The Effects of Hurricane Katrina on Corn, Wheat and Soybean Futures Prices and Basis

Angel Lara-Chavez* **and Corinne Alexander**

PROSPECTUS FOR:

2006 NCR-134 Conference on Applied Commodity Price Analysis,

Forecasting and Market Risk Management

St. Louis Missouri, April 18-19, 2006,

*Graduate student and Assistant Professor in the Department of Agricultural Economics at Purdue University.

The Effects of Hurricane Katrina on Corn, Wheat and Soybean Futures Prices and Basis

Abstract

Hurricane Katrina caused considerable damage to transportation infrastructure, grain export facilities, and to some crop areas in 2005. Assuming that financial market participants considered the disruption of the grain transportation system by Katrina as having an important impact on fundamental supply and demand factors, futures and/or national basis would subsequently adjust. The objective of this research was to determine the reaction in corn, wheat, and soybean futures and basis due to Katrina using an event study methodology. One parametric (Constant mean return) and one nonparametric procedure (Corrado's rank test) were used to define whether there were statistically significant abnormal returns. During Katrina abnormal returns were larger on the wheat futures market than on the corn and soybean futures markets, which could be partially explained by the timing of the Katrina's landfall with the grain export activities. However, there were only a few statistically significant daily abnormal returns in the futures prices due to the hurricane. There was some evidence of significant cumulative abnormal returns in the corn and wheat futures markets prior to and surrounding the Katrina's landfall. In conclusion, the majority of the corn market reaction to Katrina's damage occurred in the basis and not in the futures market. For the soybean market there was weak evidence of significant reaction in both basis and futures prices. In the case of wheat, the basis was not evaluated and wheat futures prices reacted to the disruption caused by Katrina. The reaction in the corn, wheat and soybean futures prices due to Katrina could have being moderated by the presence of large stocks and large expected production levels of these grains in 2005 or simply by the fact that the damage caused by the hurricane did not affect fundamental supply and demand factors; rather, they only affected transportation logistics.

Key words: Katrina, Futures, Basis, Event study

Introduction

Hurricane Katrina is considered as one of the most devastating natural disasters in U.S. history (Knabb, Rhome, and Brown 2005). On August 29, 2005, Katrina made its final landfall at the Mississippi border as a Category 3 hurricane[1]. Katrina caused considerable damage to the transportation infrastructure, grain export facilities, and crop areas in the Mississippi region. In 2004, 54 percent of the grain exported from the U.S. was moved through the Mississippi River, demonstrating the river's importance to the U.S. grain trade. Moreover, barge deliveries via the Mississippi region decreased considerably after Katrina and had not returned to normal levels, even two months following the storm (USDA-AMS, 2005).

This disruption of the grain transportation system may have decreased the demand of grains in U.S. and consequently had a negative effect on cash prices. A market is efficient when its prices represent all relevant and available information (Fama et al. 1969). Futures prices reveal market expectations regarding supply and demand (Peterson and Tomek, 2000). Therefore, if financial market participants considered the disruption of the grain transportation system by Katrina as having an important impact on fundamental supply and demand factors, futures prices and/or basis would subsequently adjust. The objective of this research was to determine the reaction in corn, wheat, and soybean futures and basis on the days surrounding Katrina's landfall.

The event study methodology is an analysis that determines whether there is a significant reaction in markets to an event that is hypothesized to affect commodity price behavior. Event studies have been used to evaluate the effects of information on a diverse array of events in the agricultural industry. Milonas (1987) examined the effects of USDA crop forecasts on agricultural cash and futures prices. McKenzie and Thomsen (2001) studied the effect of recalls for *E. Coli* O157:H7 on live cattle cash and futures prices. Hendson and Mazzocchi (2002) evaluated the economic impact of the announcement made by UK government regarding the link between Bovine Spongiform Encephalopathy (BSE) and human health on the beef and beef-related industries. King, Wilson and Naseem (2002) evaluated the effect on the stock prices of the firms involved in the announcement of the two largest mergers and acquisitions in the agricultural industry, the merger of Astra and Zeneca, and DuPont's acquisition of Pioneer. Most recently, Rucker, Thurman and Yoder (2005) developed a novel model--the distributional event response model (DERM) -- which allowed them to evaluate and compare the effects of three types of events on lumber futures prices. Furthermore, event study research in other fields has shown that the market value of insurance firms is significantly affected by catastrophic events, such as hurricanes (Angbazo and Narayanan 1996; Lamb 1998).

[1] The Saffir-Simpson Hurricane Scale is a 1-5 rating, where as larger is the number as larger is the hurricane's intensity.

Data and Methodology

Event study is an important methodology that measures the economic effects of a particular event on a firm, industry or market through the evaluation of asset prices (MacKinlay, 1997). Based on MacKinlay (1997), the event-study methodology consists of the following steps: 1) determination of the events of interest and the event window; 2) selection of the sample of commodity prices to include in the analysis; 3) estimation of normal returns during the estimation period; 4) calculation of abnormal returns within the event window; and 5) determination of whether the abnormal returns are statistically different from zero.

According to Mckenzie, Thomsen, and Dixon (2004), two of the most used parametric and nonparametric procedures in event studies on agricultural futures markets are the constant mean return (CMR), and the Corrado's rank test, respectively. Parametric procedures depend on assumptions regarding the return distribution. An alternative method to analyze the economic impact of events with a return distribution that is not normally distributed is to use nonparametric tests (Corrado, 1989; Cowan, 1992). Nonparametric tests do not require the same rigorous assumptions regarding return distributions as parametric tests. Thus, one parametric (CMR) and one nonparametric procedure (Corrado's rank test) were used to define whether there was a statistically significant effect on corn, wheat, and soybean futures prices and basis from the disruptions that occurred in the grain transportation system due to Katrina.

This research used the daily futures prices for December 2005 corn and wheat and the November 2005 soybean contracts from the Chicago Board of Trade. Additionally, the daily cash prices for corn and soybean were the National corn index (NCI) and the National soybean index (NSI) respectively. These indexes are calculated by the Minneapolis Grain Exchange (MGEX, 2006) and are an average of the daily cash price from approximately 90% of elevator bids in U.S. (Figure 1 and Figure 2). The basis analysis did not include wheat because of the difficulty of finding a National wheat cash price index. Two corn basis series (September and December) and two soybean basis series (September and November) were analyzed.

CMR

Even though CMR is considered to be the simplest procedure to evaluate event studies, research has found that CMR usually obtains similar results and conclusions to those obtained from more complex procedures (Brown and Warner, 1985; MacKinlay, 1997). However, a recent simulation study by Mckenzie, Thomsen, and Dixon (2004) has criticized the common methodology of using a short 8-day estimation period in the CMR procedure. These authors found that the use of short normal periods causes CMR to falsely reject the null hypothesis (Type

I error). Instead, these researchers found that a CMR model using an estimation period of 61 days is appropriate for evaluating the null hypothesis.

Since most of the research done in the futures market has used a short estimation period of 8 days, two estimation periods were selected in order to assess their performance: an 8- and a 61-day period. The estimation period was determined as the following: (T_1, T_2), where T_1 is the first day, and T_2 is the last day of the estimation period (Figure 3). The event period begins at $\tau_A = T_2 + 1$ and ends on the day τ_B . The event day (τ_0) for Katrina was considered to be the day of the hurricane landfall: August 29, 2005.

Returns were defined as daily percentage changes in the price of the commodity futures and were calculated as follows:

$$R_{it} = \ln(P_{it} / P_{it-1}) \times 100 \quad (1)$$

where R_{it} is the daily percentage change in the price return, and P_{it} is the observed *i* commodity futures price on day *t*. The normal return is defined as R_h and is the average of R_{it} calculated over the estimation period. Both the 8- and 61-day estimation periods for Katrina overlap with the occurrence of the crop production report released by the USDA on August 12th. Most research has found that crop production reports cause abnormal returns on corn, wheat, and soybean futures prices (Milonas, 1987; Sumner and Mueller, 1989; Fortenbery and Sumner 1993). To obtain a representative estimation of normal returns, the exact, previous and following days of the release of the crop production report were excluded from the estimation periods.

The abnormal returns (AR_{it}) were estimated for each commodity *i* on each day *t* during the event window as the difference between the observed and the normal returns:

$$AR_{it} = R_{it} - R_h \quad (2)$$

The total reaction of commodity *i* during hurricane Katrina can be determined through the aggregation of abnormal returns into a cumulative abnormal return (CAR):

$$CAR_i(\tau_A, \tau_B) = \sum_{t=\tau_A}^{\tau_B} AR_{it} \quad (3)$$

Thus, CAR_i represents the total impact of the hurricane Katrina on commodity *i* during the event window (τ_A,τ_B). To determine whether Katrina had a negative impact on commodity *i* futures prices, the following hypothesis was tested:

$$Ho: CAR_i(\tau_A, \tau_B) \geq 0 \quad Ha: CAR_i(\tau_A, \tau_B) < 0$$

Similarly, to define whether Katrina had weakened basis on commodity *i* the following null hypothesis was tested:

$$Ho: CAR_i(\tau_A, \tau_B) \leq 0 \quad Ha: CAR_i(\tau_A, \tau_B) > 0$$

The test statistic (T_{CMR_i}) to test the null hypothesis was:

$$T_{CMR_i} = \frac{CAR_i}{\sqrt{\text{var}(CAR_i)}} \tag{4}$$

where the variance of CAR_i was the following:

$$\text{var}(CAR_i) = \frac{1}{N-1}\sum_{t=\tau_A}^{\tau_B}\left(AR_{it} - \overline{AR}_{it}\right)^2 \times (\tau_B - \tau_A + 1) \tag{5}$$

T_{CMR} follows a t-student distribution with total degrees of freedom equal to the number of days in the estimation period minus one (N - 1). Additionally, the daily abnormal return $CAR_i = AR_i$ can be evaluated with the CMR t-test (T_{CMR}) of Equation 4.

CAR values were estimated for three event windows: (τ_{-4}, τ_0), (τ_{-2}, τ_2) and (τ_0, τ_4).The event window (τ_{-4}, τ_0) estimated the reaction of the market in anticipation of the hurricane landfall. Conversely, (τ_0, τ_4) evaluated the effect on the commodity prices as the market was assimilating the reports of damage, and (τ_{-2}, τ_2) measured the market reaction surrounding the hurricane landfall.

Corrado's rank test

Corrado's ranking procedure transforms the distribution of returns into a uniform distribution across the possible rank values, regardless of any asymmetry in the original distribution (McKenzie and Thomsen, 2001). Additionally, the rank test combines the estimation and event periods and determines a rank for each daily return (Cowan, 1992). Thus, rank one corresponds to the smallest abnormal return, while the largest rank corresponds to the largest abnormal return (Cowan, 1992). K_{it} represents the rank of the abnormal return AR_{it} in the daily abnormal return. The mean rank is one-half plus half the number of observed returns ($Kmean_i$). The rank test statistic Z_{RANKi} for the event window, composed of τ_A through τ_B, is the following:

$$Z_{RANK_i} = d^{\frac{1}{2}} \frac{K_h - Kmean_i}{\left[\sum_{i=1}^{K}\left(K_i - Kmean_i\right)^2 / K\right]^{1/2}} \tag{6}$$

where d is the number of days in the event window, K_h is the average rank across the event window, K_i is the average rank across the estimation and event periods, and K is the combined number of trading days in the estimation and event periods. Furthermore, Z_{RANKi} follows a t-student distribution, with K-1 degrees of freedom.

Results

Futures

A summary of public news regarding Katrina's progress was collected from LexisNexis and Factiva (Table 1). Under the assumption that grain markets are efficient markets, all relevant and available information should be included in current asset prices (Fama et al., 1969). In addition, following the hypothesis that Katrina may have decreased the demand of grains because of the transportation disruption, and consequently to cause a negative effect on cash and/or futures prices. It is expected that financial markets would consider information regarding the development of the hurricane over time and space as valuable information. Thus, these news reports may partially explain the commodity futures price behavior before and after the hurricane.

On Tuesday, August 23rd (τ_{-4}), Katrina was considered a tropical depression and was predicted to hit the eastern site of the Gulf of Mexico (Table 1). For corn futures prices (Table 2) and wheat futures prices (Table 3), the abnormal returns obtained for τ_{-4} were negative in both the CMR t-test and the rank test in both the 8- and 61-day estimation periods. These results imply that Katrina had a negative effect on the futures prices of both commodities, as was expected. However, the abnormal return on τ_{-4} was statistically significant only for wheat futures prices in the CMR t-test when the 8-day estimation period was used. In contrast, the abnormal returns obtained on soybean futures prices were positive, but were not statistically significant (Table 4). Thus, wheat was the only commodity with some evidence that the market may have anticipated some potential damage caused by Katrina.

On August 24th (τ_{-3}), new reports regarding the development of Katrina warned that it was even more likely to make landfall in the Gulf of Mexico. The abnormal returns on τ_{-3} were negative for all commodities, but were not statistically different from zero. This result suggests that the market did not interpret these reports as relevant, new information.

On August 25th (τ_{-2}), corn futures prices had negative, but not statistically significant abnormal returns. Wheat futures prices had positive abnormal returns that were not statistically significant. These unexpected positive abnormal returns on wheat futures prices could be explained by the USDA weekly export sales report during τ_{-2}, which announced an increase in wheat demand (Table 5). The abnormal returns were negative and statistically significant for

soybean futures prices in both the CMR t-test and the rank test, using the 8-day estimation period (Table 4). This result may be explained by the argument that the soybean market may have viewed the possibility that rain coming from Katrina could benefit yields in some soybean areas (Table 1), given that precipitation and soil moisture are extremely important during pod fill in soybean (Andresen et al., 2001). Therefore, there is some evidence that on $\tau_{-2,}$ Katrina caused a negative and significant reaction in anticipation of the hurricane landfall.

On Friday, August 26th (τ_{-1}), the abnormal returns to corn and wheat futures prices were negative, but were not statistically different from zero. In contrast, the abnormal return during τ_{-1} in the soybean market was positive, but not statistically significant. These positive abnormal returns could be partially explained by some rumors of increased soybean demand by China (Table 5).

The abnormal return during August 29th (τ_0) was negative, but was not statistically significant for wheat futures prices. In contrast, positive abnormal returns, but not statistically significant were observed during Katrina's landfall in both the corn and soybean markets. Two possible explanations for these insignificant abnormal returns are the following. First, the grain market could have already incorporated the effect of Katrina's landfall. Second, the grain market considered that Katrina would disrupt grain exports for only few days. Consequently, the market did not interpret these reports regarding Katrina's landfall as relevant, new information, and prices did not adjust.

During August 30th (τ_1), it was confirmed that the damage caused by Katrina would interrupt grain exports for at least a few days. The abnormal returns on τ_1 were negative, but were not statistically significant for corn and wheat futures prices. In contrast, a positive but not statistically significant abnormal return was observed in the soybean market. As previously mentioned, these positive abnormal returns in the soybean market may be explained by continuous rumors regarding the increase of Chinese demand and by the possible direct damage of crop areas due to Katrina (Table 5).

On August 31st (τ_2), two levees in New Orleans broke, further damaging the port, and it became evident that the time to repair this damage would be longer than previously thought (Table 1). The wheat market reacted to this new information, as represented by the negative and statistically significant abnormal returns in both estimation periods. The wheat futures prices adjusted rapidly in the expected direction to this unanticipated information, which supports the efficient markets hypothesis. Unexpectedly, the abnormal returns on (τ_2) in the corn and soybean markets were negative, but were not statistically significant. These results may suggest that wheat futures prices were more sensitive to the disruption of the transportation system due to Katrina than corn and soybean futures prices. A possible explanation is that by the time Katrina occurred wheat had already been harvested, whereas corn and soybean harvest had not yet started and the market may had considered that the transportation system would be restored before harvest was underway.

Positive and statistically significant abnormal returns were observed on September 1st (τ_3) in the corn market. Furthermore, the abnormal returns on τ_3 for the wheat futures prices were positive and statistically significant in the rank tests using both estimation periods. Soybean futures prices were positive, but were only statistically significant in the rank test using the 8-day estimation period. These unexpected positive results could be partially explained by two reasons. First, there were rumors among traders proclaiming that the disruption of exports would not last as long as previously thought (Table 1). Second, local and fund short covering, technical buying, as well as index fund buying in the corn market caused commodity prices to increase (Table 5).

On Friday September 2nd (τ_4), the abnormal returns were negative and statistically significant on corn futures prices. This result may be partially explained by the larger private crop estimates and the uncertainty regarding the consequences of Katrina on the U.S. grain transportation system (Table 5). The abnormal returns on τ_4 were negative as well for wheat and soybean futures prices, but were not statistically different from zero.

CAR values can provide information on the strength and direction of the total impact of Katrina on each commodity. All CAR values on corn futures prices were negative (Table 6). The CAR value on corn futures prices for the prior-event window (τ_{-4}, τ_0) was -4.34 when using the 8-day estimation period and -3.02 when using the 61-day estimation period. The only statistically significant CAR values occurred in the CMR t-test using the 8-day estimation period during the prior and surrounding event windows. These results imply that there was a significant reaction on corn futures prices prior to and surrounding the hurricane landfall (Table 6).

The CAR values on wheat futures prices for the prior-event window (τ_{-4}, τ_0) were -3.09 and -5.12 when using the 8- and 61-day estimation periods, respectively (Table 6). Furthermore, the CAR values on wheat futures prices for the prior and surrounding event windows were negative and statistically significant in the CMR t–test using the 8-day estimation period. The surrounding-event window obtained the largest and most significant CAR value among the three event windows evaluated. This result may indicate that most of the market reaction regarding the impact of Katrina in the wheat market occurred on the days surrounding the hurricane's landfall.

In the case of soybean futures prices, none of the CAR values were statistically significant. Additionally, the post-event window (τ_0, τ_4) had a positive CAR value when the 8-day estimation period was used. These insignificant CAR values may be partially explained by the fact that Katrina had two opposite effects on soybean futures prices. First, the negative price effect was due to the disruption of the transportation system and the expectation of beneficial yield-increasing rain during τ_{-2}. Second, the positive effect was due to potential crop losses from heavy rains and wind in the U.S. Delta region during τ_1 (Table 5).

Overall, most of the signs of the statistical tests were consistent for all of the results obtained from the two estimation periods. However, the degree of significance of abnormal returns depended on the estimation period and on the statistical test. Furthermore, in all commodities, most of the estimated CMR t –tests using the 8-day estimation period were larger in magnitude than those using the 61-day estimation period. Consistent with Mckenzie, Thomsen, and Dixon (2004), it was more likely that an abnormal return would be statistically significant using the 8-day versus the 61-day period. Subsequently, it was more likely for a Type I error to occur (i.e., obtaining a significant impact from Katrina in the future market when in reality, there was no adjustment in prices). However, in this research the 61-day estimation period includes the growing season, which is the most volatile time of futures prices (Goodwin and Schnepf, 2000). This increase on variance in the 61-day estimation period could explain its failure to reject the null hypothesis.

In addition, most of the CAR values were not statistically significant in the rank test. Therefore, the parametric (CMR) and nonparametric (rank) statistical tests had contradictory results regarding the futures market reaction to Katrina. Moreover, Brown and Warner (1985) found that variance increases during the event days, which causes parametric tests to yield statistically significant abnormal returns where none actually exists more often than expected when stock prices are evaluated. Thus, an increase in variances in the event period could cause the differences found on the degree of significance of the CAR values between the statistical tests. However, in all cases, the variances were not statistically different between the estimation period and the event period using a Levene's homogenous variances test (data not shown). Therefore, the failure to reject the null hypothesis in the rank test was not due to an increase in the variance in the event period.

Basis

The daily abnormal return on the September corn basis for August 25th (τ_{-2}) was 2.57 and statistically significant in the rank test in both estimation periods (Table 7). This positive and statistically significant reaction implied that the national corn basis weakened 0.75 cents per bushel from -45.95 to -46.70. Additionally, the abnormal returns were positive and statistically significant during Katrina's landfall (τ_0) in both the CMR t-test and the rank test in both the 8- and 61-day estimation periods. The reaction during τ_0 was larger and more significant than the reaction observed during τ_{-2}, when the national corn basis widened by 1.89 cents per bushel from - 46.61 to - 48.50.

Positive and statistically significant abnormal returns were observed on the September soybean basis during August 30th (τ_1) in both statistical tests when the 8-day estimation period was used (Table 8). This positive reaction indicated that the national soybean basis weakened by 1.28 cents per bushel from -26.76 to -28.04. Moreover, larger positive and significant abnormal returns to the basis were observed on September 1st (τ_3). However, this reaction was likely caused by a technical buying, as well as index fund buying that occurred in the commodities future market (Table 5).

Futures price volatility increases as contract maturity approaches (Milonas 1986; Galloway and Kolb, 1996). This effect is known as Samuelson effect or maturity effect. As Galloway and Kolb states (1996, p 809) the "price of futures contracts close to expiration react more strongly to new information about the commodity than do prices of more distant contracts." Katrina's landfall occurred on August 29th, about two weeks before the September contracts expired. Hence, any reaction during the days surrounding Katrina's landfall could be due to a confounding effect between Katrina and/or Samuelson effects when using the September basis series. Therefore, the corn December basis and the soybean November basis were evaluated[2].

When analyzing the corn December basis, the abnormal return was positive on August 25th but only statistically significant using the rank test (Table 9). Thus, there was weaker evidence of significant reaction during τ_{-2} using the December basis (Table 9) than the September basis (Table 7). In contrast, the abnormal return on τ_0 was positive and significant in both statistical tests. In the case of the soybean November basis, there was no evidence of a significant reaction on August 30th. The only significant abnormal return occurred during September 1st, which is likely due to technical buying (Table 9).

Conclusions and Discussion

During Katrina, daily abnormal returns were larger in the wheat market than in the corn and soybean markets. These results were unexpected since corn and soybean exports are more dependent on the Mississippi Gulf than wheat exports. A possible explanation of these results is the coincidence of the hurricane's landfall with grain export activities. Katrina's effect occurred at the end of the last week of August and first week of September. Over the last five years, weekly volumes of wheat exports were larger than the weekly volumes of corn and soybean export during these weeks (Figure 4). As a result, wheat futures prices may have been more sensitive to Katrina's disruptions than corn and soybean futures prices.

Significant daily abnormal returns occurred on τ_{-4}, τ_2, and τ_3 for wheat futures prices during Katrina. For corn futures prices, significant abnormal returns were observed on τ_3, and τ_4, whereas soybean futures prices had significant abnormal returns on τ_{-2}, and τ_3. However, abnormal returns on τ_3 and τ_4 can not be attributed only to Katrina because of the presence of technical and index fund buying and higher private crop estimates during those days, respectively. Therefore, the most conclusive daily abnormal returns occurred during τ_{-2} for the soybean future prices and during τ_2 for the wheat future prices. [3] Additionally, there was weak

[2] The nearby basis series was not used because the potential bias on the abnormal return during September 1st due to the effect of switching between the September contract and the following contract. The abnormal returns obtained on September 1st using the nearby basis series for corn and soybean were 35% and 42%, respectively.

[3] The significance of the daily abnormal returns on corn futures prices did not vary whether the September or December contract was evaluated. Similarly, conclusions regarding the reaction on the soybean futures prices were the same when using the September or November contract.

evidence of significant CAR reaction in the corn and wheat markets prior to and surrounding Katrina's landfall.

Significant daily abnormal returns on the national corn basis occurred on τ_0 for both basis series evaluated (September and December). Additionally, there was some evidence that the national corn basis widened on τ_{-2} in anticipation of the hurricane's landfall. The most definite daily abnormal return on the soybean basis occurred on September 1st, however, it can not be attributed only to Katrina because of the presence of technical and index fund buying. The only indication that Katrina may have some effect on the national soybean basis was the weak reaction on August 30th. In conclusion, the majority of the corn market reaction to Katrina's damage occurred in the basis and not in the futures market. For the soybean market there a was weak significant reaction in both futures prices and basis. In the case of wheat, basis was not evaluated and wheat futures prices reacted to the disruption caused by Katrina.

The absence of larger daily abnormal returns on the corn, wheat and soybean futures prices and basis due to Katrina could be partially explained by four factors. First, the grain market determined that the damage caused by the hurricane did not affect fundamental supply and demand factors; rather, only transportation logistics were affected. Second, the grain market may have considered that the grain export volumes would recover to normal levels by the maturity of the contracts. Third, the use of options markets may have decreased the possible impact on futures prices due to the hurricane. Fortenbery and Summer (1993) found that the use of options markets in corn and soybean has reduced the reaction and variation on futures prices due to USDA production reports. However, the trading volumes did not increase and the prices did not change very much for the corn and soybean options on the Chicago Board of Trade surrounding Katrina's landfall. Finally, the magnitude of the impact of Katrina and Rita on the grain futures prices depended on the economic context in which it occurred. Research has found that price reaction to news regarding supply and demand may be conditional on the state of the market (e.g., Kenyon et al. 1987; Colling, Irwin and Zulauf, 1996). Stock levels and crop size are two state variables that may have influenced the effect of the hurricane on commodity futures prices. Storage compensates for disturbances and the prospect of further fluctuations in the future, thus reducing the effects of uncertain events (Williams and Wright, 1991). In addition, a potential shock in the supply and demand could have a small effect on prices if the estimate of the new crop production was large (Williams and Wright, 1991; Goodwin and Schnepf, 2000). In 2004, the corn and soybean crops were the largest in U.S. history, creating large stock levels for 2005 (USDA-NASS, 2005). Furthermore, the last USDA crop production report before Katrina was released on August 12, 2005, and predicted relatively large crops. Consequently, these large stock and production levels could have moderated the effect of Katrina and Rita on corn and soybean futures prices.

Figure 1 Average daily elevator bids collected by state for the National corn index (Minneapolis Grain Exchange)

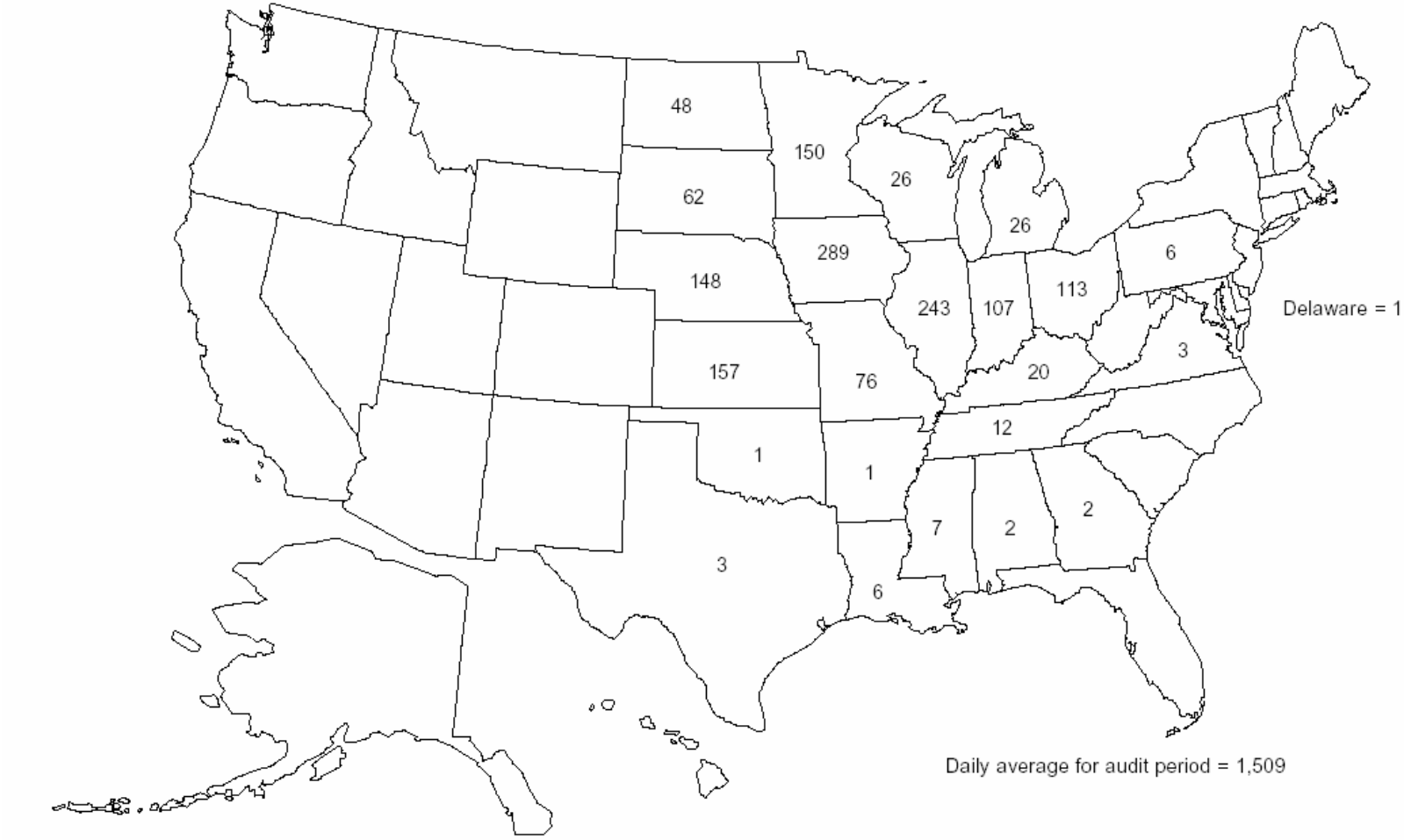

Figure 2 Average daily elevator bids collected by state for the National soybean index (Minneapolis Grain Exchange)

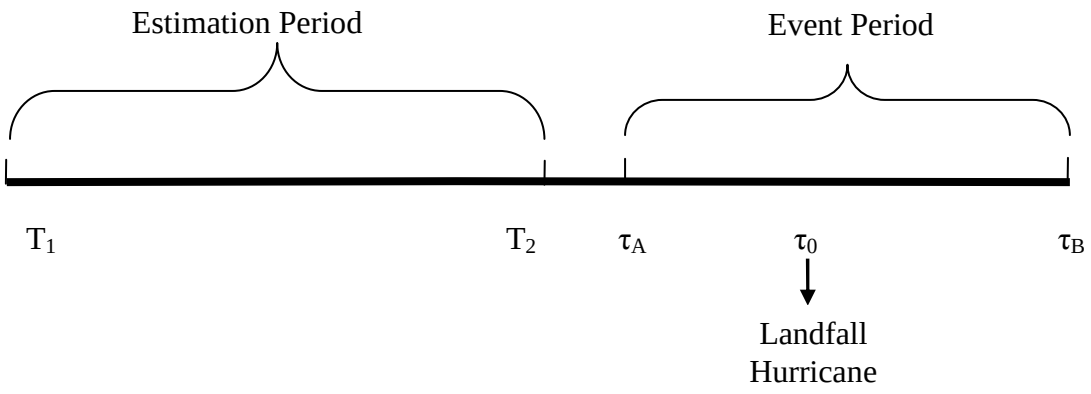

Figure 3 Diagram of the timeline of the event study evaluated.

Table 1 Summary of news releases regarding Hurricane Katrina

Date	Day	Source	Summary of the news release
23-Aug	τ_{-4}	Reuters Limited	"A tropical depression formed over the Bahamas in the western Atlantic Ocean and could head toward southern Florida and then the eastern Gulf of Mexico later this week, the National Hurricane Center said in an advisory."
24-Aug	τ_{-3}	Reuters News	"Traders were keeping an eye on Tropical Storm Katrina, which is likely to cut into the Gulf of Mexico later this week, the U.S. National Hurricane Center said."
25-Aug	τ_{-2}	Dow Jones Commodities Service	"Crop areas that took in rain this week will have beneficial weather to put that moisture to good use regarding late-season development. The biggest benefit from these rains will be for soybeans, which are capable of setting new flowers and pods even this late in the season."
26-Aug	τ_{-1}	Reuters News	"A tropical storm is swirling towards Florida moving on a path that would likely cut across southern Florida and into the Gulf of Mexico later this week."
27-Aug	Market closed	The Seattle Times	"Boats transporting corn, soybeans and wheat were being secured along bluffs north of Baton Rouge, Louisiana, the sources said, adding that grain export operations could be halted until early next week, depending on Katrina's ferocity."
28-Aug	Market closed	CNN, Breaking News	"Hurricane Katrina Projected to Hit New Orleans"
29-Aug	τ_{0}		"The Coast Guard closed all ports from New Orleans to the Florida Panhandle ahead of the arrival of Hurricane Katrina early Monday."
30-Aug	τ_{1}	St. Petersburg Times	"Hurricane Katrina's ferocious winds swiped at one of the world's busiest seaports Monday, disrupting the flow of a vast array of materials that could affect international grain supplies.
31-Aug	τ_{2}	The New York Times	"A day after New Orleans thought it had narrowly escaped the worst of Hurricane Katrina's wrath, water broke through two levees on Tuesday and virtually submerged and isolated the city."
1-Sep	τ_{3}	Dow Jones Commodities Service	"On speculative buying and ideas the disruption of exports from the Gulf will not last as long as previously thought, analysts said. Corn, wheat and soybean export sales for the week ended Aug. 31 were outstanding according to the USDA export report."
2-Sep	τ_{4}	Agra Europe	"It will take weeks rather than days to assess the impact. Many Gulf elevators still are trying to contact their workers and haven't been able to inspect their sites."

Table 2 Daily abnormal returns and t-test values of the CMR and the rank analysis for the significance of Hurricane Katrina's effect on corn December 2005 futures prices

		8-Day			61-Day		
Date	Day	Abnormal Returns	T_{CMR}	Z_{Rank}	Abnormal Returns	T_{CMR}	Z_{Rank}
8/23/2005	τ_{-4}	-1.17	-0.98	-0.61	-0.91	-0.48	-0.38
8/24/2005	τ_{-3}	-1.07	-0.84	-0.41	-0.80	-0.42	-0.34
8/25/2005	τ_{-2}	-1.42	-1.18	-1.22	-1.15	-0.61	-0.67
8/26/2005	τ_{-1}	-1.20	-1.00	-0.82	-0.93	-0.49	-0.43
8/29/2005	τ_{0}	0.52	0.43	0.82	0.78	0.41	0.77
8/30/2005	τ_{1}	-0.74	-0.61	0.20	-0.48	-0.25	-0.14
8/31/2005	τ_{2}	-1.20	-1.00	-1.02	-0.94	-0.49	-0.48
9/01/2005	τ_{3}	2.34	1.95^{2}	1.63^{1}	2.60	1.37^{1}	1.63^{1}
9/02/2005	τ_{4}	-2.56	-2.14^{2}	-1.63^{1}	-2.30	-1.21	-1.34^{1}

The symbols [1], [2], and [3] represent statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed t-test.

Table 3 Daily abnormal returns and t-test values of the CMR and the rank analysis for the significance of Hurricane Katrina's effect on wheat December 2005 futures prices

		8-Day			61-Day		
Date	Day	Abnormal Returns	T_{CMR}	Z_{Rank}	Abnormal Returns	T_{CMR}	Z_{Rank}
8/23/2005	τ_{-4}	-1.96	-1.43[1]	-1.22	-1.56	-1.08	-1.15
8/24/2005	τ_{-3}	-1.30	-0.95	-0.61	-0.89	-0.62	-0.62
8/25/2005	τ_{-2}	0.37	0.27	0.41	0.77	0.54	0.86
8/26/2005	τ_{-1}	-1.45	-1.06	-1.02	-1.05	-0.73	-0.77
8/29/2005	τ_{0}	-0.77	-0.56	0.20	-0.37	-0.25	-0.10
8/30/2005	τ_{1}	-1.31	-0.96	-0.82	-0.91	-0.63	-0.67
8/31/2005	τ_{2}	-2.18	-1.59[1]	-1.43[1]	-1.78	-1.23	-1.39[1]
9/01/2005	τ_{3}	1.17	0.85	1.43[1]	1.58	1.09	1.39[1]
9/02/2005	τ_{4}	-1.17	-0.85	-0.20	-0.76	-0.53	-0.48

The symbols [1], [2], and [3] represent statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed t-test.

Table 4 Daily abnormal returns and t-test values of the CMR and the rank analysis for the significance of Hurricane Katrina's effect on soybean November 2005 futures prices

		8-Day			61-Day		
Date	Day	Abnormal Returns	T_{CMR}	Z_{Rank}	Abnormal Returns	T_{CMR}	Z_{Rank}
8/23/2005	τ_{-4}	0.96	0.68	0.41	0.48	0.22	0.30
8/24/2005	τ_{-3}	-0.82	-0.58	-0.61	-1.30	-0.60	-0.85
8/25/2005	τ_{-2}	-2.04	-1.44[1]	-1.43[1]	-2.52	-1.16	-1.26
8/26/2005	τ_{-1}	1.15	0.81	0.82	0.66	0.31	0.40
8/29/2005	τ_{0}	1.10	0.78	0.61	0.62	0.28	0.35
8/30/2005	τ_{1}	1.26	0.89	1.02	0.78	0.36	0.45
8/31/2005	τ_{2}	-1.59	-1.12	-1.02	-2.07	-0.95	-1.10
9/01/2005	τ_{3}	1.81	1.27	1.43[1]	1.32	0.61	0.85
9/02/2005	τ_{4}	-0.89	-0.63	-0.82	-1.37	-0.63	-0.95

The symbols [1], [2], and [3] represent statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed t-test.

Table 5 Summary of news releases during the Katrina event regarding the supply and demand of corn, wheat and soybean

Date	Day	Source	Summary of new release
25-Aug	τ_{-2}	Dow Jones Commodities Service	"Wheat export sales for the week ended Aug. 18 totaled 853,500 metric tons, larger than analysts' estimates of 625,000 to 850,000 tons."
26-Aug	τ_{-1}	Dow Jones Commodities Service	"Rumors of China buying up to five cargoes of U.S. soybean supplies provided light support in a thinly traded market."
30-Aug	τ_{1}	Dow Jones Commodities Service	"Rumors of Chinese demand, talk of potential crop losses from heavy rains and wind in the U.S. Delta added to the supportive undertone of the market."
1-Sep	τ_{3}	Dow Jones Commodities Service	"CHICAGO (Dow Jones)--Chicago Board of Trade wheat, corn and soybean futures ended higher, supported by speculative buying"
2-Sep	τ_{4}	Pittsburgh Post-Gazette	"The combination of the higher private crop estimates and the confusion associated with the aftermath of Hurricane Katrina on U.S. grain and oilseed capabilities at the Louisiana Gulf attracted speculative fund selling to keep futures pinned in negative territory throughout the day."

Table 6 CAR and t-test values of the CMR and the rank analysis for the significance of Hurricane Katrina's effect on corn, wheat, and soybean futures prices

	Window	8-Day			61-Day		
Commodity	(τ_1, τ_2)	CAR	T_{CMR}	Z_{Rank}	CAR	T_{CMR}	Z_{Rank}
Corn	(-4,0)	-4.34	-1.62[1]	-1.00	-3.02	-0.71	-0.47
	(-2,2)	-4.05	-1.51[1]	-0.91	-2.72	-0.64	-0.43
	(0,4)	-1.65	-0.62	-0.46	-0.33	-0.08	0.19
Wheat	(-4,0)	-5.12	-2.53[1]	-1.00	-3.09	-0.97	-0.79
	(-2,2)	-5.35	-2.65[1]	-1.19	-3.33	-1.05	-0.92
	(0,4)	-4.27	-2.11	-0.37	-2.24	-0.71	-0.56
Soybean	(-4,0)	0.30	0.09	-0.09	-1.77	-0.37	-0.32
	(-2,2)	-0.33	-0.10	-0.46	-2.39	-0.51	-0.36
	(0,4)	1.63	0.48	0.55	-0.44	-0.09	0.02

The symbols [1], [2], and [3] represent statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed t-test.

Table 7 Daily abnormal returns and t-test values of the CMR and the rank analysis for the significance of Hurricane Katrina's effect on corn September 2005 basis

		8-Day			61-Day		
Date	Day	Abnormal Returns	T_{CMR}	Z_{Rank}	Abnormal Returns	T_{CMR}	Z_{Rank}
8/23/2005	τ_{-4}	-1.08	-0.69	-1.02	-1.44	-0.83	-0.95
8/24/2005	τ_{-3}	-0.36	-0.23	0.00	-0.71	-0.41	-0.40
8/25/2005	τ_{-2}	2.57	1.65[1]	1.43[1]	2.22	1.28	1.36[1]
8/26/2005	τ_{-1}	-1.50	-0.96	-1.43[1]	-1.86	-1.08	-1.26
8/29/2005	τ_{0}	3.73	2.39[2]	1.63[2]	3.37	1.94[2]	1.66[2]
8/30/2005	τ_{1}	-0.36	-0.23	-0.20	-0.72	-0.42	-0.45
8/31/2005	τ_{2}	-0.67	-0.43	-0.82	-1.03	-0.59	-0.65
9/1/2005	τ_{3}	1.96	1.26	1.02	1.60	0.93	1.15
9/2/2005	τ_{4}	1.17	0.75	0.61	0.82	0.47	0.55

The symbols 1, 2, and 3 represent statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed t-test.

Table 8 Daily abnormal returns and t-test values of the CMR and the rank analysis for the significance of Hurricane Katrina's effect on soybean September 2005 basis

		8-Day			61-Day		
Date	Day	Abnormal Returns	T_{CMR}	Z_{Rank}	Abnormal Returns	T_{CMR}	Z_{Rank}
8/23/2005	τ_{-4}	0.34	0.15	-0.41	-1.04	-0.23	-0.45
8/24/2005	τ_{-3}	-1.91	-0.82	-1.02	-3.30	-0.73	-0.90
8/25/2005	τ_{-2}	0.95	0.41	0.20	-0.43	-0.10	-0.05
8/26/2005	τ_{-1}	1.97	0.85	0.82	0.59	0.13	0.35
8/29/2005	τ_{0}	-1.92	-0.82	-1.22	-3.30	-0.73	-0.95
8/30/2005	τ_{1}	5.55	2.38[2]	1.43[1]	4.17	0.93	1.15
8/31/2005	τ_{2}	0.05	0.02	-0.61	-1.33	-0.30	-0.60
9/1/2005	τ_{3}	11.15	4.78[3]	1.63[2]	9.77	2.17	1.66[1]
9/2/2005	τ_{4}	5.07	2.17[2]	1.22	3.69	0.82	1.05

The symbols 1, 2, and 3 represent statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed t-test.

Table 9 Daily abnormal returns and t-test values of the CMR and the rank analysis for the significance of Hurricane Katrina's effect on corn basis relative to the December 2005 contract and on soybean basis relative to the November 2005 contract.

		Corn basis			Soybean basis		
Date	Day	Abnormal Returns‡	T_{CMR}	Z_{Rank}	Abnormal Returns‡	T_{CMR}	Z_{Rank}
8/23/2005	τ_{-4}	-0.83	-0.61	-0.98	-1.53	-0.61	-1.16
8/24/2005	τ_{-3}	-0.32	-0.23	-0.39	-1.19	-0.48	-0.97
8/25/2005	τ_{-2}	1.75	1.28	1.37[1]	0.91	0.36	0.77
8/26/2005	τ_{-1}	-0.06	-0.04	-0.20	0.97	0.39	0.97
8/29/2005	τ_{0}	4.11	2.99[3]	1.77[1]	0.15	0.06	-0.58
8/30/2005	τ_{1}	0.20	0.14	0.79	0.89	0.36	0.58
8/31/2005	τ_{2}	-0.53	-0.38	-0.59	0.84	0.34	0.19
9/01/2005	τ_{3}	0.26	0.19	0.98	5.05	2.03[2]	1.55[1]
9/02/2005	τ_{4}	-0.80	-0.58	-0.79	0.87	0.35	0.39

The symbols [1], [2], and [3] represent statistical significance at the 0.10, 0.05 and 0.01 levels, respectively, using a one-tailed t-test.

‡Abnormal returns calculated using an 8-day estimation period.

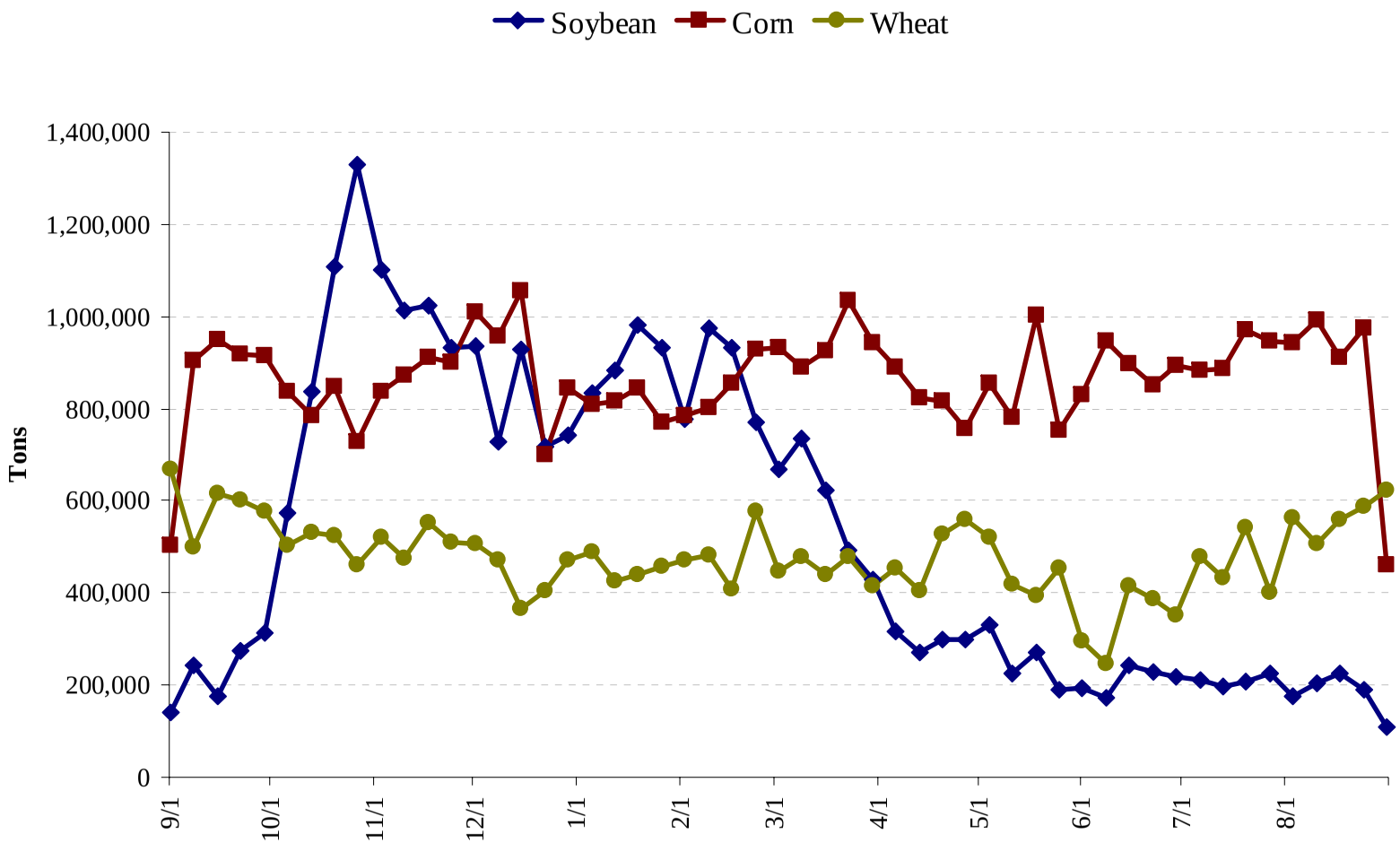

Figure 4 Average weekly loadings for soybean, corn, and wheat during 2000-2004

Reference

Andresen. J., G. Alarwarmy, A. Rotz, T. Ritchi and A. Lebaron. 2001. "Weather Impacts on Maize, Soybean, and Alfalfa Production in the Great Lake Region 1895-1996". *Agronomy Journal* 93:1059–1070

Angbazo, L. A., and R. Narayanan. 1996. "Catastrophic Shocks in the Property-Liability Insurance Industry: Evidence on Regulatory and Contagion Effects." *Journal of Risk and Insurance* 63 (4): 619-637

Brown, S., and J. Warner. 1985. "Using daily stock returns: The case of event Studies." *Journal of Financial Economics* 14: 3-31

Colling, P., *Irwin*, S. and Zulauf, C. 1996. "Reaction of Wheat, Corn, and Soybean Futures Prices to USDA "Export Inspections" Reports." *Review of Agricultural Economics* 18 (1): 127-36

Corrado, C. J. 1989. "A nonparametric test for abnormal security-price performance in event studies." *Journal of Financial Economics* 23: 385-395

Cowan, A. 1992. "Nonparametric Event Study Tests." *Review of Quantitative Finance and Accounting* 2: 343-358

Factiva http://www.factiva.com/

Fama, E., L. Fisher, M. Jensen, and R. Roll. 1969. "The Adjustment of Stock Prices to New Information." *International Economics Review* 10: 1-21

Fortenbery, R. T., and D. A Summer. 1993. "The Effects of USDA Reports in Futures and Options Markets." *The Journal of Futures Markets* 13: 157-173

Galloway, T., and R. Kolb. 1996. "Futures prices and the Maturity Effect." *The Journal of Futures Markets* 16:809-828

Goodwin, B. K., and R. Schnepf. 2000. "Determinants of Endogenous Price Risk in Corn and Wheat Futures Markets." *The Journal of Futures Markets* 20:753-774

Henson, S., and M. Mazzocchi. 2002. "Impact of Bovine Spongiform Encephalopathy on Agribusiness in the United Kingdom: Results of an Event Study of Equity Prices." *American Journal of Agricultural Economics* 84(2): 370–386

Kenyon, D., K. Kling, J. Jordan, W. Seale and N. McCabe. 1987. "Some determinants of the volatility of futures prices." *The Journal of Futures Markets* 73:73-91

Kenyon, D. 1987. "Factors Affecting Agricultural Futures Price Variance." *Journal of Futures Markets* (7): 73-91

King, J. L., N. Wilson, and A. Naseem. 2002. "A Tale of Two Mergers: What We Can Learn from Agricultural Biotechnology Event Studies." *AgBioForum* 5(1): 14-19

Knabb, R. D., J. R. Rhome, and D. P. Brown. "Tropical Cyclone Report: Hurricane Katrina." National Hurricane Center, http://www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf. (2005)

Lamb, R. P. 1995. "An Exposure-Based Analysis of Property-Liability Insurer Stock Values Around Hurricane Andrew." *Journal of Risk and Insurance* 62 (1): 11-123

LexisNexis http://www.lexisnexis.com/

MAcKinlay, A. Craig. 1997. "Event Studies in Economics and Finance." *Journal of Economic Literature* 35(1):13-39

McKenzie, A., and M. Thomsen. 2001. "The effect of E. Coli O157:H7on beef price." *Journal of Agricultural and Resource Economic* 26 (2): 431-44

McKenzie, A., M. Thomsen, and B. Dixon. 2004. “The performance of event study approaches using daily commodity futures returns.” *The Journal of Futures Markets* 24:533-555

Milonas, N. T. 1986. “Price Variability and the Maturity Effect in Futures Markets.” *The Journal of Futures Markets* 6:443-460

Milonas, N. T. 1987. “The effect of USDA crop announcement on commodity prices.” *The Journal of Futures Markets* 7: 571-589

Minneapolis Grain Exchange. 2006. “Frequently asked questions about the National Corn Index (NCI) and National Soybean Index (NSI), calculated daily by Data Transmission Network”. http://www.mgex.com/pdfs/products/indexfaq.pdf

Peterson, H.H., and W.G. Tomek. 2000. “Commodity Price Behavior: A rational Expectation Storage Model of Corn.” Working paper, Dept. of Agr., Res. & Mgr, Econ., Cornell University.

Rucker, R. R., W. Thurman, and J. K. Yoder. 2005. “Estimating the structure of market reaction to news: information events and lumber futures prices.” *American Journal of Agricultural Economics* 87(2): 482–500

Summer. D.A., and R.A. Mueller. 1989. “Are Harvest Forecast News.” *American Journal of Agricultural Economics* 71:1-8

U.S. Department of Agriculture. Grain Transportation Report. AMS, Washington DC, November (2005).

U.S. Department of Agriculture. Grain Stocks. NASS, Washington DC, January (2005).

Williams, J.C., and B. Wright. 1991. Storage and commodity markets, New York: Cambridge University Press.