by the nearest contract up to one month before maturity and then rolling their position to the second nearest contract.[13]

Measurements of Hedging and Speculative Positions and Activities

A variety of measurements of position and pressure variables based on CFTC's COT (1995–2011, 24 commodity markets) and CIT (2006–2011, twelve commodity markets) report data are used to test for lead-lag relationships between hedging and speculative activities and prices. Proxies for *hedging* and *speculative pressures* are calculated following the literature (e.g., De Roon et al.

2000; Sanders et al. 2004) for COT and CIT report data, respectively. The percent net long position held by commercials is referred to as hedging pressure variable (HP),

$$\mathrm{HP}_t = \frac{\mathrm{CL}_t - \mathrm{CS}_t}{\mathrm{CL}_t + \mathrm{CS}_t}, \text{ and } \mathrm{HP}_t^{\text{-CIT}} = \frac{\mathrm{CL}_t^{\text{-CITL}} - \mathrm{CS}_t^{\text{-CITS}}}{\mathrm{CL}_t^{\text{-CITL}} + \mathrm{CS}_t^{\text{-CITS}}}, \tag{3}$$

the percent net long position held by noncommercials as speculative pressure variable (SP),

$$\mathrm{SP}_t = \frac{\mathrm{NCL}_t - \mathrm{NCS}_t}{\mathrm{NCL}_t + \mathrm{NCS}_t + 2 \cdot \mathrm{NCSP}_t}, \text{ and } \mathrm{SP}_t^{\text{-CIT}} = \frac{\mathrm{NCL}_t^{\text{-CITL}} - \mathrm{NCS}_t^{\text{-CITS}}}{\mathrm{NCL}_t^{\text{-CITL}} + \mathrm{NCS}_t^{\text{-CITS}} + 2 \cdot \mathrm{NCSP}_t}, \tag{4}$$

and the percent net long position held by nonreporting traders as small trader pressure variable (STP),

$$\mathrm{STP}_t = \frac{\mathrm{NRL}_t - \mathrm{NRS}_t}{\mathrm{NRL}_t + \mathrm{NRS}_t}. \tag{5}$$

Based on CIT report data, the percent net long position held by commodity index traders is referred to as commodity index trader pressure variable (CITP):

$$\mathrm{CITP}_t = \frac{\mathrm{CITL}_t - \mathrm{CITS}_t}{\mathrm{CITL}_t + \mathrm{CITS}_t}. \tag{6}$$

Hedging, speculative, small trader and commodity index trader pressure variables are bound to be between -1 and 1, and they are to be interpreted as follows. For example, a HP of -0.3 means that 30% of commercials are net short. Vice versa, a SP of 0.3 means that 30% of noncommercials are net long. The pressure variables HP, SP, and STP (and CITP for CIT report data), weighted by their percent of TOI, will sum to zero.

Moreover, Working's (1960) "T" speculative index is included as an additional proxy for speculative activity. For CIT report data, the index is adjusted by classifying index traders as speculators (e.g., Sanders et al. 2010):

$$\mathrm{T}_t = \begin{cases} 1 + \frac{\mathrm{NCS}_t}{\mathrm{CL}_t + \mathrm{CS}_t}, & \text{if } \mathrm{CS}_t \geq \mathrm{CL}_t, \text{ or} \\ 1 + \frac{\mathrm{NCL}_t}{\mathrm{CL}_t + \mathrm{CS}_t}, & \text{if } \mathrm{CL}_t > \mathrm{CS}_t. \end{cases}, \tag{7}$$

$$\mathrm{T}_t^{\text{CITadj}} = \begin{cases} 1 + \frac{\mathrm{NCS}_t^{\text{-CITS}} + \mathrm{CITS}}{\mathrm{CL}_t^{\text{-CITL}} + \mathrm{CS}_t^{\text{-CITS}}}, & \text{if } \mathrm{CS}_t^{\text{-CITS}} \geq \mathrm{CL}_t^{\text{-CITL}}, \text{ or} \\ 1 + \frac{\mathrm{NCL}_t^{\text{-CITL}} + \mathrm{CITL}}{\mathrm{CL}_t^{\text{-CITL}} + \mathrm{CS}_t^{\text{-CITS}}}, & \text{if } \mathrm{CL}_t^{\text{-CITL}} > \mathrm{CS}_t^{\text{-CITS}}. \end{cases}$$

This speculative index was proposed by Working (1960) as a measure of technically "excess" speculation. Long and short hedgers will not always trade at the same time or in the same quantity, and speculators meet hedging demand. The T index has a minimum value of 1.00, when the level of speculation equals hedging needs. "Excess" speculation, in this technical sense, means the level of speculation (noncommercial positions) relative to hedging (commercial

positions). For example, an index level of 1.30 means that there is 30% speculation in excess of that what is necessary to meet hedging needs. Working (1960) discussed that excess speculation is necessary for the functioning of futures markets, and the majority of prior studies (e.g., Labys and Granger 1970; Peck 1980; Leuthold 1983) were concerned about the lack of speculation to meet hedging needs.[14]

Augmented Granger-causality Test

To test for lead-lag relationships among position variables and prices, bivariate Granger-causality tests in a vector autoregression (VAR) framework (Lütkepohl 2007) are conducted. The concept of Granger-causality can be explained as follow. In the case of two time series, Ps_t and Pr_t, Ps_t Granger-causes Pr_t if Pr_t can be better predicted using the histories of both Ps_t and Pr_t than it can by using the histories of Pr_t alone.

However, Granger-causality test statistics have nonstandard asymptotic properties if the VAR contains non-stationary (and possibly cointegrated) time series variables, and thus, conventional tests are not valid (Lütkepohl 2007, Ch. 7). To avoid the problem of non-stationary in Granger-causality tests, the majority of previous studies on relationships between positions and prices (e.g., Röthig and Chiarella 2007; Sanders et al. 2009; Gilbert 2010a 2010b) have differenced possibly non-stationary time series data, and they do not tend to consider possible cointegration.[15]

In this study, an augmented Granger-causality framework is used that is robust to integrated or cointegrated time series contained in VAR models. Toda and Yamamoto (1995) presented a lag-augmented Granger-causality approach that is valid even if time series variables are difference-stationary (or cointegrated). The Toda-Yamamoto Granger-causality framework is as follows. First, the maximum order of integration d_{max} of the variables considered has to be determined, e.g., by Augmented Dickey-Fuller tests (ADF). Then, the optimal lag order p of the VAR model has to be selected using multivariate Information Criteria, e.g., by Bayesian Information Criterion (BIC). Next, the lag-augmented VAR($p + d_{max}$)

$$\begin{bmatrix} \mathrm{Pr}_t \\ \mathrm{Ps}_t \end{bmatrix} = \sum_{i=1}^{p+d_{max}} \begin{bmatrix} \gamma_{1,i} & \gamma_{2,i} \\ \gamma_{3,i} & \gamma_{4,i} \end{bmatrix} \begin{bmatrix} \mathrm{Pr}_{t-i} \\ \mathrm{Ps}_{t-i} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + t \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \tag{8}$$

is estimated, with Pr_t/Ps_t denoting price/position variables. In this study, the VAR in equation is modeled with additional constant terms α_1 and α_2, linear time trend terms β_1 and β_2, and $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are error terms. Ps_t is not Granger-causal for Pr_t iif the bivariate VAR($p + d_{max}$) process has $\gamma_{2,i} = 0$, for all $i = 1, 2, ..., p$. That is, it requires checking whether specific coefficients are zero, and testing H_0: $\gamma_{2,i} = 0, \forall i \leq p$ is a test that Ps_t does not Granger-cause Pr_t. Similarly, testing H_0: $\gamma_{3,i} = 0, \forall i \leq p$ is a test that Pr_t does not Granger-cause Ps_t. For both cases, a rejection of the null hypothesis implies there is Granger-causality. Note that the Granger-causality null hypothesis of zero coefficients is tested on only the first p coefficients.

Another approach would be to test before for cointegration, and then, conditional on the test results, choose either the VAR or VECM for the causality resting (e.g., used in Röthig 2011).

However, this is an example of "preliminary test testing", and significance levels and the power of the causality test will be distorted. Results obtained by Clarke and Mirza (2006) suggest that an approach such as proposed by Toda and Yamamoto (1995) is preferred to the practice of pretesting for cointegration. In a recent paper, Bauer and Maynard (2012) indicate that the lag-augmented approach can provide robust Granger-causality tests not only in the case of non-stationarity, but also for problems such as long-memory and certain (unmodeled) structural breaks.[16]

In addition to Granger-causality, tests on the cumulative directional impact from one time series variable to the other are of interest (e.g., Sanders et al. 2009). For example, the cumulative impact from Pr_t to Ps_t is tested by the null hypothesis

$$\mathrm{H}_0 : \sum_{i=1}^{p} \gamma_{3,i} = 0. \tag{9}$$

If $\gamma_{3,i} = 0, \forall i \leq p$ and $\sum_{i=1}^{p} \gamma_{3,i} = 0$ are rejected (i.e., there is Granger-causality and a directional impact), then there is "positive feedback" from Pr_t to Ps_t when $\sum_{i=1}^{p} \gamma_{3,i} > 0$, or "negative feedback" from Pr_t to Ps_t when $\sum_{i=1}^{p} \gamma_{3,i} < 0$. In the context of traders' positions and prices, a "positive feedback" indicates trend followers since traders tend to increase their long position after prices increase, and vice versa. On the other hand, a "negative feedback" indicates contrarians since traders tend to buy after price declines and sell after price increases.

Summary Statistics and Contemporaneous Correlations

Commodity futures markets have indeed experienced a tremendous increase both in market size and prices since the middle of the decade of the 2000s (e.g., Stoll and Whaley 2010; Buyuksahin and Harris 2011; Sanders and Irwin 2012b). By visual inspection, patterns of positions and prices may easily suggest a tendency of the variables to increase in tandem since the mid-2000s.

Summary statistics of prices and variables for COT and CIT report data used in this study suggest a wide variation of positions and prices, increasing more than tenfold for some commodities from minimum to maximum. ADF test results suggest that prices tend to be I(1), i.e., order of integration of one, while mixed evidence of I(0) and I(1) is found for position and pressure variables.[17] The variables for hedging and speculative pressures have negative and positive mean values, respectively. That means, on average, hedgers are net short while speculators are net long. However, standard deviations, minimum and maximum values indicate substantial variation across commodities and time. The mean values for small trader pressure variables suggest a somewhat mixed pattern with some positive and some negative values, indicating a range of different hedging or speculative behavior of small nonreporting traders. Since commodity index funds are mostly long-only, index trader pressure variables are always positive, meaning that index trader are net long.

Contemporaneous relationships between changes in prices (returns) and positions are highlighted in table 1. Overall, correlations are highly significant and consistent in signs across commodities and COT/CIT report data for position variables for hedgers and speculators (speculator

long/short, hedger long/short), and hedging and speculative pressure variables. Changes in hedging and speculative pressures are negatively and positively associated with returns, respectively. Price returns appear to have a positive relationship with changes in speculative long and hedging short positions. On the other hand, returns show a negative relationship with speculative short and hedging long position changes. For nonreporting positions and small trader pressure, the results are mixed, indicating again the heterogenous behavior of nonreporting traders. In addition, commodity index trader positions show less consistent results, with only index trader long position variables mostly significant and always positively related with price returns across commodities. Finally, changes in the speculative T index (COT and CIT report data) tend to have a negative relationship with price returns.

Note again, however, that these contemporaneous relationships do not indicate that either long speculative, short hedging, and long index trader positions, or speculative pressures lead to increasing prices, as they do not indicate that either short speculative and long hedging positions, hedging pressures, or the speculative index lead to decreasing prices. In principle, the contemporaneous relationships could reflect four different systematic lead-lag relationships: positions may lead prices as assumed by the concepts of *hedging* and *speculative pressures*, prices may lead positions as previous prices are an input of trading behavior, the lead-lag relationships may be bidirectional, or there is no lead-lag relationship at all and prices and positions react contemporaneously to another factor.

Therefore, to test these lead-lag relationships, Toda-Yamamoto Granger-causality tests are applied between prices and a variety of position data categories (i.e., speculator long/short, hedger long/short, non-reporting long/short, index trader long/short), and variables on hedging and speculative activity (hedging pressure, speculative pressure, small trader pressure, index trader pressure, Working's T speculative index) based on COT (1995 to 2011) and CIT (2006 to 2011) report data, respectively.[18] To analyze possible structural changes due to the emergence of new financial market participants and the start of the growth of commodity futures markets that began around 2004, COT report data are additionally analyzed in two subsamples, 1995 to 2003, and 2004 to 2011.

Are Prices led by Trading Position Activities of Groups of Market Participants?

Table 2 shows test results for Granger-causality and cumulative directional impacts from position variables to prices, for COT and CIT report data, estimated over the full sample periods (1995 through 2011, and 2006 through 2011, respectively) and all commodities (24 and twelve commodity futures markets, respectively). The reported figures denote the cumulative directional impact (i.e., $\sum_{i=1}^{p} \gamma_{2,i}$ to measure and test impacts from Ps_t to Pr_t), asterisks and daggers indicate significance for Granger-causality and cumulative directional impacts tests, respectively. For the vast majority of commodities and position variables, the null hypotheses of no Granger-causality and no directional impacts cannot be rejected. In particular, for pressure and speculative index variables, the null hypothesis that pressure variables do not lead prices could only be rejected for a few commodities based on COT reports (five for hedging pressure, three for speculative pressure and for the speculative index, respectively) and CIT reports (one for hedging pressure and index

trader pressure, none for speculative pressure, and two for the speculative index). In addition, the signs of directional impacts do not indicate any consistent direction across commodity markets. There is, therefore, hardly any indication that positions systematically lead prices.

While over the full sample period of COT report data (1995 through 2011) test results for Granger-causality and cumulative directional impacts suggest little relationships, structural changes experienced in commodity futures markets may have affected the relationships among trading positions and prices.[19] For COT report data, test results for lead-lag relationships from trading position variables to prices in subsample periods (1995 to 2003, 2004 to 2011) in table 3 do not indicate any substantial change. Consistent with the full sample, for the majority of commodities and position variables, the null hypotheses of no Granger-causality and no directional impact cannot be rejected. For example, the null hypothesis of no Granger-causality is rejected only for four and three commodities for hedging and speculative pressure in the first period, and only for four commodities for hedging and speculative pressure in the second period, respectively. As for the entire sample period, signs of directional impacts do not suggest any consistent direction across commodity markets and periods. That is, there is little indication that structural changes in commodity futures markets have changed lead-lag relationships from position variables to prices, and positions still do not appear to lead prices in commodity futures markets.

Are Trading Positions of Groups of Market Participants led by Prices?

In contrast to relationships from position variables to prices, Granger-causality test results in table 4 do indicate systematic lead-lag relationships from prices to position variables over the full sample and almost all commodities. In particular for COT report data, speculative long/short, hedging short, and most importantly, the pressure variables and the speculative index appear to be systematically led by prices. Most important, the null hypothesis for no Granger-causality is rejected for all commodities for speculative pressure and 22 for hedging pressure. Out of the 24 commodities tested, Granger-causality is found for small trader pressure for 18 commodities, for the speculative index for 20 commodities, hedging short 15 commodities, and speculative long/short for 18 and 23 commodities, respectively.

Cumulative directional impacts tend to show a consistent pattern for position variables. Since significant directional impact measures are negative and positive for 13 and seven tested commodities for speculative short and nonreporting long, speculators tend to decrease their short positions and nonreporting traders increase their long positions after prices increase. In addition, results for directional impact measures for speculative and small trader pressure show "positive feedbacks" since significant and positive results could be obtained for ten commodities for speculative pressure and 12 commodities for small trader pressure (however, two significant results are negative). This indicates that speculators and small traders tend to be trend followers. On the other hand, hedgers tend to buy after price declines and sell after price increases since all seven significant test results for hedging pressure show negative directional impacts. This may imply that hedgers are contrarian traders.[20] Finally, the speculative T index tend to show "negative feedback" since all 16 significant test results in the directional impact are negative. The

results of the directional impacts from prices to position variables appear to correspond to contemporaneous correlations in table 1. Thus, these findings indicate that the contemporaneous relationship between prices and positions may be explained by directional impacts from prices to positions, and not vice versa.

While directional impacts based on CIT report data tend to be consistent in signs with results obtained based on COT, however, lead-lag relationships are less significant across commodities. Out of twelve agricultural commodities included in CIT reports, Granger-causality is found for speculative and hedging short for nine and five commodities, for speculative pressure for seven, for the speculative index for eight, and for hedging pressure only for two commodities. Interestingly, since for index trader long/short and index trader pressure Granger-causality and cumulative impacts can in each case only be significantly found for one commodity markets and signs of impacts measure do not tend to be consistent across commodities, commodity index traders do not appear to be led by previous prices.[21]

To analyze whether structural changes in commodity futures markets have changed lead-lag relationships from prices to positions, Granger-causality and directional impact test results for the subsample periods based on COT report data are reported in table 5. For the first period (1995 to 2003), out of 24 tested commodities, Granger-causality is found for 18 and all 24 commodities for hedging and speculative pressure, eleven for small trader pressure, twelve for the speculative index, 21 and 22 for speculative long/short, and eight and ten for hedging long/short, respectively. For the second period (2004 to 2011), prices Granger-cause positions for 17 commodities for hedging and 19 for speculative pressure, 13 for small trader pressure, 18 for the speculative index, eight and 17 for speculative long/short, and six and ten for hedging long/short, respectively. In addition, signs and test results of directional impacts lead to the same interpretations for both periods: speculators tend to be trend followers (who buy after price increases and sell after price declines) and hedgers contrarian traders (who buy after price declines and sell after price increases). Overall, these results indicate that structural changes in commodity futures markets have not had substantial impacts on relationships between position variables and prices, and, most importantly, on any pressures on prices from hedging or speculation.

In summary, these results strongly suggest that the contemporaneous relationships between prices and positions are not explained by lead-lag effects from hedging and speculative behavior, as the concepts of *hedging* and *speculative pressures* assume, but they may be explained that hedging and speculative positions are affected by prices changes.

Robustness Analysis

Presented results of lead-lag relationships between position variables and prices may be sensitive to alternative position and price data, different subsample periods, and an alternative Granger-causality test approach. First, the COT open interest data used in this study are futures plus futures-equivalent option positions. Futures-only COT data are weekly available from the CFTC on a longer time period, from October 1992 to December 2011.[22] Thus, to examine whether results are sensitive to alternative COT data, all Granger-causality tests are also applied on futures-only data on the entire available period and two subsamples (October 1992 to

December 2003, January 2004 to December 2011). Next, there is an inconsistency between COT data and futures prices. While COT data are aggregated across all contracts, only the nearby futures price is used. Although open interest tend to be largest in the nearby contract, futures prices for the first, second, and third deferred contracts, and open-interest-weighted futures prices based on the nearby and the three deferred contracts, are alternatively used in the tests.

Moreover, while futures markets and prices began to grow around 2004, changed relationships between positions and prices could have started to evolve later in time. Thus, tests are applied on alternative subsample periods (second period starting in 2005, 2006, 2007, and 2008). Then, to assess whether test results are sensitive to the Toda-Yamamoto framework, all Granger-causality and directional impact tests are also conducted on differenced time series data to avoid non-stationarity, i.e., on price return and changes of position variables, without lag-augmentation.[23] All test results based on these alternative price and position data, different periods, and the alternative test approach lead to the same conclusions: systematic lead-lag relationships from prices to position variables, but not vice versa, and results are generally consistent between subsample periods.[24]

Discussions and Interpretations of Results

The presented results in this paper provide a statistically rather conclusive picture, however, they may be subject to some discussion in their interpretations. For example, rejected Granger-causality tests should only be viewed as a preliminary indication of a true "causal" relationship. They should not be interpreted as “cause” and “effect” relations but rather be interpreted as lead and lag relations between prices and hedging and speculative activities. Economic agents’ expectations on the future could make it appear as if there is a relationship between two variables when in fact there is none, or the observed lead-lag relationship may actually be the result of a third omitted variable. It is possible that prices and trading activities react to the same common factors without any "causal" relationship (e.g., Gilbert 2010b; Buyuksahin and Harris 2011).

Another limitation of Granger-causality tests is that they are not fully capable of explaining the contemporaneous correlation. Granger-causality tests will capture these relationships only in so far as previous values of position variables are helpful in forecasting current prices, and vice versa. Thus, the test power on hypotheses on relationships between hedgers’ and speculators’ positions and prices may be weak. The available weekly data may also mask relationships within weeks (e.g., Gilbert 2010b; Irwin and Sanders 2011 2012a).

Finally, while "causal" relationships could be much more dynamic (e.g., time-varying), Granger-causality tests will only be capable of detecting systematic patterns. That is, presented test results cannot rule out the possibility that pressures on prices from hedging or speculative behavior exist over specific or short intervals of time. Thus, it cannot be concluded that pressures from hedging or speculation do not exist at all. Only systematic lead-lag relationships from position variables to prices do not seem to be a characteristic of commodity futures markets, and this does not appear to have substantially changed given structural changes in markets.

Nevertheless, even if there were lead-lag relationships from pressures of hedgers and speculators on prices that are more dynamic (or nonlinear), only within limited or short periods of time, or simply not detectable due to power properties of Granger-causality tests, lead-lag relationships from prices to hedging and speculative positions would still predominate. Granger-causality tests appear to have enough power to detect that position variables are generally affected by prices, and these relationships seem to be (at least) linear, systematic, and consistent over commodities and sample periods. Thus, even in the possible case of "true" bidirectional causality, the "causal direction" that prices tend to lead variables on hedging and speculative activity would still predominate, and *hedging* and *speculative pressures* may themselves be driven by feedbacks from previous prices.

In summary, empirical results indicate rather little systematic lead-lag relationship from hedging and speculative positions to prices, and thus, the concepts of *hedging* and *speculative pressures* lack support from empirical evidence. On the other hand, results suggest that position variables, and therefore hedging and speculative behavior, tend to be influenced by prices, which may explain the observed contemporaneous relationships. This is also consistent with the efficient-market hypothesis as previous prices appear to be an input for hedging and speculative activities (Fama 1970). Based on the subsample results, there is little reason to assume that structural changes in commodity futures markets have substantially changed these relationships.

Conclusions and Implications

There has been a long and ardent debate whether pressures of hedging or speculation lead prices. Indeed, the contemporaneous relationship between price changes and (net) position changes of market participants is easily interpreted as pressure from positions to prices, but empirical evidence suggests rather little systematic lead-lag relationship. In this study, for the vast majority of commodities and position variables based on COT and CIT report data, the null hypothesis of no Granger-causality cannot be rejected. Furthermore, structural changes in trading and participants in commodity futures markets do not appear to have changed these relationships since results obtained for subsample periods are generally consistent. Thus, these empirical findings cast considerable doubt on systematic effects of *hedging* and *speculative pressures* in commodity futures markets. This does not imply that pressures from hedging or speculation do not exist at all, however, they have very probably not been a systematic characteristic of commodity futures markets, neither in the period from 1992 through 2003, nor from 2004 through 2011.

In contrast, there is strong evidence that prices tend to lead variables on positions, and on hedging and speculative activity. Granger-causality test results indicate systematic lead-lag relationships from prices to position variables over the full sample and the vast majority of commodities. In particular, based on COT report data, the null hypothesis for no Granger-causality is rejected for 22 and all 24 commodities for hedging and speculative pressure variables. In addition, results of directional impacts from prices to position variables correspond to contemporaneous correlations. Speculators and nonreporting traders tend to be trend followers (who buy after price increases and sell after price declines) and hedgers contrarian traders (who buy after price declines and sell after price increases). These findings indicate that the contemporaneous relationship between prices

and positions may be explained by directional impacts from prices to positions, and not vice versa. Furthermore, results based on on CIT reports suggest that positions of commodity index traders, however, do not appear to react systematically to previous prices.

Importantly, these results generally hold across a range of different commodity futures markets (agricultural, livestock, softs, energy, and metals), over periods before and after the financialization of commodity markets, and different periods when market prices are stable, trend upward and are volatile. The results are also robust to a variety of measurements of hedging and speculative activities, COT and CIT report data, futures-only and futures plus delta-adjusted option data, prices from nearby and deferred futures contracts, and they are robust to different test frameworks.

In conclusion, this paper provides evidence that effects of *hedging* and *speculative pressures* are not helpful in explaining prices in commodity futures markets. The findings of this paper contribute to the literature by providing empirical evidence that the financialization of commodity futures markets has not substantially changed relationships among hedging and speculative activities and prices in commodity futures markets, and neither hedging nor speculative positions lead prices. It supports and contributes to findings of studies on previous time periods (e.g., Wang 2003; Bryant et al. 2006) and particular commodities in agricultural (e.g., Röthig and Chiarella 2007; Sanders et al. 2009) and energy futures markets (e.g., Sanders et al. 2004; Buyuksahin and Harris 2011) that speculative and hedging traders respond to previous prices, but not vice versa. This does still hold even after the emergence of new financial market participants and the start of the growth of commodity futures markets that began around 2004.

These findings are of importance for policymakers, regulators and traders alike. The public policy debate should take note that neither hedging nor speculative positions systematically lead prices, and consequently, policy decisions simply aimed at further limiting speculative positions in commodity futures markets are not based on empirical evidence and may not be beneficial for the functioning of price discovery and hedging in these markets. Indeed, results suggest that hedging and speculative positions follow prices, and not the other way round. Implications for traders are that, while conducted tests cannot rule out that position data may be useful in combination with other information, COT and CIT report data provide little direct insight to predict future prices. In fact, as traders' positions respond to price changes, previous prices are an input for hedging and speculative decisions.

While this study has contributed to questions on systematic relationships between hedging, speculative, and index trader positions and prices in commodity futures markets, more issues remain. For example, further research is needed to examine the role of groups of traders in co-movements among different commodity and with equity markets (Tang and Xiong 2010; Buyuksahin and Robe 2011 2012). In addition, it would be interesting to analyze how relationships between prices and traders' positions behave during times of price bubbles (Gilbert 2010b; Phillips and Yu 2011; Etienne et al. 2012 2013; Gutierrez 2013).

References

Aigner, I. Opening speech by Ilse Aigner, Federal Minister of Food, Agriculture and Consumer Protection, at the International Green Week 2012. January 19, 2012. Available at: http://www.bmelv.de/SharedDocs/Reden/EN/2012/01-19-AI-Eroeffnungsrede-IGW2012.html

Basu, D. and J. Miffre. "Capturing the Risk Premium of Commodity Futures: The Role of Hedging Pressure." 2009. Available at SSRN: http://ssrn.com/abstract=1340873

Bauer, D. and A. Maynard. "Persistence-robust Surplus-lag Granger Causality Testing." *Journal of Econometrics*, 169(2012): 203–300.

Bessembinder, H. "Systematic Risk, Hedging Pressure, and Risk Premiums in Futures Markets." *The Review of Financial Studies*, 5(1992):637–667.

Briese, S. *The Commitments of Traders Bible: How to Profit from Insider Market Intelligence*. John Wiley and Sons, Inc., Hoboken, NJ, 2008.

Brunetti, C., B. Buyuksahin and J.H. Harris. "Speculators, Prices, and Market Volatility." CFTC and IEA Working Paper, Washington DC and Paris, 2011. Available at SSRN: http://papers.ssrn.com/abstract=1736737

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

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

Buyuksahin, B. and M.A. Robe. "Does 'Paper Oil' Matter? Energy Markets' Financialization and Equity-Commodity Co-Movements." 2011. Available at SSRN: http://papers.ssrn.com/abstract=1855264

Buyuksahin, B. and M.A. Robe. "Speculators, Commodities and Cross-Market Linkages." 2012. Available at SSRN: http://ssrn.com/abstract=1707103

Carchano, O. and A. Pardo. "Rolling over Stock Index Futures Contracts." *The Journal of Futures Markets*, 29(2009):684–694.

Carter, C.A. "Commodity Futures Markets: A Survey." *Australian Journal of Agricultural and Resource Economics*, 43(1999):209–247.

CFTC. Commission Actions in Response to the Comprehensive Review of the Commitments of Traders Reporting Program. Washington, DC, CFTC, June 21, 2006.

Chang, E.C. "Returns to Speculators and the Theory of Normal Backwardation." *Journal of Finance*, 40(1985):193–208.

Chatrath, A., Y. Liang and F. Song. "Commitment of Traders, Basis Behavior, and the Issue of Risk Premia in Futures Markets." *The Journal of Futures Markets*, 17(1997):707–731.

Clarke, J.A. and S. Mirza. "A Comparison of some Common Methods for Detecting Granger Noncausality." *Journal of Statistical Computation and Simulation*, 76(2006):207–231.

Cooke, B. and M. Robles. "Recent Food Price Movements: A Time Series Analysis." International Food Policy Research Institute (IFPRI). Discussion Paper no. 00942, December, 2009.

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

Dolado, J. and H. Lütkepohl. "Making Wald Tests work for Cointegrated VAR Systems." *Econometric Reviews*, 15(1996):369–38.

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

Etienne, X.L., S.H. Irwin and P. Garcia. "Price Explosiveness and Index Trader Behavior in the Corn, Soybean, and Wheat Futures Markets." Proceedings of the NCCC134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, St. Louis, MO, April 16-17, 2012. Available at: http://www.farmdoc.illinois.edu/nccc134/conf_2012/pdf/confp03-12.pdf

Etienne X.L., S.H. Irwin and P. Garcia. "Bubbles in Food Commodity Markets: Four Decades of Evidence." Paper presented at the IMF Conference on "Understanding International Commodity Price Fluctuations", Washington, D.C., March, 20-21, 2013. Available at IMF: http://www.imf.org/external/np/seminars/eng/2012/commodity/

Fama, E. "Efficient Capital Markets: A Review of Theory and Empirical Work." *The Journal of Finance*, 25(1970):1043–1053.

Garcia, P. and R.M. Leuthold. "A Selected Review of Agricultural Commodity Futures and Options Markets." *European Review of Agricultural Economics*, 31(2004):235–272.

Gilbert, C.L. "How to Understand High Food Prices." *Journal of Agricultural Economics*, 61(2010a):398–425.

Gilbert, C.L. "Speculative Influences on Commodity Futures Prices, 2006-2008." UNCTAD Discussion Papers 197, 2010b.

Gilbert, C.L. and S. Pfuderer "The Financialization of Food Commodity Markets." Forthcoming in: Jha, R., T. Gaiha and A. Deolalikar (eds.). *Handbook on Food: Demand, Supply, Sustainability and Security*. 2013.

Gutierrez, L. "Speculative Bubbles in Agricultural Commodity Markets." *European Review of Agricultural Economics*, 40(2013):217–238.

Hicks, J.R. *Value and Capital*. Oxford University Press, London, 1939.

Irwin, S.H., D.R. Sanders and R.P. Merrin. "Devil or Angel? The Role of Speculation in the Recent Commodity Price Boom (and Bust)." *Journal of Agricultural and Applied Economics*, 41(2009):377–391.

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

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

Irwin, S.H. and D.R. Sanders. "Financialization and Structural Change in Commodity Futures Markets." *Journal of Agricultural and Applied Economics*, 44(2012b):371–396.

Keynes, J.M. *A Treatise on Money, II: The Applied Theory of Money*. MacMillan, London, 1930.

Labys, W.C. and C.W.J. Granger. *Speculation, Hedging and Commodity Price Forecasts.* Heath Lexington Books, Lexington, MA, 1970.

Leuthold, R.M. "Commercial Use and Speculative Measures of the Livestock Commodity Futures Markets." *Journal of Futures Markets*, 3(1983):113–135.

Liu, Q. "Price Relations among Hog, Corn, and Soybean Meal Futures." *The Journal of Futures Markets*, 25(2005):491–514.

Lütkepohl, H. *New Introduction to Multiple Time Series Analysis.* Springer, Berlin, 2007.

Ma, K., M. Mercer, and M. Walker. "Rolling over Futures Contracts: A Note." *The Journal of Futures Markets*, 12(1992):203–217.

Miffre, J. "Hedging Pressure-based Long/Short Commodity Strategy used for Third Generation Commodity Index." Hedge Funds Review, January 20, 2012.

Peck, A.E. "The Role of Economic Analysis in Futures Market Regulation." *American Journal of Agricultural Economics*, 62(1980):1037–1043.

Phillips, P.C.B. and J. Yu. "Dating the Timeline of Financial Bubbles during the Subprime Crisis." *Quantitative Economics*, 2(2011):455–491.

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

Plastina, A. "Hedge Funds and Cotton Prices". International Cotton Advisory Committee. COTTON : Review of the World Situation 63,3(2010):15–22.

Rutledge, D.J.S. "Estimation of Hedging and Speculative Positions in Futures Markets: An Alternative Approach." *Food Research Institute Studies*, 16(1977):205–211.

Röthig, A. and C. Chiarella. "Investigating Nonlinear Speculation in Cattle, Corn, and Hog Futures Markets Using Logistic Smooth Transition Regression Models." *The Journal of Futures Markets*, 27(2007):719–737.

Röthig, A. "On Speculators and Hedgers in Currency Futures Markets: Who leads Whom?" *International Journal of Finance and Economics*, 16(2011):63–69.

Saikkonen, P. and H. Lütkepohl. "Infinite-order Cointegrated Vector Autoregressive Processes." *Econometric Theory*, 12(1996):814–844.

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

Sanders, D.R., S.H. Irwin and R.P. Merrin. "Smart Money: The Forecasting Ability of CFTC Large Traders in Agricultural Futures Markets.", *Journal of Agricultural and Resource Economics*, 34(2009):276–296.

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

Sanders, D.R. and S.H. Irwin. "New Evidence on the Impact of Index Funds in U.S. Grain Futures Markets." *Canadian Journal of Agricultural Economics*, 59(2011):519–532.

Singleton, K.J. "Investor Flows and the 2008 Boom/Bust in Oil Prices." Working paper. Graduate School of Business, Stanford University, 2011. Available at SSRN: http://ssrn.com/abstract=1793449

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

Tang, K. and W. Xiong. "Index Investing and the Financialization of Commodities." NBER Working Paper 16385. 2010. Available at NBER: http://www.nber.org/papers/w16385

Toda, H.Y. and P.C.B. Phillips. "Vector Autoregressions and Causality: A Theoretical Overview and Simulation Study." *Econometric Reviews*, 13(1994):259–285.

Toda, H. Y. and T. Yamamoto. "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes." *Journal of Econometrics*, 66(1995):225–250.

Upperman, F. *Commitments of Traders: Strategies for Tracking the Market and Trading Profitably.* John Wiley and Sons, Inc., Hoboken, NJ, 2006.

Wang, C. "The Behavior and Performance of Major Types of Futures Traders." *The Journal of Futures Markets*, 23(2003):1–31.

Will, M.G., S. Prehn, I. Pies and T. Glauben. "Is Financial Speculation with Agricultural Commodities Harmful or Helpful? – A Literature Review of Current Empirical Research." Discussion Paper No. 2012-27, Chair in Economic Ethics, Martin-Luther-University Halle-Wittenberg, 2012.

Working, H. "Speculation on Hedging Markets." *Food Research Institute Studies*, 1(1960):185–220.

Zapata, H.O. and A.N. Rambaldi. "Monte Carlo Evidence on Cointegration and Causation." *Oxford Bulletin of Economics and Statistics*, 59(1997):285–298.

Endnotes

[1]For example, the German Federal Minister for Food, Agriculture and Consumer Protection, Ilse Aigner, put it bluntly in a recent speech: "We want bread – and we do not want speculation that fails to put bread on the tables!" (Aigner 2012). More recently in March 2013, a group of twelve NGOs supported by about 240.000 signatures submitted a petition to the German Federal Minister of Finance, Wolfgang Schäuble, to tighten regulations of speculation in agricultural commodity markets.

[2]Recent discussions how position changes and money inflows may affect prices in commodity futures markets include, e.g., Irwin et al. (2009), Gilbert (2010a), Pirrong (2010), and Irwin and Sanders (2011). General surveys on the functioning of commodity futures markets can be found in, e.g., Carter (1999) and Garcia and Leuthold (2004).

[3]Other studies include Chang (1985) and Chatrath et al. (1997). Findings of Bessembinder (1992) and De Roon et al. (2000), however, were criticized (e.g., Sanders et al. 2004) since their results reflect a strictly contemporaneous relationship and are not sufficient to conclude that commercial traders create *hedging pressure* on prices. The "causal" relationship could also be the opposite.

[4]More recent studies that focus on the influence of commodity index traders include Stoll and Whaley (2010), Sanders and Irwin (2011), Brunetti et al. (2011), or Irwin and Sanders (2012a). They found very little evidence that index positions influence price movements in commodity futures markets.

[5]On the other hand, there is some indication that traders' positions may be affected by prices. Results obtained by Wang (2003), Sanders et al. (2004), Röthig and Chiarella (2007), and Buyuksahin and Harris (2011) suggest that price changes precede position changes.

[6]The hog contract was changed from live hog to lean hog, starting with the February 1997 contract. See, e.g., Liu (2005) for further details.

[7]Note that these COT data include futures and futures-equivalent option positions. Futures-only positions are available weekly since October 1992. They were released monthly 1975 through 1991 and bimonthly from January 1991 to September 1992. Prior to 1975, the reports were issued semimonthly.

[8]Available COT data are subject to some adjustments. Before 1998, corn, oats, soybeans, and wheat (CBOT), wheat (KCBT), and wheat (MGE) futures positions are measured in thousands of bushels. Since 1998, they are measured as number of contracts (contract size 5,000 bushels). Therefore, all corn, oats, soybeans, and wheat futures positions data prior to 1998 are divided by five in order that the related data series are measured in consistent units over the sample period. Furthermore, COT data are missing for September 11, 2001 for softs and energy futures markets, and are linearly interpolated.

[9]That is, not all commercial traders may be acting as hedgers. In practice, hedgers may not always and exclusively hedge positions in the physical markets and also exhibit speculative behavior. On the other hand, because of speculative position limits, speculators may have some incentives to be classified as commericals. Thus, while noncommericals can be assumed to be a relatively accurate classification of speculators, commerical positions may reflect not only pure hedging motives. In addition, there is no information available on the trading motives of nonreporting traders, and it may be assumed that they reflect a range of different hedging or speculative trading of small traders.

[10]CIT reports are also referred to as the *Supplemental Commitments of Traders* or SCOT reports.

[11]The futures markets included in CIT reports are CBOT corn, soybeans, soybean oil, and wheat; KCBT wheat; CME feeder cattle, live cattle, lean hogs; ICE cocoa, coffee, cotton, and sugar.

[12]The CFTC also started to publish the *Disaggregated Commitments of Traders* report (DCOT). The DCOT report disaggregates the commercials in the COT report into processors and merchants as well as swap dealers, and noncommercial trader categories into managed money and other reportables. DCOT data are available beginning in June 2006. These classifications, however, do not resolve the uncertainty about swap dealer positions. A valuable discussion on the differences between the different report classifications can be found in Irwin and Sanders (2012a).

[13]Note that the construction of a weekly price series based on rolling from contract to contract could potentially result in "jumps" in the price series. Some studies have analyzed different approaches to construct a price series by rolling from contract to contract (e.g., Ma et al. 1992; Carchano and Pardo 2009), however, it is not clear what the effect

might be (if any) on Granger-causality testing. To assess whether test results are sensitive to the used price series, Granger-causality tests are additionally conducted on differenced price series using only differences of weekly prices of always the same contracts, and they are alternatively applied on open-interest-weighted futures prices based on the nearby and the next three deferred contracts.

[14]One problem of the T index is how to deal with nonreporting positions. Following the literature for the calculation of the T index (e.g., Rutledge 1977; Sanders et al. 2010), nonreporting positions are simply allocated to the commercial and noncommercial categories in proportions as observed for reporting traders since there is no information available on the trading motives of nonreporting traders.

[15]However, Buyuksahin and Harris (2011) used Granger-causality tests in the framework of Dolado and Lütkepohl (1996) that is robust to integrated and cointegrated data.

[16]Note that there are also similar approaches given by Dolado and Lütkepohl (1996) and Saikkonen and Lütkepohl (1996). A further discussion on Granger-causality tests in the presence of integrated or cointegrated data can also be found in, e.g., Toda and Phillips (1994) and Zapata and Rambaldi (1997).

[17]As found in previous studies (e.g., Bryant et al. 2006; Buyuksahin and Harris 2011), ADF test results generally imply that commodity futures price time series appear to be I(1) while variables of hedging and speculative activities tend to be I(0). However, no variable appears to have a greater order of integration than one. To conserve space summary statistics are not reported, and they are available from the author upon request.

[18]To determine the lag order for each bivariate VAR, the BIC is used (with a maximum lag order of 10 lags). Since the maximum order of integration in any bivariate relationship appears to be one, one additional lag, $d_{max} = 1$, is included in the VAR model. Note again that the null hypothesis of no Granger-causality is only tested on the first p lag coefficients. In addition, the potential for heteroscedasticity is considered, and tests for heteroscedasticity (Breusch-Pagan tests) are performed for VAR models. Heteroscedasticity-consistent standard errors are used to correct the standard errors when necessary.

[19]Furthermore, since position data and futures prices started to increase around 2004, constants and linear time trend coefficients in equation 8 will not be stable over the full sample period, and thus, the full sample may not represent a consistent time series process.

[20]Previous studies have generally found that speculative positions react positively to prices. Sanders et al. (2004) and Sanders et al. (2009) for energy and agricultural markets, respectively, conclude that speculators tend to be trend followers while evidence for trend following or contrarian trading behavior of hedgers and nonreporting traders varies for markets. In addition, analyzing only three agricultural futures markets, Röthig and Chiarella (2007) found that speculation responds positively to previous price changes while significant results could not be reached for hedging positions. In an analysis of nonlinearities in the response of speculative positions to price changes, they found that speculative trading activity induced by price changes are stronger during price expansions.

[21]The results of hardly any lead-lag relationship between commodity index traders and prices are in particular interesting given generally positive contemporaneous correlations between changes of index trader long positions and price returns reported in table 1. This indicates that relationships are either only apparent within a weekly time frame (which is unlikely given the long-term investment strategy of index funds) or there is no lead-lag relationship at all and index trader long positions and prices tend to respond contemporaneously to another factor.

[22]Note that CIT reports, available starting January 2006, have always included futures plus option-equivalent futures positions, and futures-only CIT positions are not reported.

[23]Note that only differences of weekly prices of always the same contracts are used. That is, when rolling from the nearest contract to the second nearest contract, the price difference of the second nearest contract is used.

[24]To conserve space, all these alternative results are not presented in this paper. They are available from the author upon request.

Table 1. Correlations between Price Returns and Position Variable Changes, COT Reports (Mar. 1995 to Dec. 2011) and CIT Reports (Jan. 2006 to Dec. 2011)

COT Reports	NCL	NCS	CL	CS	NRL	NRS	HP	SP	STP	T
Corn (CBOT)	0.54**	-0.41**	-0.16**	0.54**	0.44**	-0.01	-0.59**	0.41**	0.52**	-0.21**
Wheat (CBOT)	0.45**	-0.4**	-0.05	0.5**	0.24**	0.03	-0.51**	0.46**	0.24**	-0.17**
Wheat (KCBT)	0.42**	-0.32**	-0.24**	0.36**	0.24**	0.07*	-0.48**	0.36**	0.23**	-0.2**
Wheat (MGE)	0.22**	-0.23**	-0.08*	0.26**	0.19**	0.06	-0.31**	0.19**	0.13**	-0.11**
Soybeans (CBOT)	0.54**	-0.36**	-0.27**	0.47**	0.45**	0.11**	-0.64**	0.48**	0.45**	-0.18**
Soybean Meal (CBOT)	0.54**	-0.39**	-0.39**	0.52**	0.43**	-0.19**	-0.61**	0.52**	0.49**	-0.2**
Soybean Oil (CBOT)	0.53**	-0.46**	-0.39**	0.49**	0.4**	-0.34**	-0.6**	0.5**	0.58**	-0.1**
Oats (CBOT)	0.38**	-0.34**	-0.28**	0.39**	0.27**	-0.1**	-0.48**	0.37**	0.3**	-0.23**
Lean Hogs (CME)	0.26**	-0.15**	-0.1**	0.26**	0.08*	0.03	-0.28**	0.22**	0.07*	-0.11**
Feeder Cattle (CME)	0.28**	-0.25**	-0.24**	0.2**	-0.21**	-0.02	-0.37**	0.33**	-0.17**	-0.13**
Live Cattle (CME)	0.33**	-0.23**	-0.1**	0.27**	-0.1**	0.11**	-0.32**	0.3**	-0.16**	-0.21**
Orange Juice (ICE)	0.43**	-0.43**	-0.17**	0.55**	0.41**	-0.21**	-0.54**	0.41**	0.49**	-0.36**
Coffee (ICE)	0.54**	-0.38**	-0.27**	0.52**	0.25**	-0.07*	-0.63**	0.5**	0.35**	-0.12**
Cotton (ICE)	0.39**	-0.35**	-0.01	0.42**	0.31**	-0.14**	-0.43**	0.34**	0.45**	-0.21**
Cocoa (ICE)	0.47**	-0.21**	-0.23**	0.42**	0.25**	-0.09*	-0.56**	0.4**	0.37**	0.1**
Sugar (ICE)	0.43**	-0.38**	-0.09**	0.45**	0.45**	-0.17**	-0.47**	0.33**	0.53**	-0.23**
Crude Oil (NYMEX)	0.45**	-0.29**	-0.1**	0.09**	0.14**	0.1**	-0.42**	0.37**	0.09**	-0.14**
Heating Oil (NYMEX)	0.45**	-0.22**	-0.18**	0.36**	0.36**	-0.02	-0.53**	0.42**	0.38**	0.05
Natural Gas (NYMEX)	0.1**	-0.07	0.09**	0.19**	0.1**	-0.05	-0.23**	0.27**	0.2**	-0.1**
Gasoline (NYMEX)	0.44**	-0.23**	-0.14**	0.26**	0.37**	0.01	-0.47**	0.35**	0.4**	-0.18**
Gold (COMEX)	0.61**	-0.3**	-0.11**	0.63**	0.44**	0.02	-0.52**	0.38**	0.33**	-0.13**
Silver (COMEX)	0.53**	-0.26**	-0.23**	0.51**	0.39**	0.2**	-0.45**	0.34**	0.03	-0.24**
Copper (COMEX)	0.39**	-0.21**	-0.3**	0.44**	0.3**	-0.12**	-0.48**	0.36**	0.34**	-0.08*
Platinum (NYMEX)	0.42**	-0.17**	-0.22**	0.41**	0.26**	-0.06	-0.36**	0.25**	0.2**	-0.14**
CIT Reports	NCL^{-CITL}	NCS^{-CITS}	CL^{-CITL}	CS^{-CITS}	CITL	CITS	HP^{-CIT}	SP^{-CIT}	CITP	T^{CITadj}
Corn (CBOT)	0.59**	-0.4**	-0.18**	0.6**	0.22**	0.1	-0.59**	0.47**	-0.05	-0.4**
Wheat (CBOT)	0.41**	-0.37**	-0.06	0.51**	0.26**	0.09	-0.36**	0.51**	-0.05	-0.4**
Wheat (KCBT)	0.42**	-0.31**	-0.18**	0.47**	0.16**	-0.08	-0.48**	0.45**	0.14*	-0.36**
Soybeans (CBOT)	0.59**	-0.39**	-0.41**	0.48**	0.27**	-0.05	-0.64**	0.55**	0.11*	-0.36**
Soybean Oil (CBOT)	0.51**	-0.41**	-0.38**	0.46**	0.09	-0.09	-0.59**	0.54**	0.15*	-0.42**
Lean Hogs (CME)	0.27**	-0.17**	-0.13*	0.32**	0.05	-0.02	-0.24**	0.28**	0	-0.2**
Feeder Cattle (CME)	0.24**	-0.24**	-0.21**	0.23**	0.09	-0.11*	-0.34**	0.3**	0.12*	-0.12*
Live Cattle (CME)	0.37**	-0.2**	-0.17**	0.35**	0.21**	0.02	-0.31**	0.33**	0.01	-0.22**
Coffee (ICE)	0.69**	-0.41**	-0.32**	0.57**	0.26**	0.01	-0.64**	0.58**	0.01	-0.43**
Cotton (ICE)	0.37**	-0.31**	0.07	0.41**	0.23**	0.13*	-0.24**	0.32**	-0.1	-0.3**
Cocoa (ICE)	0.49**	0.02	-0.24**	0.4**	0.18**	-0.1	-0.53**	0.33**	0.16**	-0.06
Sugar (ICE)	0.44**	-0.35**	-0.06	0.4**	0.15*	0.19**	-0.37**	0.34**	-0.16**	-0.27**

Notes: Single (*) and double (**) asterisks denote significance for a *t*-test with the null hypothesis that the correlation is zero at the 5% and 1% levels, respectively. The number of observations is 872 and 313 for COT and CIT report data, respectively.

Table 2. Toda-Yamamoto Granger-Causality and Cumulative Directional Impact Test Results, Positions to Prices, COT (Mar. 1995 to Dec. 2011) and CIT Reports (Jan. 2006 to Dec. 2011)

COT Report Data	NCL → Price	NCS → Price	CL → Price	CS → Price	NRL → Price	NRS → Price	HP → Price	SP → Price	STP → Price	T → Price
Corn (CBOT)	-0.01	0.01	0.02	0	0.01	0	3.57	-3.29	2.16	1.21
Wheat (CBOT)	-0.03	0.03	-0.08*†	0	-0.06	-0.01	7.46	-4.76	-4.55	8.24
Wheat (KCBT)	0.02	-0.1	0.02	0.09†	-0.09	-0.09	0.28	0.37	1.29	-14.43
Wheat (MGE)	-0.57*‡	-0.25*	0.11	0.03	-0.13	0	1.39	0.22	-1.53	12.02
Soybeans (CBOT)	0.02	0	0.02	0.01	0.02	0	-3.84	1.82	10.7*†	-15.34
Soybean Meal (CBOT)	0.04	-0.01	0	0.03	0.01	0.02	1.12	-1.86	1.42	-6.94
Soybean Oil (CBOT)	-0.01	0.03	-0.03	0	0.12†	0.11	0.06	-0.07	-1.84	-7.1
Oats (CBOT)	-0.17	1.18	0.16	-0.46**	-0.73*†	0.56	3.06*	-1	-7.91*†	6.75
Lean Hogs (CME)	-0.14†	-0.08	-0.03	0.02	0.12	0	2.67	1.34	3.58	-1.92
Feeder Cattle (CME)	0.11	-0.1	0.03	0.21	-0.18	0.06	-1.88	1.43	0.49	-1.14
Live Cattle (CME)	0.03	-0.01	0	0.02	0	0.02	-3.2	2.55	-2.18	-1.56
Orange Juice (ICE)	-0.16	0.32	0.12	-0.27**‡	-0.64**‡	0.14	3.42	-4.23	0.14	15.62
Coffee (ICE)	0.09	0.07**	-0.01	0.01*	-0.14	0.24	6.69*	-3.26*	-4.24	29.58*‡
Cotton (ICE)	-0.01	0.03	-0.06**	-0.06**†	-0.03	-0.11	3.83	-2.93	6.91*†	6.22
Cocoa (ICE)	-0.02	0.08**	0	-0.05*	-0.15	0.2	6.89**	-2.7*	-5.13*†	9.39
Sugar (ICE)	-0.04†	0.04	0.02	0	0.01	-0.01	15.71**‡	-7.19**‡	-6.48	43.98**‡
Crude Oil (NYMEX)	-0.01	0.03	-0.01	-0.01	-0.01	-0.01	-12.02	1.61	3.09	6.44
Heating Oil (NYMEX)	-0.04	0.08	0.03	0.01	-0.01	0.08	-0.81	1.4	2.28	-6.16
Natural Gas (NYMEX)	-0.01	-0.07*†	-0.01	0	0.11	-0.03	22.06**	-1.03	-5.96	-15.07
Gasoline (NYMEX)	0.02	-0.03	-0.02	-0.06**†	0	0.17	-2.96	-0.49	-3.18	7.19
Gold (COMEX)	0	0	0	0	0.03	0.03	1.51	-0.79	-0.84	12.12*†
Silver (COMEX)	0	0.03	0.01	0.02	0.09	0.25*‡	2.68	-1.73	-5.34	3.74
Copper (COMEX)	-0.05	-0.01	0.06	-0.03	0.09*	0.17	-0.13	-0.99	-1.13	7.97
Platinum (NYMEX)	-0.06	-0.07	-0.1	-0.11	-0.56*	-0.16	0.25	0.2	-0.99**	-1.37
CIT Report Data	NCL$^{\text{-CITL}}$ → Price	NCS$^{\text{-CITS}}$ → Price	CL$^{\text{-CITL}}$ → Price	CS$^{\text{-CITS}}$ → Price	CITL → Price	CITS → Price	HP$^{\text{-CIT}}$ → Price	SP$^{\text{-CIT}}$ → Price	CITP → Price	T$^{\text{CITadj}}$ → Price
Corn (CBOT)	-0.02	0.01	0.01	0	-0.05	-0.01	-13.23	-7.88	2.52	1.32
Wheat (CBOT)	-0.02	0.04	-0.08	-0.04	-0.2*†	-0.2	-12.45	-6.33	23.22	-6.96
Wheat (KCBT)	0.02	-0.34†	-0.03	0.17	0.05	-0.14	-2.41	12.81	2.44	-24.59†
Soybeans (CBOT)	0.03	-0.05	0.03	0.01	0.03	-0.08	2.88	1.54	15.21	-10.9
Soybean Oil (CBOT)	-0.04	0.05	-0.06	-0.01	0.05	-0.11	8.26*	-8.3	10.17	10.71
Lean Hogs (CME)	-0.09	-0.05	0.12	0.04	-0.11	0.08	11.11	-2.05	0.68	-1.31
Feeder Cattle (CME)	0.09	-0.18	0.29	0.35*	-0.31	0.19	-1.7	3.27	0.09	-1.66**
Live Cattle (CME)	0.01	0	-0.02	0.02	0.01	0.24*†	-4.57	5.86	-19.84*†	-4.86
Coffee (ICE)	0	0.06**	-0.12	0.02**	-0.1	-0.02	10.03	-6.85	-3.18	5.4**
Cotton (ICE)	0.1	-0.02	-0.1*†	-0.08**†	0.41*†	0.44	9.46	8.59	-24.27	6.45
Cocoa (ICE)	0.02	0.07	-0.07	-0.04	-0.17	0.04	-4.36	-5.37	-2.66	9.82
Sugar (ICE)	0.01	-0.07	0.02	0.01	0.01	-0.03	21.17	-16.54	3.59	-31.23

Notes: The reported figures denote the cumulative directional impact (i.e., $\sum_{i=1}^{p} \gamma_{2,i}$ to test impacts from Ps_t to Pr_t). Position data are in 1.000 contracts. Prices are logarithmized and cumulative impacts are multiplied by 100. Single (*) and double (**) asterisks denote significance for Granger-causality and single (†) and double (‡) daggers denote significance for directional impact at the 5% and 1% levels, respectively. The number of observations is 872 and 313 for COT and CIT report data, respectively. To determine the lag order for each bivariate VAR, the BIC is selected (with a maximum lag order of 10 lags). VAR models are checked for heteroskedasticity, and robust standard errors are used when considered necessary.

Table 3. Toda-Yamamoto Granger-Causality and Cumulative Directional Impact Test Results, Positions to Prices, COT Reports, Subsample Periods: Mar. 1995 to Dec. 2003 and Jan. 2004 to Dec. 2011

	NCL → Price	NCS → Price	CL → Price	CS → Price	NRL → Price	NRS → Price	HP → Price	SP → Price	STP → Price	T → Price
March 1995 through December 2003										
Corn (CBOT)	0	0	0	0.01	-0.02	-0.03	-4.18	0.29	-2.87	32.27
Wheat (CBOT)	0	0.02	-0.01	-0.02	-0.19**‡	-0.02	2.85	-0.63	-9.71*†	4.15
Wheat (KCBT)	-0.05	0.02	0.05	0.06	-0.09	-0.05	2.44	-1.58	1.47	14.17
Wheat (MGE)	0.8	0.05	0.04	-0.09	-0.15	0.07	1.42	1.59	-1.51	-0.6
Soybeans (CBOT)	0.03	-0.06	-0.04	-0.01	-0.03	-0.05	-9.1*	6.38	6.63	-2.07
Soybean Meal (CBOT)	0.07	-0.06	0	0	0.05	0.02	0.08	-1.69	5.45	-15.29
Soybean Oil (CBOT)	0.03	0	-0.02	0	-0.06	0.12	0.06	-0.45	-1.01	-4.7
Oats (CBOT)	0.3*	0	0.95	-0.64*	-0.96*†	1.16	4.93**	-4.84	-10.74*†	-7.84
Lean Hogs (CME)	-0.07	-0.18	-0.06	0.01	0.21	0.3*†	3.67	1.38	-0.5	-5.02
Feeder Cattle (CME)	0.13	-0.05	-0.08	-0.01	-0.3	-0.05	-0.84	1.65	1.14	-0.11
Live Cattle (CME)	0.03	0.01	-0.03	-0.03	0.05	0.05	0.42	-1.55	0.5	2.13
Orange Juice (ICE)	-0.24	0.4*†	0.26*†	-0.31*†	-0.75**‡	-0.12*	5.62	-3.99	1.23	18.14
Coffee (ICE)	0.01	0.14*	0.15	-0.16*	-0.02	0.48	8.07	-3.96*	-10.17	-25.37
Cotton (ICE)	-0.04	0.03	0.09	0.02	0	-0.04	4.69	-3.35	3.52	-5.32
Cocoa (ICE)	-0.17	0.1	0.07	-0.06	-0.2	0.11	14.63**	-3.77*†	-6.96	-5.26
Sugar (ICE)	-0.09**‡	0.03	0.04	-0.05**†	0.02	0.07	12.81**‡	-5.24**‡	-9.49*†	45.74*†
Crude Oil (NYMEX)	0.01	-0.06	0	-0.01	0.01	-0.07	-9.02	2.08	8.43	-60.7
Heating Oil (NYMEX)	-0.04	-0.04	0.04	-0.01	0.05	-0.12	0.79	1.29	16.79*†	-27.65
Natural Gas (NYMEX)	0.11	-0.16	0.01	-0.01	-0.12*	-0.1	-4.54	2.79	3.14	-110.9
Gasoline (NYMEX)	0.14	-0.24	-0.01	0.05	0.23	0.16	-13.48	4.99	2.24	-71.47*†
Gold (COMEX)	-0.01	-0.01	0	-0.01	0.02	0.02	-0.38	0.21	-1.97	10.65
Silver (COMEX)	-0.03	0.04	0.01	-0.05	0.01	0.18*†	2.2	-1.45	-6.1*†	4.62
Copper (COMEX)	-0.03	0.01	-0.01	-0.04	-0.21	0.22	0.89	-1.11	-0.88	8.76
Platinum (NYMEX)	0.09	-0.02	-0.05	0	0.43	0	-1	0	3.76*†	-0.77
January 2004 through December 2011										
Corn (CBOT)	-0.02	0.01	-0.01	0	0.02	0	15.23	-7.94	6.67	8.46
Wheat (CBOT)	-0.05	0.04	-0.09*†	0	0.02	0.01	18.53	-9.35	-0.02	26.89
Wheat (KCBT)	0.02	-0.17	0	0.1	-0.08	-0.11	-3.09	4.18	2.14	-21.33
Wheat (MGE)	-0.69**‡	0.53	0.3	-0.06	-0.12	-0.07	1.84	1.11	-0.92	-18.59
Soybeans (CBOT)	0.02	-0.06	-0.01	0.02	0.07	0.03	-1.63	-3.2	15.88	-35.78*†
Soybean Meal (CBOT)	0.01	0	0	0.05	-0.03	-0.02	6.02	-7.79	0.54	-5.09
Soybean Oil (CBOT)	-0.04	0.04	-0.03	0.01	0.12*	0.07	7.07	-3.86	4.62	-13.34
Oats (CBOT)	0.4	0.45	-0.5	-0.33	-0.41	-0.03	1.44	0.15	-5.95	17.57
Lean Hogs (CME)	-0.14†	-0.1	-0.04	0.04	0.03	-0.13	0.91	-1.42	8.72	-26.72*†
Feeder Cattle (CME)	0.13	-0.14	0.14	0.3*	0.06	0.14	-4.61*	2.59	-1.4	-3.09
Live Cattle (CME)	0.04	-0.02	-0.03	0.02	-0.03	0.01	-13.11**†	10.44†	-4.88	-5.72
Orange Juice (ICE)	-0.09	0.33	0	-0.22	-0.7	0.26	0.09	-0.57	-3.83	18.86
Coffee (ICE)	0.06	0.07	-0.07	0.01*	-0.25*	0.19	-0.97	1.22	2.01	12.06
Cotton (ICE)	0	0.05	-0.1**‡	-0.08**‡	-0.05	-0.17	3.08	-2.53	9.18	14.18
Cocoa (ICE)	0.03	0.06	-0.05	-0.05	-0.11	0.05	-2.02*	-0.88	-3.56	23.83
Sugar (ICE)	-0.02	-0.05	0.02	0.01	0	-0.04	24.67	-19.7*†	7.29	41.41
Crude Oil (NYMEX)	-0.01	0.03	0	0	0.01	0	0.53	1.97	7.23	89.7
Heating Oil (NYMEX)	-0.02	0.17	0.02	-0.04	-0.03	0	-2.5*	-22.97**‡	4.97	4.86
Natural Gas (NYMEX)	-0.01	-0.05	-0.07*†	-0.05	-0.01	0.19	-39.59	31.67	-4.18	0.56
Gasoline (NYMEX)	0.03	-0.03	0.05	0.05	0.21	0.14	-6.42	-9.57*	-8.34	-26.69
Gold (COMEX)	0	0.04	0.01	0	0.02	0.01	4.57	-4.39	1.06	0.98
Silver (COMEX)	0.06	0.15	-0.07	0.11†	0.24	0.09	-5.43	-2.92	-2.57	19.37
Copper (COMEX)	-0.02	-0.01	0.07	0	0.03	0.04	-2.82	14.55*†	0.19	21.84
Platinum (NYMEX)	-0.12	-0.28	-0.22	-0.19	0.66	-0.3	-2.1	-1.41	-1.34*	-1.64

Notes: The reported figures denote the cumulative directional impact (i.e., $\sum_{i=1}^{p} \gamma_{2,i}$ to test impacts from Ps_t to Pr_t). Position data are in 1.000 contracts. Prices are logarithmized and cumulative impacts are multiplied by 100. Single (*) and double (**) asterisks denote significance for Granger-causality and single (†) and double (‡) daggers denote significance for directional impact at the 5% and 1% levels, respectively. The number of observations is 439 and 417 for the first and second subsample period, respectively. To determine the lag order for each bivariate VAR, the BIC is selected (with a maximum lag order of 10 lags). VAR models are checked for heteroskedasticity, and robust standard errors are used when considered necessary.

Table 4. Toda-Yamamoto Granger-Causality and Cumulative Directional Impact Test Results, Prices to Positions, COT (Mar. 1995 to Dec. 2011) and CIT Reports (Jan. 2006 to Dec. 2011)

COT Report Data	Price → NCL	Price → NCS	Price → CL	Price → CS	Price → NRL	Price → NRS	Price → HP	Price → SP	Price → STP	Price → T
Corn (CBOT)	17.8	-19.02**†	33.16**	30.06	1.76	27.52**‡	-0.03	0.05**	-0.07**‡	-0.02**†
Wheat (CBOT)	7.56**†	-7.08**	-2.2	11.84**	3.97	0.09	-0.02**	0.05**	0.04	-0.03**†
Wheat (KCBT)	-0.3*	-1.88**	-2.46	2.41*	4.98	1.49	-0.04**	0.1**	0.08**‡	-0.03**†
Wheat (MGE)	-0.81**	-0.56**	0.24*	-0.19	2.71**‡	0.91	0**	0.43**‡	0.08*†	-0.05**‡
Soybeans (CBOT)	3.45	-3.47**	-0.24*	-6.33	12.23*†	13.04*†	0	0.04**	-0.05	-0.03**‡
Soybean Meal (CBOT)	2.44**	-9.04**‡	-5.53	6.92**	8.26**‡	-3.43*†	-0.03**	0.11**†	0.08**	-0.04**‡
Soybean Oil (CBOT)	5.18**	-6.36**	-5.11	10.32**	5.92**†	-3.58**	-0.02**	0.09**	0.09**	-0.05**‡
Oats (CBOT)	0.46**†	-0.63**‡	0.12	0.63**	0.74	0.1	-0.05**	0.2**‡	0.1*†	-0.04**‡
Lean Hogs (CME)	2.09*	-2.52**†	-1.42	-0.41*	1.23	2.21	-0.09**†	0.16**‡	-0.01	-0.09**‡
Feeder Cattle (CME)	0.1**	-0.69**	-0.5	0.72**	0.6	1.54**	-0.1**	0.13**	0.02**	-0.44**‡
Live Cattle (CME)	2.85	-3.65**	-1.25	5.8	1.13	9.29**‡	-0.07**†	0.07**	-0.09*†	-0.04**
Orange Juice (ICE)	2.34**‡	-2.88**‡	-2.98*†	3.48**†	-0.98	0.71	-0.02**	0.08**†	0.06	-0.04**‡
Coffee (ICE)	0.69**	-5.19**‡	-3.15	2.16**	0.59	-0.17	-0.11**‡	0.12**†	0.05**	-0.05**‡
Cotton (ICE)	1.75	-5.08**†	5.23	12.48†	3.75*†	-0.95	-0.08**†	0.11**†	0.07	-0.03**†
Cocoa (ICE)	2.76**	-4.35**†	-5.12**	1.95**	2.76	0.67	-0.04**†	0.14**‡	0.14*†	0**
Sugar (ICE)	4.83**	-10.12**†	4.34	6.56	16.27**‡	-9.74**‡	-0.06**†	0.14**†	0.16**‡	-0.02**
Crude Oil (NYMEX)	-2.29**	-9.17	-1.63	-30.03	2.76**	3.73	-0.01**	0.02**	0.11**‡	0
Heating Oil (NYMEX)	5.15**	-4.51**‡	-12.35*†	6.32	1.49	0.43**	-0.01**	0.04**	0.09**‡	0
Natural Gas (NYMEX)	5.04	-10.44**‡	5.61	-20.15**†	-0.45*	-4.92**‡	0.01**	-0.01**	0.07**‡	0
Gasoline (NYMEX)	1.29**	1.82**	11.87**‡	-8.61**	3.93**‡	0.7*	-0.02**	0.02**	0.18**‡	0**
Gold (COMEX)	25.23	-19.97**†	-0.89	61.07**†	-1.86**	6.08	-0.08*	0.18**‡	0.18*†	-0.09**‡
Silver (COMEX)	1.9**	-2.99**†	-3.31	8.27**	0.75**	-0.4**	-0.07**†	0.04**	-0.01	-0.04**‡
Copper (COMEX)	3.65**	-0.63*	-5.87*†	5.69**	0.89**	-1.47	-0.01**	0.05**	0.23**‡	-0.05*†
Platinum (NYMEX)	2.45**‡	0.5**	-1.84**‡	-1.87	0.23	-0.34**	-0.08**	-0.02**	0.18**†	0.01
CIT Report Data	**Price → NCL$^{\text{-CITL}}$**	**Price → NCS$^{\text{-CITS}}$**	**Price → CL$^{\text{-CITL}}$**	**Price → CS$^{\text{-CITS}}$**	**Price → CITL**	**Price → CITS**	**Price → HP$^{\text{-CIT}}$**	**Price → SP$^{\text{-CIT}}$**	**Price → CITP**	**Price → T$^{\text{CITadj}}$**
Corn (CBOT)	25.29	-25.12*	65.48**‡	26.09	16.04	4.73	0.02	0.06*†	0	-0.04**†
Wheat (CBOT)	10.65*†	-7.29	2.13	15.12	-6.11	2.87	-0.04	0.06**†	-0.02	-0.07
Wheat (KCBT)	1.89	-3.52**	-1.84	3.16	0.76	0.46	-0.01	0.06	0	-0.05**†
Soybeans (CBOT)	7.3	-9.67	7.8	-0.8	13.73*†	-1.22	-0.11	0.04	0.03	-0.05
Soybean Oil (CBOT)	1.32	-8.89*	3.42	16.6**	2.33	1.3	0.01	-0.01*	0.01	-0.05*
Lean Hogs (CME)	-0.58	-2.15**	-2.33	-7.41*	0.42	-2.11	-0.07	0*	0.06	0.03**
Feeder Cattle (CME)	-0.42*	-2.7**	-2.02	3.16**	1.6	-0.17	-0.44**†	0.19**	0.06	-1.27**‡
Live Cattle (CME)	5.8	-14.43*	-12.42	3.93	7.42	0.78	-0.11	0.05	0	-0.06
Coffee (ICE)	1.84	-9.75**‡	-0.03	4.41**	0.01	0.42	-0.06	0.11**†	-0.01	-0.08**‡
Cotton (ICE)	-3.37	-3.77	13.44	12.33	2.07	1.66	0.04	0.02	-0.02	-0.05*†
Cocoa (ICE)	1.67**	-5.63**	-14.46**‡	-1.31**	-0.9	-1.47	-0.1**†	0.07**	0.09	-0.02**
Sugar (ICE)	-3.72	-13.15*†	12.61	4.78	-9.41	18.18*†	0.01	0.01	-0.08*†	-0.02

Notes: The reported figures denote the cumulative directional impact (i.e., $\sum_{i=1}^{p} \gamma_{3,i}$ to test impacts from Pr_t to Ps_t). Position data are in 1.000 contracts and prices are logarithmized. Single (*) and double (**) asterisks denote significance for Granger-causality and single (†) and double (‡) daggers denote significance for directional impact at the 5% and 1% levels, respectively. he number of observations is 872 and 313 for COT and CIT report data, respectively. To determine the lag order for each bivariate VAR, the BIC is selected (with a maximum lag order of 10 lags). VAR models are checked for heteroskedasticity, and robust standard errors are used when considered necessary.

Table 5. Toda-Yamamoto Granger-Causality and Cumulative Directional Impact Test Results, Prices to Positions, COT Reports, Subsample Periods: Mar. 1995 to Dec. 2003 and Jan. 2004 to Dec. 2011

	Price → NCL	Price → NCS	Price → CL	Price → CS	Price → NRL	Price → NRS	Price → HP	Price → SP	Price → STP	Price → T
					March 1995 through December 2003					
Corn (CBOT)	9.43*	-0.09**	13.95	-9.24	-1.19	8.81**	0.04	0.01**	-0.09	-0.03*†
Wheat (CBOT)	4.91**	-6.32**	1.38	-1.51**	-1.27	-4.48	-0.01**	0.08**	0.07	-0.05**
Wheat (KCBT)	4.88**‡	0.98**	-3.25	-1.34	2.37	-1.17	-0.05*	0.44**‡	0.12*†	-0.03
Wheat (MGE)	1.72**‡	-0.59**	-3.24	1.8	0.5	0.5	-0.22**‡	0.72**‡	0.06	-0.02
Soybeans (CBOT)	-0.39*	-8.93**†	6.38	1.47	12.19	12.79*†	0.07	0.05*	-0.07	-0.05*†
Soybean Meal (CBOT)	-2.54*	-6.13*†	9.88	4.93**	1.19	0.22	-0.14	0.34**‡	0**	-0.03
Soybean Oil (CBOT)	10.58**	-15.47**†	-14.38	-1.56**	13.18**‡	-5.67**	-0.11**	0.33**†	0.09**	-0.04
Oats (CBOT)	0.4**	-0.79**‡	0.26	-0.04	0.17	0.25	0.01	0.23**‡	0.04	-0.03
Lean Hogs (CME)	3.42*†	-2.5**‡	-1.78	-0.16	0.75	1.54	-0.12**	0.23**‡	-0.02	-0.1**‡
Feeder Cattle (CME)	1.33**	0.18**	-1.12	-0.22*	2.11	3.53**†	0.22*	0.01**	-0.22*†	-0.22
Live Cattle (CME)	5.4	-8.43	-6.6	11.26	2.22	4.09	-0.08*	0.25*†	-0.06	-0.14**‡
Orange Juice (ICE)	1.91*	-3.68**†	-0.42	0.93	-3.43*†	0.95	0.05	0.07**	0	-0.06**†
Coffee (ICE)	2.62*	-4.52**‡	-6.2**‡	4.06	-0.93	0.08	-0.11*	0.12**	0.07	-0.05**‡
Cotton (ICE)	10.2**‡	-9.35**†	-6.22	7.25	0.26	-1.33	-0.18**†	0.24**†	0.06	-0.03
Cocoa (ICE)	5.88**†	-2.18**	-6.21*†	4.06	-0.23	0.14	-0.04**	0.22**‡	0.15*†	0.01
Sugar (ICE)	12.21**†	-13.06**†	-3.54**	3.5**	17.82**‡	-16.75**‡	-0.12**	0.36**‡	0.15**	-0.01**
Crude Oil (NYMEX)	10.93**	-16.72**‡	11.64*	-35.87**	10.56**	12.12	0**	0.01**	0.04**	0
Heating Oil (NYMEX)	9.74**†	-5.53**‡	-15.78**‡	-5.24	5.69	-1.79	-0.06*	0.19**†	0.08	0
Natural Gas (NYMEX)	1.46	-7.95**‡	-3.99	-33.16**†	3.52	-4.66**	0**	0*	0.08**‡	0
Gasoline (NYMEX)	3.02**	-1.74**	7.75*	-13.44**†	4.56*†	-5.63**‡	-0.05**	0.08**	0.21**‡	-0.02**‡
Gold (COMEX)	57.74	-29.76**	-36.24	151.34**‡	12.33	-13.29	-0.2	0.47**‡	0.51**‡	-0.11**‡
Silver (COMEX)	10.75**	-10.59**†	-11.14	10.36**	4.54	5.37	-0.27**†	0.24**	0.01	-0.16**‡
Copper (COMEX)	-7.58**	-0.15**	12.74**	2.52	-4.38**	-0.05**	0.39**†	0.37**‡	-0.14**‡	
Platinum (NYMEX)	1.82**	0.14	-3.92**‡	-0.62	0.28	-1.14**‡	-0.23**	0.14**	0.22	-0.17*†
					January 2004 through December 2011					
Corn (CBOT)	26.28	-32.46**‡	71.92**‡	52.11	-0.47	25.86*†	-0.05†	0.06**†	-0.06*†	-0.03**‡
Wheat (CBOT)	9.16*	-9.05**	-5.2	19.35*	5.12	2.61	-0.06**†	0.07**	0.01	-0.03*†
Wheat (KCBT)	0.83	-4.51**†	-3.14	5.12	6.66	3.47	-0.04**	0.1**	0.03	-0.05**‡
Wheat (MGE)	-1.26**	-3.14**‡	-2.56	-0.35	3.39**‡	1.23	0.01**	-0.09**	0.08*†	-0.01**
Soybeans (CBOT)	6.72	-14.54*†	29.43*†	-6.78	13.55	16.25*†	-0.05	0.05**	-0.03	-0.02
Soybean Meal (CBOT)	5.93	-12.48**‡	-14.54**‡	10.52	12.34**‡	-0.65	-0.05*	0.07**	0.12	-0.05**‡
Soybean Oil (CBOT)	3.67	-5.06**	0.67	15.99**	8.56**†	-8.33*†	0	-0.01**	0.19*†	-0.05**‡
Oats (CBOT)	0.54**	-0.57*†	-0.03	1.16**	0.99*†	-0.01	-0.08**	0.22**†	0.15**‡	-0.04*†
Lean Hogs (CME)	1.56	-3.15**	-1.42	-1.43	2.09	3.41	-0.03	0.03*	-0.02	-0.01**
Feeder Cattle (CME)	-0.61*	-2.23**	-0.16	1.34**	-0.18	0.39**	-0.32**‡	0.21**†	-0.27**‡	-0.36**†
Live Cattle (CME)	-0.15	-8.32**	-3.98	3.33	0.56	14.24*†	-0.05*	0.03**	-0.13*†	-0.02**
Orange Juice (ICE)	2.35**†	-1.91**‡	-4.25*†	5.2**†	0.54	0.33	-0.05**	0.14**‡	0.07	-0.04**†
Coffee (ICE)	0.16*	-8.24**‡	1.16	2.13**	3.16**†	-0.18	-0.05**	0.08**	0.19**‡	-0.06**‡
Cotton (ICE)	-3.32	-3.26**	13.31	16.21	6.17*†	-0.73	0	0.02**	0.06	-0.03**†
Cocoa (ICE)	1.12**	-6.94**†	-11.06**‡	-1.46**	6.03**‡	0.87	-0.05**	0.06**	0.16	-0.01**
Sugar (ICE)	0.65	-13.07*†	6.48	10.29	15.61	-6.46	-0.01	0.01	0.13*†	-0.02*
Crude Oil (NYMEX)	-2.95	-2.28	-2.29	68.91	15.86	-3.64	0**	0.01	0.14**‡	0
Heating Oil (NYMEX)	3.17**	-3.56	-9.26	15.89*†	4.59	-3.23**	0.02**	0.11**‡	0.02**	0.01
Natural Gas (NYMEX)	8.47	-14.52	-12.85	12.28	8.7*‡	-2.05	-0.03**‡	0.02**‡	0.04	0.01
Gasoline (NYMEX)	6.26	-3.25	-0.32	10.1	7.78**‡	-0.01	-0.07**‡	-0.01	0.11**†	-0.02*†
Gold (COMEX)	20.13	-17.24*†	18.27	64.79	26.32**‡	16.22*†	-0.01	0.02	0.09	-0.04*
Silver (COMEX)	-0.99	-2.55	-1.51	7*	3.07**	4.18**‡	-0.08*†	0.1**‡	-0.01	-0.03*†
Copper (COMEX)	5.63	2.95	2.88	8.98*†	3.34**†	-0.84	-0.05	0.01	0.18**‡	0.01
Platinum (NYMEX)	1.65	-1.17	-1.19*†	-1.36	1.46**‡	-0.57**	-0.17*†	0.26*†	0.3**‡	-0.05

Notes: The reported figures denote the cumulative directional impact (i.e., $\sum_{i=1}^{p} \gamma_{3,i}$ to test impacts from Pr_t to Ps_t). Position data are in 1.000 contracts and prices are logarithmized. Single (*) and double (**) asterisks denote significance for Granger-causality and single (†) and double (‡) daggers denote significance for directional impact at the 5% and 1% levels, respectively. The number of observations is 439 and 417 for the first and second subsample period, respectively. To determine the lag order for each bivariate VAR, the BIC is selected (with a maximum lag order of 10 lags). VAR models are checked for heteroskedasticity, and robust standard errors are used when considered necessary.