Spreads and Non-Convergence in CBOT Corn, Soybean, and Wheat Futures: Are Index Funds to Blame?

by

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November 2009

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Abstract

The purpose of this paper was to evaluate the role of index funds in recent convergence problems of CBOT corn, soybean, and wheat futures contracts. These new market participants are widely thought to have inflated futures prices and/or expanded spreads between futures prices. Large spreads in futures markets contribute to lack of convergence by uncoupling cash and futures markets. Statistical tests provide no evidence that rolling of positions by index funds or the initiation of large index positions in a "crowded market space" contribute to an expansion of the spreads. Other factors including a combination of CBOT contract storage rates that lagged market rates and a change in underlying supply and demand conditions that was common to all three grain futures markets appears to be the most promising avenue for explaining the large carry and attendant non-convergence.

Keywords: cash price, convergence, corn, delivery, futures price, index fund, soybeans, wheat

JEL Categories: Q11, Q13

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In U.S. agriculture, futures markets play an important role in price discovery, risk transfer, and the allocation of inventories through time. Because of the traditionally close relationship between futures and cash prices futures markets affect input and output decisions, and the distribution of returns. Considerable research has been performed to assess the ability of agricultural futures markets to assimilate and transmit information and to transfer risk. Findings generally indicate that in well-designed contracts futures prices respond rapidly to new information, provide unbiased if imprecise forecasts of subsequent cash prices, and transmit information quickly throughout the marketing system (Carter 1999; Williams 2001; Garcia and Leuthold 2004). With regards to managing risk, the potential benefits of using futures contracts to hedge price risk have been identified for a variety of contracts and market situations (e.g., Lien and Tse 2002; Tomek and Peterson 2001).

Central to futures market performance is convergence between futures and cash prices at expiration. In reality, convergence is not exact; differences between cash and futures exist due to transactions costs, short-term manipulation and market congestion, and imperfect information which limit arbitrage. It also has been recognized that futures contracts provide sellers with delivery options for the timing, location, and grade to be delivered (Hranaiova and Tomek 2002). In this context, it is more realistic and meaningful to think of a zone of convergence between cash and futures prices, with the bounds of convergence determined by the cost of participating in the delivery process.

The lack of consistently acceptable convergence performance for Chicago Board of Trade (CBOT) corn, soybean, and wheat contracts since late 2005 has been widely discussed

(e.g., Henriques 2008; USS/PSI 2009).[1] Convergence performance is summarized in Figure 1, depicting delivery location basis levels (cash minus futures) on the first delivery date of each contract for the three commodities over January or March 2000 through September 2009.[2] Using estimates of the direct costs of delivery in the range of 6 to 8 cents per bushel (i.e., barge load out, storage and interest opportunity costs) to establish a zone of convergence, it is evident that lack of convergence existed for extended and varied periods particularly since late 2005. Performance has been consistently weakest in wheat, with delivery location basis at times exceeding one dollar per bushel, a level of disconnect between cash and futures not previously experienced in grain markets.

The economic damage associated with non-convergence problems is two-fold. First, the failure to converge leads to bias in the price discovery process as futures do not represent subsequent cash prices. Second, uncertainty in basis behavior increases as markets bounce unpredictably between converging and not converging and this leads to marked declines in hedging effectiveness (Irwin et al. 2008). Working (1953 1954) argues persuasively that futures markets for storable commodities depend primarily on hedging for their existence. Gray (1966) also argues that a first prerequisite for contract success is its usefulness for hedging. Consequently, the long-run viability of a commodity futures market may be threatened if the market does not provide an efficient hedging mechanism for producers, merchants and processors. For instance, Paul, Kahl, and Tomek (1981) show that hedging effectiveness in the Maine potato futures market declined precipitously in the 1970s. The market disappeared shortly thereafter in the early 1980s. As Hieronymus (1977, p. 340) warns, "When a contract is out of balance the disadvantaged side ceases trading and the contract disappears." Exchanges are certainly aware of this critical dimension of contract success and invest considerable resources in

structuring and modifying contracts to reflect cash market activities and changes in hedging effectiveness.

Given the magnitude and persistence of recent convergence problems it is not surprising that a public and heated debate has erupted about the factors responsible for the situation. Much of the debate has focused on the trading activities of 'long-only' index funds, which have grown rapidly in popularity over the last five years as large institutional investors and wealthy individuals sought to diversify investment portfolios and profit from rising commodity prices.[3] These new market participants are widely thought to have inflated futures prices and/or expanded spreads between futures prices. The most prominent statement of this position is found in a recent report by the U.S. Senate's Permanent Subcommittee on Investigations (USS/PSI 2009, p. 2):

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

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

The purpose of this paper is to evaluate the role of index funds in the recent convergence problems of CBOT corn, soybean, and wheat futures contracts. The first part of the analysis

examines how large spreads in futures prices contribute to lack of convergence by uncoupling cash and futures markets. The second part of the analysis investigates whether index fund trading expanded spreads in CBOT corn, soybean, and wheat futures, and therefore is responsible for the observed convergence problems. Two types of tests are used in the analysis: 1) an event study test of the behavior of spreads during the time window when index funds tend to roll positions from one futures contract to the next; and 2) Granger causality tests of the relationship between index trader positions and spreads. Since these tests provide no evidence that index funds expand spreads in the three CBOT futures markets, the third part of the paper examines other factors that may have contributed to the rising spreads and non-convergence.

CBOT Delivery System

Futures contracts are standardized forward contracts, with all terms fixed except price (Peck 1985, p. 11). For agricultural futures contracts with physical delivery, such as CBOT corn, soybean, and wheat contracts, the defined terms include the delivery territory, deliverable grades, and period of delivery. The delivery process is an essential component of futures contracts with physical delivery, as it ties futures and cash prices together. In a perfect market with costless delivery at one location and one date, arbitrage should force the futures price at expiration to equal the cash price.[4] If futures are above the cash price, the cash commodity is bought, futures sold and delivery made. If the cash price exceeds futures, then futures are bought and the buyer stands for delivery. This type of arbitrage should prevent the law of one price from being violated. When the delivery system is functioning properly, only a minimal number of futures deliveries are needed since long and short futures position holders are indifferent to offsetting their positions rather than making and taking delivery.

If delivery of a CBOT corn, soybean, or wheat futures contract is made, it is at the discretion of the short position holder to initiate delivery. The long position holder, however, can force a delivery by refusing to offset his or her futures position until expiration of the futures contract is imminent. The delivery process consists of a three-day sequence: 1) Intention Day where the short declares their intention for delivery to the CBOT Clearinghouse, 2) Notice Day where the Clearinghouse notifies the oldest outstanding long position holder with an invoice for delivery, and 3) Delivery Day where the seller and the buyer exchange delivery instruments and payment. The delivery instrument for CBOT corn and soybeans since March 2000 and CBOT wheat since July 2008 is a shipping certificate. Shipping certificates give the holder the right, but not the obligation to demand load-out of the designated commodity from the shipping station of a firm that issued the shipping certificate. Previous to the above dates, the delivery instrument for CBOT corn, soybeans, and wheat was a warehouse receipt that represented grain in store at a designated terminal elevator facility. Since all three markets now use shipping certificates the remainder of this discussion focuses on shipping certificates.[5]

Only firms approved by the CBOT as "regular for delivery" are allowed to issue shipping certificates. The regular firm is the source of all delivery instruments for their facilities or shipping stations. If a short position holder is not a regular firm, he/she must buy a shipping certificate from a regular firm, another holder of a certificate, or have taken delivery on a previous long futures position. Only the short position holder that is also a regular firm has the ability to initiate an “original” delivery.

Firms regular for CBOT delivery have shipping stations within the delivery territory of the futures contract. They must meet certain exchange requirements to be eligible for regularity such as a minimum net worth of $5 million. The firms regular for delivery issue shipping

certificates based on the loading capabilities of the shipping stations registered. The delivery territory for corn futures contracts is a 204-mile section of the Illinois River from terminals in Chicago, Illinois and Burns Harbor, Indiana south to Pekin, Illinois. For soybean futures contracts the delivery territory is extended an additional 200 miles along the Illinois and Mississippi Rivers to St. Louis, Missouri. Chicago and Burns Harbor deliveries occur at par for both corn and soybeans, with discounts for deliveries on the Illinois River running between 2 and 6 cents per bushel. In July 2009, the delivery territory for the CBOT wheat futures contract was expanded from facilities in Chicago, Illinois, Toledo, Ohio, and St. Louis, Missouri to include facilities in a 12-county area of Northwest Ohio, facilities on the Ohio River from Cincinnati to the Mississippi River, and facilities on the Mississippi River from south of St. Louis to Memphis, Tennessee. Wheat deliveries at Northwest Ohio locations are allowed at a 20 cent per bushel discount to the par locations of Chicago and Toledo, Ohio River locations are at par, and Mississippi River locations are allowed at a 20 cent per bushel premium.

A long that has stopped a futures delivery, i.e., taken delivery within the contract delivery territory, has several options as a shipping certificate holder. The firm or individual may continue to hold the shipping certificate and pay the storage charge for the contract set by the CBOT, sell the shipping certificate to someone else at a negotiated price, sell a futures contract and re-tender the shipping certificate by making an intention for delivery on the futures market using the delivery process as outlined above, or cancel the certificate by demanding load-out of the physical commodity.

If a shipping certificate owner requests load-out, the owner surrenders the certificate to the CBOT for cancellation. At the same time the certificate owner provides the warehouseman/shipper with written loading orders that identify when the requested delivery of

grain should occur and specifies the grade and estimated number of bushels to be loaded. It is the responsibility of the certificate owner to arrange for proper conveyance of the grain to be loaded out. The shipper orders the conveyance to the shipping station for actual placement for loading. The shipper must begin load out at the registered daily rate of loading for the shipping station within three business days following receipt of loading orders or within one business day of constructive placement, whichever occurs later. Final settlement charges are based on official weights and grades, which completes the delivery through load-out process linking futures and cash markets.

Spreads and Non-Convergence

The key role that the "carry" plays in delivery decisions has been emphasized by a number of writers (e.g., Peck and Williams 1991; Hranaiova and Tomek 2002). The nearby carry is given by the difference, or spread, between prices of the expiring futures contract and the next-to-expire contract. Large carry markets contribute to lack of convergence by "uncoupling" cash and futures markets when futures prices are above cash prices. As noted in the previous section, the delivery instrument for CBOT corn, soybeans, and wheat is a shipping certificate. Those longs who receive certificates from shorts in the delivery process are not required to cancel those instruments for shipment. The instruments can be held indefinitely with the holder paying storage costs at the official rates specified by the CBOT in contract rules. The taker in delivery (the long) may choose to hold the delivery instrument rather than load out if the spread between the price of the expiring and next-to-expire futures contracts exceeds the cost of owning the delivery instrument. Therefore, as the magnitude of the nearby spread exceeds the full cost

of carry for market participants with access to low-cost capital, those participants can (and do) stand for delivery but do not cancel delivery certificates for load out.[6]

The lack of load out, then, means that deliveries do not result in cash commodity purchases by the taker that would contribute towards higher cash prices and better convergence. Alternatively, a smaller carry in the market and the absence of an "abnormal" return to certificate ownership would motivate participants with long positions to liquidate prior to delivery, putting downward pressure on nearby futures and contributing to better convergence.

An example will help illustrate the incentives that drive longs to buy and hold shipping certificates in large carry markets. On December 1, 2008 the price of the expiring December 2008 CBOT wheat futures contract was $5.0975/bushel and the price of next-to-expire March 2009 contract was $5.28, or a spread of 18.25 cents per bushel. If a trader bought the December contract at $5.0975, took delivery, and held the shipping certificate until March 1, 2009, the storage charges incurred would have been 15.015 cents (16.5 hundredths of a cent per day (official CBOT rate) x 91 days). By simultaneously selling the March 2009 contract at $5.28, a net return after storage costs of 3.235 cents = 18.25 – 15.015 cents could have been locked in by the trader. This return can be converted to an annualized percentage return of 2.545% [(3.235/509.75)(365/91)(100)] and compared to the cost of financing the trade. On December 1, 2008 the three-month LIBOR rate, a commonly-used interest measure in carry calculations, was 2.22% per annum. Since the financing cost is less than the net return after storage costs, a risk-neutral trader has a clear incentive to buy and hold wheat shipping certificates.

The most common metric for expressing the magnitude of spreads in the futures industry is "percent of full carry." The percent of full carry for nearby spreads is computed as:

(1) $$Carry_t = \left[\frac{F2_t - F1_t}{S_t + I_t} \right] \times 100,$$

where $F1_t$ is the settlement price of the t^{th} expiring futures contract on the first delivery date for this contract, $F2_t$ is the settlement price of next-to-expire futures contract on the first delivery date of the t^{th} expiring futures contract, S_t is the CBOT contract storage rate per day times the number of days (n_t) between the first delivery date for the expiring and next-to-expire futures contracts, and I_t is interest opportunity cost, computed as the settlement price of the expiring futures contract on the first day of delivery $(F1_t)$ times the appropriately adjusted 3-month LIBOR interest rate $\left[I_t = F1_t \times (r_t/365) \times n_t \right]$.

Figure 2 shows the nearby spread between prices for the expiring and next-to-expire contracts, expressed as a percent of full carry, on the first delivery date of each expiring CBOT corn, soybean, and wheat futures contract over January or March 2000 through September 2009.[7] The series start in January or March of 2000 contracts since these were the first contracts in corn and soybeans that traded under a shipping certificate delivery system. Note that the scale for percent of full carry in Figure 2 is cut off at zero since large negative carry values (inverted markets or "backwardations") distort comparisons.[8] The charts reveal a similar pattern across the three commodities. There was a relatively brief period in 2000 and 2001 when spreads exceeded 80% of fully carry and then spreads generally were capped near 80% of full carry through early 2005; but beginning in the last half of 2005 spreads routinely approached or exceeded 100% of full carry. As noted above, the relatively large carry creates incentives for takers of delivery (longs) to hold delivery instruments rather than canceling via load out. This general pattern is illustrated in Figure 3 for total outstanding shipping certificates or registered

warehouse receipts. Note especially the decline in registered certificates for soybeans in late 2008 and corn in March 2009 that follows a drop in the carry below 80% in these two markets.

Figure 4 illustrates the relationship between the magnitude of the carry and the basis (cash minus futures) at delivery locations on the first delivery date of each expiring corn, soybean, and wheat futures contract over January or March 2000 through September 2009. The charts are constructed so that the zero line for basis on the left *y*-axis scale corresponds to 80% of full carry on the right *y*-axis scale. In addition, the scale for cost of carry (right *y*-axis) is cut off at -220% since very large negative carry values during inverted markets distort comparisons. Inspection of the charts shows a consistent pattern of poor convergence whenever the carry exceeds about 80% and better performance when the carry is below 80%.[9] Note that the pattern is evident not only during recent years but also in 2000-2001, when corn and wheat experienced another period of non-convergence, albeit at much smaller basis levels. Also, a break near 80% implies that at least some participants in the delivery process find it attractive to hold shipping certificates even when the implied return is less than the three-month LIBOR interest rate. Two other observations are particularly relevant regarding the most recent behavior of delivery location basis and carry. First, the recovery of corn basis levels since March 2009, soybean basis since January 2009, and wheat basis in September 2007, December 2007, and March 2008 tracks the decline in carry below 80%.[10] Second, the large carry in wheat since May 2008 continues to inhibit convergence.

The relationship between the percent of full cost of carry and delivery location basis levels is analyzed further in Table 1.[11] Several important observations follow. First, the contrast between average basis above and below 80% of full carry is striking and provides strong evidence of the important role that carry plays in the physical delivery process. The differences

in the averages are statistically significant in every case based on *t*-tests (independent sample and unequal variance; see Snedecor and Cochrane 1989, pp.96-98). Second, the level of the average basis when carry is above 80% is well above the direct costs of participating in delivery (6 to 8 cents) in all cases. Third, the difference between the averages is about the same for corn and soybeans and represents a weakening of the basis by about 10 to 20 cents. Fourth, the magnitude of the weakening of the basis in wheat, about 30 to 40 cents, is substantially higher compared to corn and soybeans.

In sum, the analysis in this section pinpoints an unusually large carry in nearby spreads as the main factor driving poor convergence performance of CBOT corn, soybean, and wheat futures contracts in recent years. The large carry led to a historically large wedge between futures and cash prices. This raises the question of whether index funds caused the jump in the carry for these markets starting in the second half of 2005.

Roll Tests

The idea of long-only investment vehicles that track an index of commodity futures prices is not new (e.g., Greer 1978; Bodie and Rosansky 1980), but actual investment in such instruments did not achieve "lift off" until the last decade. The Commodity Futures Trading Commission (CFTC) estimates that index fund investment peaked at the end of the second quarter of 2008 at $201 billion but dropped to $137 billion by the end of the third quarter of 2009. It is not surprising that money flows of this size have drawn the attention of other futures market participants, exchange officials, and regulators (see pp. 40-41 of USS/PSS 2009 for an extensive list).

Since commodity futures contracts have a limited life, index fund providers developed "roll" strategies to transfer long positions from an expiring contract to a later contract. The S&P GSCI Index™ is one of the most widely tracked indexes and the roll process for this index is described as follows:

> "The rolling forward of the underlying futures contracts in the excess return index portfolio occurs once each month, on the fifth through ninth business days (the roll period). As explained above, some of the underlying commodity contracts expire in the next month and thus need to be rolled forward. The simplest way to think of the process is as rolling from one basket of nearby futures (the first nearby basket) to a basket of futures contracts that are further from expiration (the second nearby basket). The S&P GSCI™ is calculated as though these rolls occur at the end of each day during the roll period at the daily settlement prices."[12]

Some argue that the rolling of positions, like that described above, leads to an expansion of spreads in commodity futures markets. The basic idea is that rolling of positions by index funds occurs roughly in unison and is of such magnitude that the price of the nearby contract, which funds are selling, is pushed down and the price of the next contract, which funds are buying, is pushed up. The net result is that the spread between the nearby and next nearby contract expands to accommodate the movement of large index fund positions between contracts. This increase is argued to be permanent once index fund positions become "large" and the market expects this rolling activity to occur as each contract nears expiration.

In order to formally test the impact of index fund rolling in CBOT corn, soybeans and wheat futures, Table 2 presents the average behavior of nearby spreads during the first 13 business days of the calendar month prior to contract expiration over March 1995 through July 2009.[13] The time window for the analysis is centered on days 5-9, the time period of the so-called "Goldman roll" when index funds tend to roll their positions from the nearby to the next deferred contract. This is the "event window" in the terminology of event studies. Four sub-periods are represented in each market. The first is March 1995 through November or December

2001, which represents a period with very little index fund trading. The second is January or March 2002 through November or December 2003, which is the time period when index fund trading first began to appear in earnest. The third is January or March 2004 through November or December 2005, which is the period of most rapid growth in index fund trading (Sanders, Irwin, and Merrin 2008). The fourth is January or March 2006 through July 2009, which is the period with the largest index fund positions and also problems regarding non-convergence in CBOT corn, soybean, and wheat futures.

The averages in Table 2 reveal a consistent increase in the size of the spread to the next contract (expressed as a percent of full carry) during "Goldman roll" days 5 through 9. However, three observations are important. First, the spike in the magnitude of the spread either disappears entirely or noticeably recedes during days 10 through 13, so rolling did not necessarily lead to a permanent increase in the magnitude of the spread. Second, the spike in the magnitude of the spread during the roll period was present long before convergence became an issue and before long-only index funds had a major presence in these markets. This is not surprising since the time window when index funds roll to the next contract is also the same time period when many other traders roll their positions. Third, none of the average differences between the spreads on days 1-4 and days 5-9 or days 1-4 and days 10-13 were statistically significant based on *t*-tests (independent sample and unequal variance; see Snedecor and Cochrane 1989, pp.96-98).

We conclude that rolling of positions by long-only index funds is unlikely to explain the increase in the size of nearby spreads experienced since late 2005. It is recognized that "second generation" index funds have less frequent or mechanical roll strategies and this may not be picked up by the test used here. Another possibility is that the presence of large index fund

positions changed the dynamics of deferred futures prices relative to nearby prices. We turn to testing this hypothesis in the next section.

Granger Causality Tests

The argument that large index fund positions changed the structure of futures price spreads relies upon well- established patterns of hedger and speculator trading in commodity futures markets. Petzel (2009, pp. 8-9) recently provided a useful synthesis of this argument:

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

This view implies that the initiation of large positions by index funds in a "crowded market space" is the problem not the rolling of index fund positions *per se*.

Testing the "crowded market" hypothesis with respect to nearby spreads in CBOT corn, soybean, and wheat futures requires data on the positions of index funds. Starting in 2007—in response to complaints by other market participants about the rapid increase in long-only index money flowing into the markets—the CFTC began reporting the weekly positions held by index traders in the *Commodity Index Traders* (CIT) report, as a supplement to the *Commitments of Traders* (COT) report. The *CIT* data are released each Friday in conjunction with the traditional *COT* report and show the combined futures and options positions as of the previous Tuesday's market close. The primary limitation of the *CIT* data is the lack of observations prior to 2006 when spreads tended to be smaller and non-convergence was not an issue. Fortunately, the

CFTC collected additional data for CBOT corn, soybeans, and wheat over 2004-2005 at the request of the U.S. Senate Permanent Subcommittee on Investigations (USS/PSI, 2009) and these additional observations are used in the present analysis.[14]

To correspond with the release dates for the *CIT* data, the percent of full carry is computed for nearest-to-expiration contracts on Tuesdays using equation (1). The percent of full carry and CIT data are available from January 6, 2004 through September 1, 2009 (296 weekly observations). Figure 5 contains charts of the carry and net long position of CITs for CBOT corn, soybeans, and wheat futures. The graphs highlight the rapid increase in commodity index positions that occurred from 2004 to 2006 in corn and wheat and 2004 to 2007 in soybeans. The net long position of index traders increased about seven times over these time intervals. A positive temporal relationship appears to exist between carry and CIT net positions. This should be viewed with some caution because the scale for carry is truncated at zero and this eliminates the impact of very large market inversions. Based on the full set of observations, the contemporaneous correlation coefficient between the carry and CIT net positions is relatively small for each of the three markets, 0.25 for corn, 0.14 for soybeans, and 0.18 for wheat. Nonetheless, all three of the correlations are statistically significant.

Sanders, Irwin, and Merrin (2009) and numerous other writers point out that a positive contemporaneous correlation does not necessarily imply a causal relationship. In the present case, the correlation may reflect the common reaction of positions and the carry structure in futures prices to fundamental supply and demand information or the correlation simply may be spurious. Granger causality is a standard linear technique for determining whether a "true" relationship exists between two time series. The basic idea is that if event *X* causes event *Y*, then

event *X* should precede event *Y* in time. In order to conduct Granger causality tests, the following regression model is estimated for each of the three commodities,

(2) $$Carry_t = \alpha + \sum_{i=1}^{m} \gamma_i Carry_{t-i} + \sum_{j=1}^{n} \beta_i \Delta CIT_{t-j} + \varepsilon_t$$

where $Carry_t$ is the Tuesday percent of full carry as defined above and ΔCIT_{t-j} is the measure of lagged commodity index trader positions. Some care is needed when interpreting statistical test results from Granger causality regressions. Hamilton (1994, p. 308) suggests it is better to describe Granger causality tests between *X* and *Y* as tests of whether *X* helps forecast *Y* rather than whether *X* truly causes *Y*.

The regression model is estimated via ordinary least squares (OLS) for lag lengths of 1 to 4 weeks (*m* and *n* = 1, 2, 3, and 4). The lag structure of the best-fitting model is selected using the Schwartz information criteria. The relatively short lag search and Schwartz criteria are used to minimize any data mining tendencies associated with the model selection procedure. If the residuals show evidence of heteroskedasticity then White's covariance estimator is used to correct the standard errors. If residuals demonstrate autocorrelation then the Newey-West covariance estimator is applied.

CIT positions in equation (2) are measured two ways in order to test the sensitivity of results to the measurement of index trader positions. The first position variable is the number of net long contracts held by CITs (long contracts – short contracts), the same variable shown in Figure 5. This measure probably best reflects what most observers mean when they argue that index positions are "too big." The second position variable is the net long position of CITs divided by total market open interest. This is a relative "market share" measure of the size of CIT positions. Augmented Dickey-Fuller (ADF) tests indicate both variables generally are non-stationary in levels over 2004-2009 for all three markets, and therefore, first differences of the

CIT variables are used to estimated equation (2). ADF tests on the percent of full carry over 2004-2009 generally indicate this variable is stationary in levels for corn, soybeans, and wheat, and hence, it is specified in level terms for estimation of the regressions.

Granger causality test results are shown in Table 3. Reported statistics include *p*-values for testing the null hypothesis of no causality from CIT positions to the carry $\left(H_0 : \beta_j = 0 \; \forall \, j\right)$, no autocorrelation in the carry $\left(H_0 : \gamma_i = 0 \; \forall \, i\right)$, and the joint null hypothesis of no autocorrelation in the carry and no causality from CIT positions to the carry $\left(H_0 : \gamma_i = \beta_j = 0 \; \forall \, i, j\right)$. Estimates of the long-run multiplier for the carry with respect to changes in CIT positions are reported in order to provide information on the sign and magnitude of estimated relationships.[15] The multipliers assume full "long-run" dynamic adjustment of the carry to changes in CIT positions (Hendry 1996, pp.213) and can be interpreted in elasticity terms.

Not surprisingly, the null hypothesis of no autocorrelation in the percent of full carry is rejected for all models presented in Table 3. Estimated first lag coefficients ranged from about 0.6 to 0.8, indicating strongly positive autocorrelation in the carry. In contrast, the null hypothesis that CIT positions do not cause the carry is not rejected in any case when positions are measured as the number of net long contracts (Panel A, Table 3). Note that corn and soybean regression models are estimated using two sample periods, the full sample period, 2004-2009, and a shorter sample, 2005-2008. The latter sample eliminates periods with extreme inversions in 2004 and 2009. For example, the minimum percent of full carry in soybeans during 2004 was -3,777%. These inversions result in suspiciously large, negative point estimates on lagged CIT position changes. This is particularly striking in soybeans where the long-run multiplier drops from -11.482 to -0.189 when the trimmed sample is considered. Nonetheless, all of the estimates

of the long-run multiplier are negative, just the opposite of that predicted by the "crowded market" hypothesis.

The null hypothesis that CIT positions do not cause the carry is rejected for both corn regression models but none of the soybean or wheat models when positions are measured as a percent of total market open interest (Panel B, Table 3). However, the direction of the relationship in corn is negative not positive as expected. The smaller of the two multiplier estimates indicates a one-percentage point increase in CIT market share in corn implies a 6.5 percentage point drop in the carry. While insignificant, the negative point estimates of the long-run impact are also of a surprisingly large magnitude in soybeans and wheat.

The Granger causality test results allow one to confidently conclude that index fund positions are not associated with an expansion of the nearby spreads in CBOT corn, soybeans, and wheat futures. The evidence is simply inconsistent with the argument that large positions by index funds sharply expand spreads in a "crowded market space." In fact, the evidence points in just the opposite direction. It is possible that the large addition to market liquidity provided by index funds actually provided a brake on the expansion of the spreads in the grain markets during the last several years. However, given the overall lack of statistical significance between the percent of full carry and index fund positions and the sensitivity of estimates to the presence of large market inversions, this conclusion should be considered suggestive at best.

Other Factors

If index funds are not responsible for the expansion of the carry and non-convergence in CBOT corn, soybean, and wheat futures, it is natural to ask what was responsible. One possible factor is CBOT contract storage rates that simply lagged behind market storage rates, which would, all

else equal, result in a rise in the percent of full carry. The CBOT conducted a storage cost survey of 47 firms in mid-2008 to assess this possibility. Survey results indicated that storage rates (mainly at interior country elevators) averaged approximately 4.3, 4.6, and 7.1 cents per bushel per month for corn, soybeans, and wheat, respectively. Costs for corn and soybeans are near the storage rates on CBOT contracts at the time the survey was taken (4.5 cents per bushel), which makes it difficult to argue that the large carry in corn and soybeans at the time was due to CBOT contract storage rates that were too low in relation to commercial storage rates. However, commercial storage rates are substantially higher for wheat in comparison to the CBOT contract rate at the time (also 4.5 cents per bushel). This supports the view that low contract rates contributed to the large carry in wheat.

As noted earlier, large carries in corn and soybeans began to disappear in very late 2008 and relatively smaller carries persisted into September 2009 (Figure 2). As a result, convergence performance was good for the January through September 2009 soybean contracts (and the November 2008 contract late in the delivery period) and the March through September 2009 corn contracts (Figure 1). The reason for large carry markets giving way to smaller spreads is not clear and it does not appear to be entirely explained by the increase in CBOT storage rates that began with the November 2008 soybean contract and the December 2008 corn contract. The absolute size of spreads declined, not just the spreads as a percent of full carry, and the soybean market actually became inverted.

It is instructive to note how the recent situation in corn and soybeans contrasts with the period of non-convergence that emerged in 2000. The shipping certificate delivery system was introduced for the March 2000 corn and January 2000 soybean contracts and storage rates on January 1, 2000 were dropped from 4.5 to 3.0 cents per month for Illinois River shipping stations

and from 4.5 to 3.6 cents per month for Chicago. Poor convergence was observed, particularly in corn, for the March through September 2000 contracts and the storage rate was raised back to 4.5 cents per month for all locations on October 31, 2001. This was a clear instance of non-convergence being associated with CBOT storage rates at below market rates.

For wheat, poor convergence continued through the May 2009 contract (Figure 1), suggesting that if low maximum allowable storage rates were the cause of full carry markets, the increase in rates to 5 cents per month was not large enough. Beginning with the July 2009 contract, the maximum allowable storage rate was increased seasonally to 8 cents per bushel per month for the July 18th through December 17th period. Based on the most recent CBOT survey of commercial storage rates, 8 cents appears to equal or exceed the actual cost of commercial storage and it would have been reasonable to expect this to reduce the incidence of full carry markets and contribute to better convergence performance. However, spreads simply ended up expanding enough to offset the increase in the storage rate and carry remained near 100% through expiration of the September 2009 CBOT wheat contract. This suggests that additional factors contributed to the persistently large carry in wheat.

One possibility is structural problems with contract design that lead to congestion in the delivery process and distortion of cash and futures prices. Hieronymus (1977, p.341) summarizes the issue as follows,

> "Delivery on futures contracts is a sampling of value process. The objective is to get a representative sample. There must be a sufficient amount of the commodity move to and through the delivery points that no one can control and distort the price. The amount must be large enough that the price is representative of the value of the commodity generally so that the relationships with prices at other points of commerce are rational."

Figure 6 shows the annual commercial shipments of grain through facilities regular for delivery of CBOT corn, soybeans, and wheat over 1975 through 2008.[16] Declining commercial activity

in the corn and soybean markets led to a change in delivery locations in 2000 for these contracts and the magnitude of commercial activity at delivery locations increased sharply as a result. Commercial activity through facilities regular for delivery of wheat has been persistently small, even in comparison to corn and soybeans before the 2000 change in delivery locations. This suggests that CBOT wheat delivery markets are out of position.

It is interesting to note that concerns about delivery specifications of the wheat contract stretch all the way back to the 1920s (Gray and Peck 1981). The fundamental problem is that changes in wheat production patterns, transportation logistics, and trade flows have left the contract with an increasingly narrow commercial flow of wheat to draw upon in the delivery process. However, this problem pre-dated recent non-convergence problems; it is not obvious how conditions changed in a way that would have contributed to explaining the recent poor basis and convergence performance.

The CBOT attempted to address congestion issues with the addition of delivery locations for wheat in Northwest Ohio (shuttle trains) and at selected Ohio and Mississippi River barge shipping stations starting with the July 2009 contract. The pricing differentials for the new delivery locations do not appear to be "safety-valve" differentials in the sense that the new locations are expected to be used for delivery only under unusual market conditions. Despite the competitive nature of the new delivery locations, spreads remained wide and convergence very poor for the July and September 2009 wheat contracts.

Some type of change in underlying supply and demand conditions that is common to all three grain futures markets seems like a more promising explanation for the large carry and attendant non-convergence. One possibility along these lines is suggested by Pirrong (2008). He develops a theoretical model where a positive shock to the variance of fundamental market

uncertainty increases the precautionary demand for commodity stocks. This increased demand is then expressed in the market through an increase in spot prices, which leads to a decrease in consumption and an increase in production, and hence, an increase in stocks. In turn this leads to an increase in the expected price of storage, as reflected in an increase in the spread between near and deferred futures. The implication of this theory is that an additional term should be added to the conventional view of the determinants of spreads in futures contracts for storable commodities,

(3) Spread = Storage Cost + Interest Cost - Convenience Yield + Risk Premium.

An increase in the risk premium component of corn, soybean, and wheat spreads is consistent with the high level of market volatility experienced in recent years. Nonetheless, the existence of this additional risk premium component in spreads has not been confirmed by empirical testing.

Summary and Conclusions

Chicago Board of Trade (CBOT) corn, soybean, and wheat contracts since late 2005 experienced lengthy episodes of poor convergence performance. Performance has been consistently weakest in wheat, with delivery location basis at times exceeding one dollar per bushel. A public and heated debate has erupted about the factors responsible for the non-convergence. Much of the debate has focused on the trading activities of 'long-only' index funds. These new market participants are widely thought to have inflated futures prices and/or expanded spreads between futures prices (e.g., USS/PSS, 2009).

The purpose of this paper is to evaluate the role of index funds in the recent convergence problems of CBOT corn, soybean, and wheat futures contracts. The first part of the analysis

demonstrates how large spreads in futures markets contribute to lack of convergence by uncoupling cash and futures markets. The second part of the analysis tests whether index fund trading expanded spreads in CBOT corn, soybean, and wheat futures. Statistical test results provide no evidence that rolling of positions by index funds or the initiation of large index positions in a "crowded market space" contribute to an expansion of the spreads. Since the statistical evidence does not support allegations that index funds are ultimately responsible for non-convergence problems in the three CBOT futures markets, other factors are examined that may have contributed to the rising spreads. A combination of CBOT contract storage rates that lagged market rates and a change in underlying supply and demand conditions that was common to all three grain futures markets appears to be the most promising avenue for explaining the large carry and attendant non-convergence.

Further research is needed to better understand several policy issues related to recent non-convergence problems. For example, the CBOT recently proposed a variable storage rate rule in a further attempt to address convergence problems in wheat (see CFTC 2009). It is uncertain whether this rule change will solve the problems in wheat or whether it will introduce new instabilities. The CBOT wheat contract also appears to be widely used to trade "wheat" generically. In contrast, the delivery market locations make the contract a soft red winter wheat contract at maturity. This potential disconnect is acknowledged by the industry and CBOT but the full implications have not been investigated. Other more theoretical questions also need to be addressed. Is there a rational economic explanation for the rise in the carry in corn, soybean, and wheat futures markets the last several years? What are the incentives and actions of all of the players in the delivery process? In particular, what are the incentives of firms that are regular for delivery to provide the shipping certificates desired by longs?

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Endnotes

[1] While the CBOT is now part of the CME Group, Inc., the CBOT remains the self-regulatory organization that is approved by the Commodity Futures Trading Commission (CFTC) to list the corn, soybean, and wheat futures contracts for trading.

[2] Cash prices for corn and soybeans are adjusted for location and grade differentials specified in CBOT contract rules. All cash price data are obtained from the Agricultural Marketing Service of the U.S. Department of Agriculture (http://marketnews.usda.gov/portal/lg). Settlement prices are used for futures. Basis is computed as cash price minus futures price.

[3] In reality, a variety of investment instruments are lumped under the heading "commodity index fund." Individuals may enter directly into over-the-counter (OTC) contracts with swap dealers to gain the desired exposure to returns from a particular index of commodity prices. Some firms also offer investment funds whose returns are tied to a commodity index. Exchange-traded funds (ETFs) and structured notes (ETNs) have also recently been developed to make it even easier to gain commodity exposure. ETFs and ETNs trade on securities exchanges in the same manner as stocks on individual companies. See Engelke and Yuen (2008) and USS/PSS (2009) for further details.

[4] Standard arbitrage theory also predicts that delivery for a commodity futures contract with multiple delivery locations will occur at the "cheapest-to-deliver" location, as this location will provide makers of delivery (shorts) the lowest cost alternative for sourcing the grain to satisfy delivery obligations.

[5] The CBOT Rulebook contains complete details on the delivery process (http://www.cmegroup.com/rulebook/CBOT/I/7/7.pdf).

[6] Similar incentives are at work when the delivery instrument is a warehouse receipt, as with wheat before July 2008. The main difference is that the supply of warehouse receipts is limited by total storage capacity at delivery locations.

[7] We follow previous researchers and focus our analysis on the first day of delivery (third and final day of the three day delivery sequence). Similar results are found for other dates, such as the final day of delivery, and are available from the authors upon request.

[8] Also note that marginal convenience yield in percent of full carry terms can be computed by simply subtracting the percent of full carry from 100. Convenience yield is the operational benefit derived by inventory holders from holding stocks (Working 1949).

[9] The simple correlation coefficient between the carry and basis at these locations is -0.49 for corn, -0.22 for soybeans, and -0.48 for wheat.

[10] At first glance, November 2008 in soybeans appears to be an anomaly in the relationship. In fact, basis on the first day of delivery for this contract was likely distorted by an extremely large spike in barge rates due to a backup of unsold fertilizer in the supply chain. By the last day of the delivery period for the November 2008 soybean contract, basis narrowed to -13.25 cents per bushel.

[11] St. Louis is a delivery location for soybeans and wheat but is excluded from the analysis because to date it has been rarely used as a delivery location.

[12] http://www2.goldmansachs.com/services/securities/products/sp-gsci-commodity-index/roll-period.html.

[13] September contracts for corn and wheat and August and September contracts for soybeans are excluded from the analysis because index funds typically do not trade in these relatively low volume contract months.

[14] The authors are indebted to the staff of the U.S. Senate Permanent Subcommittee on Investigations for providing the 2004-2005 index trader position data.

[15] When CIT position changes are measured in terms of net long contracts the long-run multiplier is computed as: $\left(\overline{\Delta CIT}\cdot\sum_{j=1}^{n}\beta_i\right)\Big/\left(1-\sum_{i=1}^{m}\gamma_i\right)$. When CIT position changes are measured as percent of total open interest the long-run m is computed as: $\left(\sum_{j=1}^{n}\beta_i\right)\Big/\left(1-\sum_{i=1}^{m}\gamma_i\right)$.

[16] Shipments for Toledo wheat over 1989-1996 could not be located. Missing observations for these years were replaced by the average level of shipments over all other years in the sample.

Table 1. Average Delivery Location Basis on the First Day of Delivery for CBOT Corn, Soybean, and Wheat Futures when Nearby Spreads are Below and Above 80% of Full Carry, January or March 2000 - September 2009 Contracts

Commodity/ Delivery Location	Average Delivery Location Basis: Below 80% of Full Carry	Average Delivery Location Basis: Above 80% of Full Carry	Difference	t-statistic
		---cents/bu.---		
Corn				
Chicago	-3.1	-14.3	11.2 ***	4.37
Illinois River North of Peoria	-3.2	-20.8	17.6 ***	5.21
Soybeans				
Chicago	-9.3	-25.8	16.5 ***	5.37
Illinois River North of Peoria	-14.3	-35.9	21.5 ***	3.31
Illinois River South of Peoria	-17.1	-33.1	-16.0 ***	3.09
Wheat				
Chicago	-8.1	-35.7	27.6 ***	2.84
Toledo	-4.3	-45.3	41.0 ***	5.46

Notes: Cash prices for corn and soybeans are adjusted for location and grade differentials specified in contract rules. Settlement prices are used for futures. Basis is computed as cash price minus futures price. One, two, and three stars denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 2. Average Nearby Spreads for CBOT Corn, Soybean, and Wheat Futures during the Roll Window of Long-Only Index Funds, March 1995 - July 2009 Contracts

	Average Nearby Spread during Roll Window				
Commodity/Contracts	**Days 1-4**	**Days 5-9**	**Days 10-13**	***t*-statistic 1**	***t*-statistic 2**
		---% of full carry---			
Corn					
March 1995 - December 2001	25.6	28.3	23.6	-0.103	0.074
March 2002 - December 2003	40.9	45.8	40.3	-0.367	0.041
March 2004 - December 2005	66.9	76.7	74.0	-0.882	-0.653
March 2006 - July 2009	96.1	97.9	95.3	-0.356	0.166
March 1995 - July 2009	50.8	54.5	50.5	-0.276	0.021
Soybeans					
March 1995 - November 2001	19.4	16.8	4.5	0.096	0.482
January 2002 - November 2003	-7.3	-2.0	-2.7	-0.229	-0.218
January 2004 - November 2005	31.3	35.6	27.5	-0.257	0.211
January 2006 - July 2009	42.8	20.5	13.6	0.291	0.372
March 1995 - July 2009	23.4	17.5	8.8	0.245	0.576
Wheat					
March 1995 - December 2001	43.4	55.1	52.0	-0.613	-0.443
March 2002 - December 2003	47.2	59.8	50.7	-0.820	-0.198
March 2004 - December 2005	85.5	91.0	84.7	-1.128	0.164
March 2006 - July 2009	109.1	110.9	105.0	-0.417	0.921
March 1995 - July 2009	65.9	74.4	69.4	-0.824	-0.332

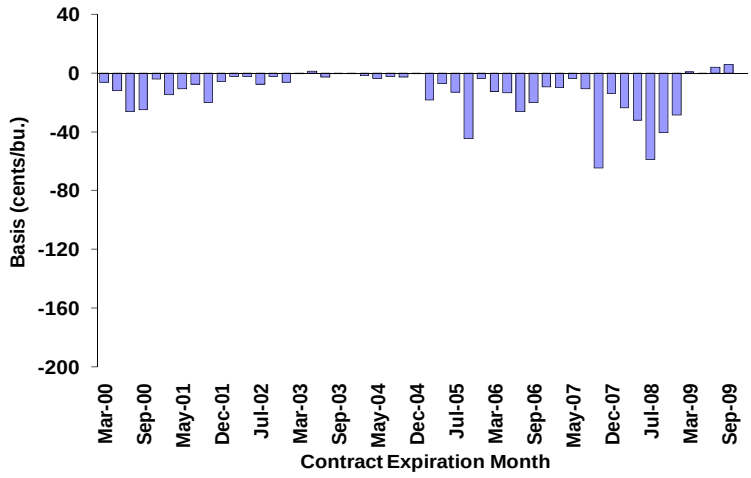
Notes: The event window for each contract is the first 13 business days of the calendar month prior to contract expiration. The time window is centered on days 5-9, the time period of the "Goldman roll" where index funds tend to roll their positions from the nearby to the next deferred contract. The hypothesis tested by the *t*-statistic 1 is that the average spread on days 1-4 equals the average spread on days 5-9. The hypothesis tested by the *t*-statistic 2 is that the average spread on days 1-4 equals the average spread on days 10-13.

Table 3. Granger Causality Test Results for the Null Hypothesis that Weekly Commodity Index Trader (CIT) Positions do not Cause Spreads in CBOT Corn, Soybean, and Wheat Futures, January 6, 2004 - September 1, 2009

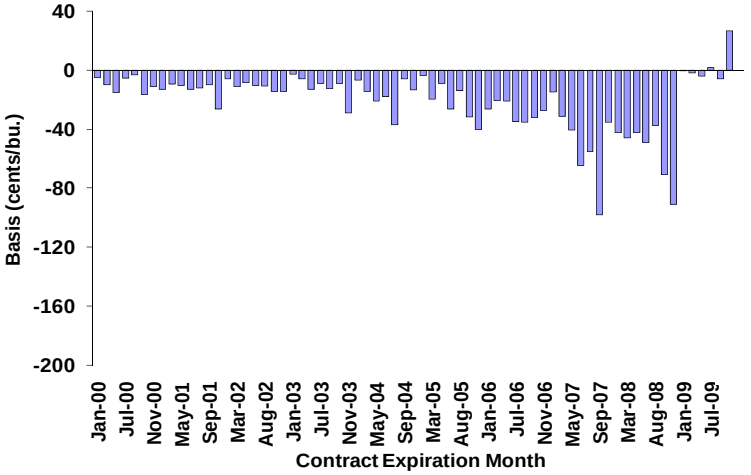
Market	Sample Period	*m,n*	*p* -values for Hypothesis Tests			Long-Run Multiplier
			$\beta_j = 0, \ \forall j$	$\gamma_i = 0, \ \forall i$	$\gamma_i = \beta_j = 0, \ \forall i,j$	
Panel A: CIT Positions Measured in Net Long Contracts						
Corn	2004-2009	1,1	0.120	0.000	0.000	-0.583
Corn	2005-2008	1,1	0.285	0.000	0.000	-0.150
Soybeans	2004-2009	2,2	0.431	0.000	0.000	-11.482
Soybeans	2005-2008	2,2	0.695	0.000	0.000	-0.189
Wheat	2004-2009	2,2	0.683	0.000	0.000	-0.398
Panel B: CIT Positions Measured in Percent of Market Open Interest						
Corn	2004-2009	1,1	0.029	0.000	0.000	-14.175 **
Corn	2005-2008	1,1	0.002	0.000	0.000	-6.532 ***
Soybeans	2004-2009	2,2	0.245	0.000	0.000	-314.154
Soybeans	2005-2008	2,2	0.136	0.000	0.000	-29.901
Wheat	2004-2009	2,2	0.808	0.000	0.000	-1.209

Note: The reported *p* -values test, respectively, the null hypothesis of no causality from CIT positions to the carry, no autocorrelation in the carry, and the joint null hypothesis of no autocorrelation in the carry and no causality from CIT positions to the carry. One, two, and three stars denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Corn, Illinois River North of Peoria



Panel B. Soybeans, Illinois River South of Peoria



Panel C. Wheat, Toledo

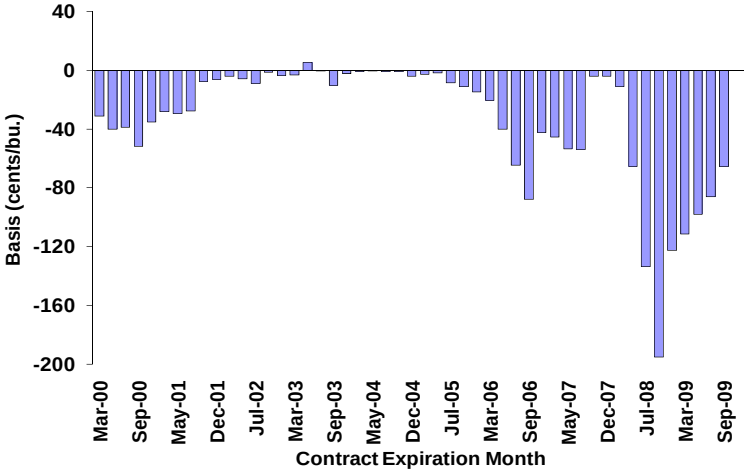
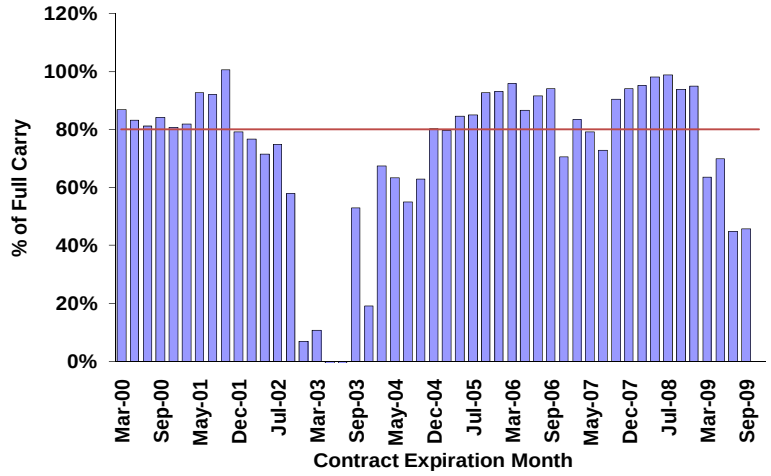
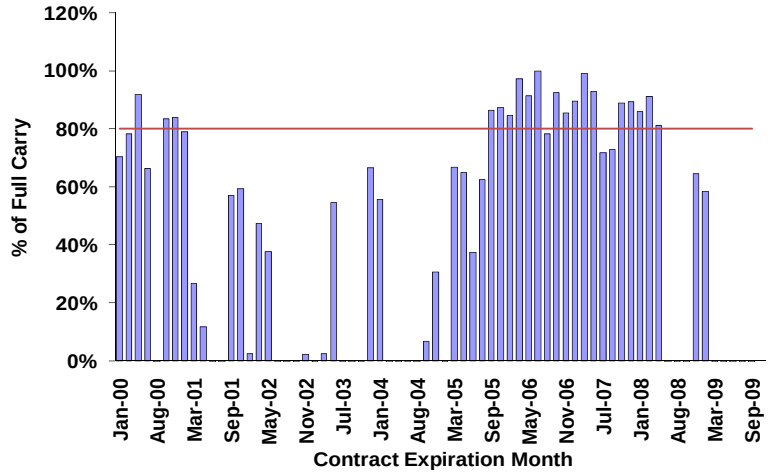


Figure 1. Basis (cash minus futures) on the First Day of Delivery at Selected Delivery Locations for CBOT Corn, Soybean, and Wheat Futures, January or March 2000 - September 2009 Contracts

Panel A. Corn



Panel B. Soybeans



Panel C. Wheat

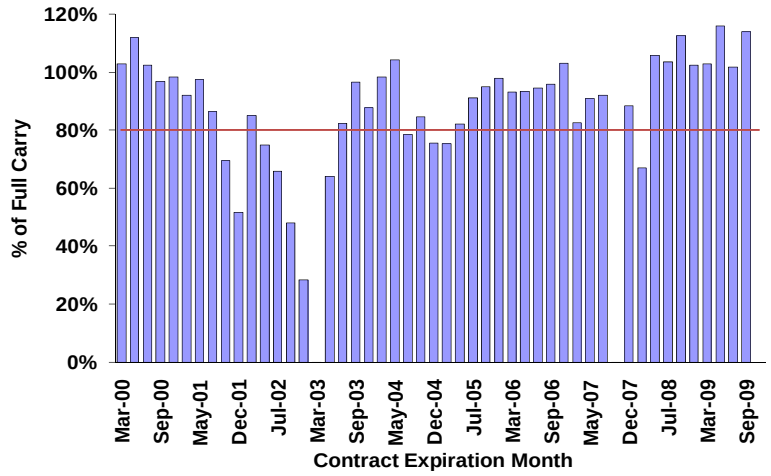
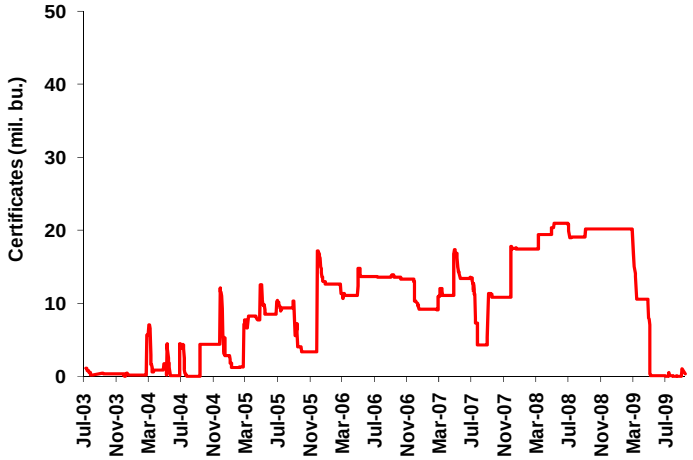
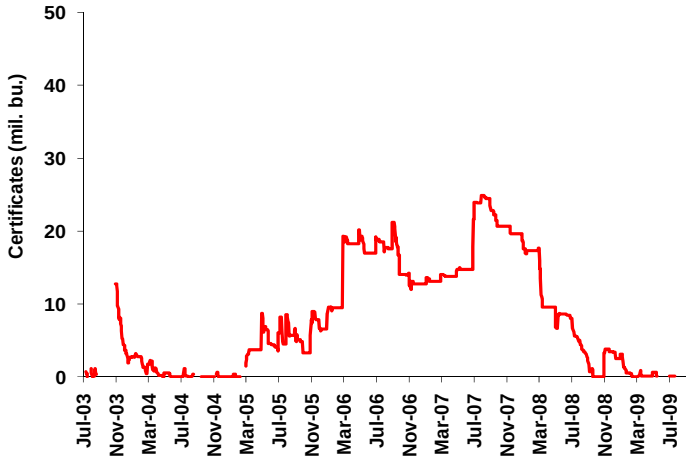


Figure 2. Spread (percent of full carry) on the First Day of Delivery between Prices of the Expiring and Next-to-Expire Contracts for CBOT Corn, Soybean, and Wheat Futures, January or March 2000 - September 2009 Contracts

Panel A. Corn



Panel B. Soybeans



Panel C. Wheat

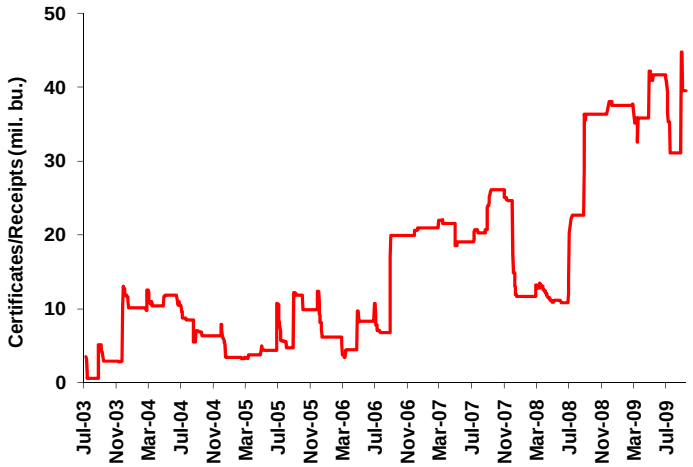
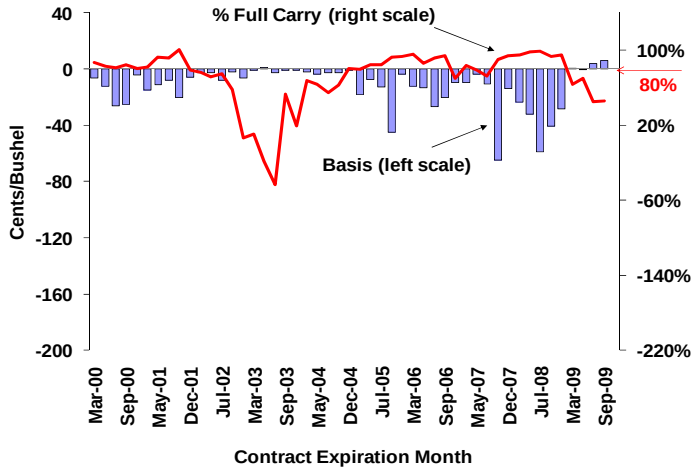
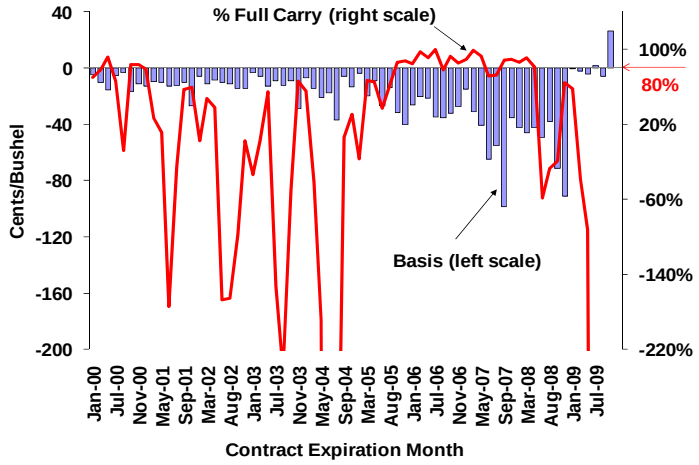


Figure 3. Daily Total of Registered Shipping Certificates or Warehouse Receipts for CBOT Corn, Soybean, and Wheat Futures, July 11, 2003 - September 15, 2009

Panel A. Corn, Illinois River North of Peoria



Panel B. Soybeans, Illinois River South of Peoria



Panel C. Wheat, Toledo

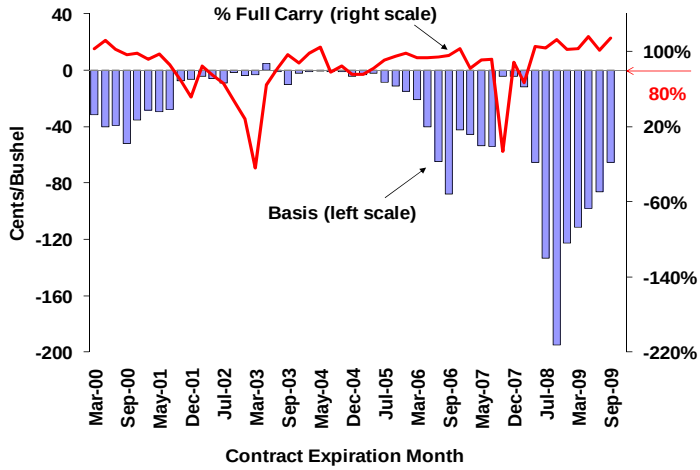
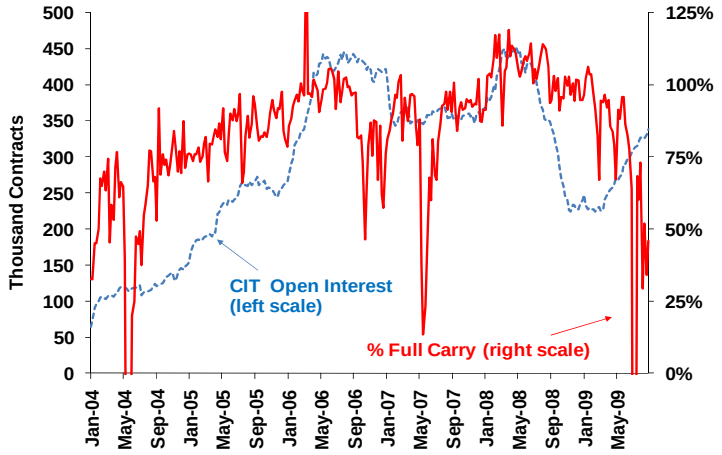
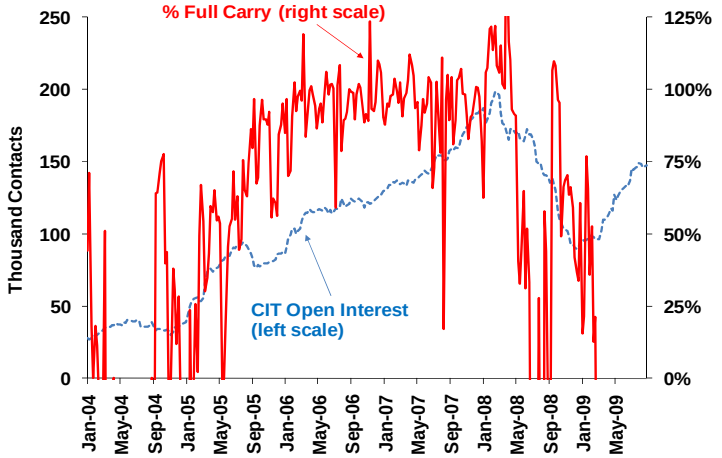


Figure 4. Basis and Percent of Full Carry on the First Day of Delivery at Selected Delivery Locations for CBOT Corn, Soybean, and Wheat Futures, January or March 2000 - September 2009 Contracts

Panel A. Corn



Panel B. Soybeans



Panel C. Wheat

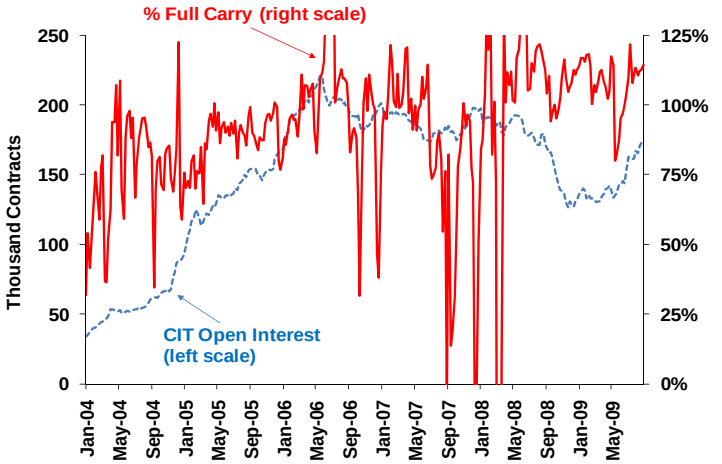
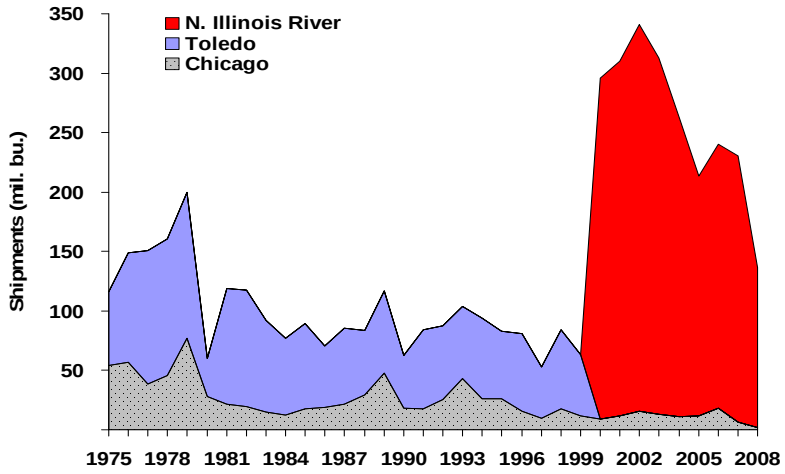
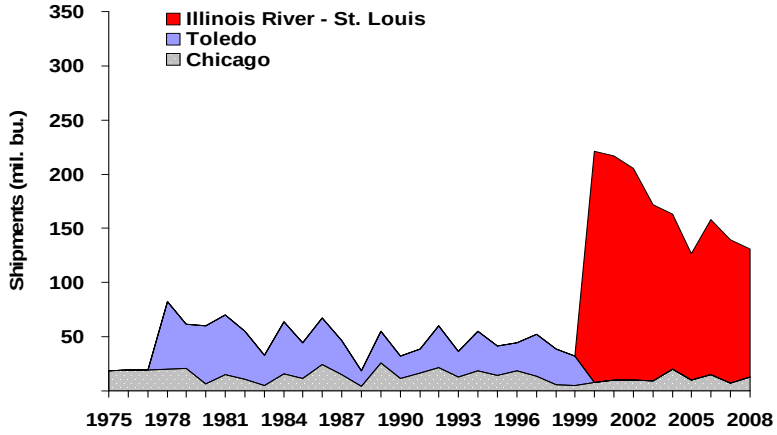


Figure 5. Weekly Net Long Open Interest of Commodity Index Traders (CIT) and Percent of Full Carry for CBOT Corn, Soybean, and Wheat Futures, January 6, 2004 - September 1, 2009

Panel A. Corn



Panel B. Soybeans



Panel C. Wheat

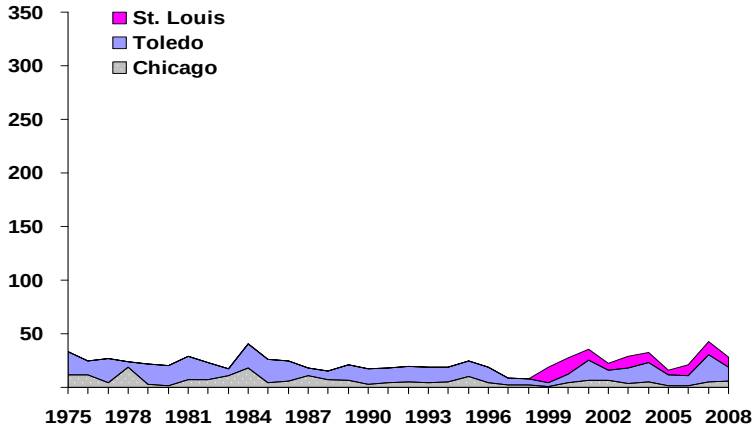


Figure 6. Annual Commercial Shipments at Facilities Regular for Delivery of CBOT Corn, Soybean, and Wheat Futures, 1975-2008.