Surprises, Dispersion and the Informational Impact of USDA Reports

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Abstract

We examine the role of information asymmetry on the changes in bid-ask spreads during major United States Department of Agriculture (USDA) announcements. Our analyses using corn, wheat and soybean futures indicate that information asymmetry is significantly higher during the USDA announcement days than on non-announcement days. Increased information asymmetry prior to the news announcements is driven by the divergence in private information possessed by market participants (dispersion in analyst forecast). Once the news is released, both forecast dispersion and news surprises (the difference between actuals and market expectations) contribute to increased information asymmetry and wider bid-ask spreads.

JEL Classification: G1, C58, E44

Keywords: Agricultural Commodities, Bid-Ask Spreads, Spread Decomposition

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1. Introduction

It is generally accepted that public news events affect the cost of trading. In the context of agricultural commodities, several studies investigate the widening of the bid-ask spread (BAS) to United States Department of Agriculture (USDA) announcements (e.g. Wang et al., 2014; and Lehecka et al., 2014). These studies suggest that the BAS widens around USDA announcements due to increased volume and volatility on the day of the release. In addition, several studies show that active trading during the release of extensive new information may exacerbate price volatility and could present challenges for some producers seeking to manage risk, hence resulting in a wider BAS (Garcia et al., 1997; Isengildina-Massa et al., 2008; McKenzie, 2008; Adjemian, 2012). An issue that has received little attention to date is the fact that trading costs (BAS) has several components and news events can affect these various components differently.

Market microstructure theory generally acknowledges two main components that make up the BAS. The first component reflects the difference in information held by traders and liquidity providers, and is commonly referred to as the information asymmetry component. In a market where a subset of traders has superior information relative to the liquidity provider, the liquidity provider will increase the BAS to recover losses she will make when trading with an informed counterparty (see e.g. Glosten and Milgrom, 1985; and Glosten, 1987). The second component reflects the costs that liquidity provider incurs for providing liquidity, and includes order processing (fees, equipment, etc.) and inventory costs. Large news events, such as the USDA announcements can indeed have significant impacts on both components of the BAS, and understanding the impact that news events have on these different components can provide important insights on the behavior and dynamics of the BAS.

In this paper, we examine how the different components of the BAS are affected by USDA announcements. Our sample contains transaction-level data of agricultural commodities futures on corn, wheat and soybean from January 2013 to July 2016, a time period where the USDA announcements occur during trading hours. We consider USDA announcements such as the World Agricultural Supply and Demand Estimates (WASDE), Grain Stocks, Prospective Planting and Acreage reports. We then employ the commonly used spread decomposition model of Madhavan et al. (1997) to decompose the BAS into its two components, information asymmetry and liquidity provision costs. In line with prior research, we document that the BAS increases significantly, and that both components of the BAS are significantly affected by the USDA announcements. Interestingly, we observe that the information asymmetry component of the spread increases, while the liquidity provision component decreases (the information asymmetry component of the spread increases from 9.1% to 31.7%, 34.1% to 53.3%, and 35.6% to 51.4% for corn, wheat and soybean futures, respectively, in the 40-minute window surrounding the news release on non-announcement days versus announcement days). This finding suggests that around the USDA announcement there is both an increase in liquidity-motivated trading which reduces the liquidity cost component, and in informed trading, which causes the information asymmetry component to increase. This finding sheds light on previous studies on the BAS (e.g. Wang et al. (2014) document that BAS responds negatively to volume and positively to volatility). Our results suggest that, in this case, volume would proxy for liquidity-motivated trade, while volatility would proxy for the degree of information asymmetry in the market.

To further examine what drives the increase in information asymmetry around the USDA announcements, we focus on the resolution of uncertainty occurring at the time of the announcement (McNew and Espinosa, 1994). To capture the resolution of uncertainty, we focus on two metrics. First, we consider the surprise in the USDA announcement (measured by the difference between actual figures announced and market expectations). Second, we consider the degree of dispersion in analyst forecasts (measured by the interquartile range of different analysts one week prior to the USDA announcement).

When we focus on the period prior to the USDA announcement, we observe that the dispersion in analyst forecasts is a strong determinant of the degree of information asymmetry. This implies that when there is a high disagreement about the content of the upcoming USDA announcement, there is a large amount of trade based on private information. This finding is in line with e.g. McNichols and Trueman (1994) and Riordan et al. (2013) who argue that a high degree of uncertainty about a public disclosure before the announcement provides for an environment where the acquisition of private information is beneficial. After the USDA announcement we observe that both analyst forecast dispersion and news surprises are responsible for increased information asymmetry. This finding suggests that a big surprise or a large dispersion in beliefs creates an environment where some market participants can process information faster than others. Investors who can process this information and its implications faster, have a short-term informational advantage over other traders (Kim and Verrecchia, 1994).[1]

Our work contributes to the literature in several ways. First, to our knowledge, this is the first paper that applies a spread decomposition model to the BAS for agricultural commodity futures, and documents the significant change that occur in these components around the time of USDA announcements. Our results in this regard provide insights into the determinants of

[1]E.g. Kauffman (2013) suggests that small agricultural enterprises may not have the resources to process new information quickly enough to place trades in competition with large trading firms.

the BAS. Second, we explore what causes the increase in information asymmetry that we observe around the USDA announcement by linking it to two measures of the informational environment around the announcement: news surprise and analyst dispersion. To our knowledge analyst dispersion data as a measure of the informational environment has not been used previously. We document that both metrics of the informational environment provide information about the degree of informed trading around the USDA announcement.

We structure the remainder of this paper as follows. Section 2 details the model we use to decompose the bid-ask spread into its two components. Section 3 describes the data, and particularly defines how we measure news surprises and analyst forecast dispersion. Section 4 reports our empirical findings. Finally, Section 5 concludes.

2. Spread Decomposition Model

To decompose the spread into its two components (information asymmetry and liquidity provision costs), we employ the commonly used spread decomposition model of Madhavan, Richardson and Roomans (1997) (MRR, hereafter). The information asymmetry component reflects the compensation a liquidity provider requires for trading against better informed counterparties, and thus reflects the degree of information privately obtained by market participants. The liquidity provision component aggregates inventory and order processing costs.[2]

[2]Inventory costs reflect the costs the liquidity provider faces for holding a position that deviates from her optimal position, whereas order processing costs reflect the direct costs a liquidity provider faces in making a market (i.e. fees, equipment, etc.). As inventory costs are less relevant in an electronic limit order book market (since there are no designated market makers in the agricultural futures markets such as the Chicago Mercantile Exchange), and we are predominantly interested in the asymmetric information component, we refrain from decomposing liquidity costs into its two parts.

The MRR model is based on the standard market microstructure assumption that changes in public beliefs about the value of an asset can originate from two sources. First, public beliefs can change due to the arrival of new public information. Public news may cause revisions in beliefs of market participants without any trade occurring. Second, changes in public beliefs can be due to privately informed trades, which become public knowledge through order flow. An informed buy (sell) order will be associated with an increase (decrease) in price, and thus the market can learn about the degree of informed trade by considering the price impact of trades.

To formalize these two sources of information, let ϵ_t be the innovation in beliefs due to new public information and x_t be a trade indicator variable (+1 if a trade is buyer-initiated, -1 if a trade is seller-initiated, and 0 otherwise).[3] The change in beliefs due to privately informed trades (order flow) is expressed as $\theta(x_t - E[x_t|x_{t-1}])$, where $(x_t - E[x_t|x_{t-1}])$ is the surprise in order flow and $\theta \geq 0$ measures the degree of information asymmetry. Higher values of θ indicate larger permanent price impacts of the surprise in order flow. Given these definitions, the post-trade expected value of an asset, μ_t, conditional on new public information and order flow innovations, can be expressed as,

$$\mu_t = \mu_{t-1} + \theta(x_t - E[x_t|x_{t-1}]) + \epsilon_t. \tag{1}$$

Liquidity providers' quotes reflect this expected value, but also incorporate their compensation for providing liquidity. As such, the bid and ask prices quoted by liquidity providers reflect the expected value of the asset conditional on the arrival of a buy or sell

[3]Some trades end up being executed at the midpoint, commonly known as crossing trades. We estimate the probability of trades at the midpoint as $\lambda = 1 - |x_t|$.

order plus a compensation for their cost of doing business. Let $\phi \geq 0$ be the liquidity provider's compensation for inventory and order processing costs. The ask price will then be the price conditional on a buy order arriving, while the bid price is the price conditional on a sell order arriving, i.e.,

$$p_t^a = \mu_{t-1} + \theta(1 - E[x_t|x_{t-1}]) + \phi + \epsilon_t \tag{2}$$
$$p_t^b = \mu_{t-1} - \theta(1 + E[x_t|x_{t-1}]) - \phi + \epsilon_t.$$

The bid-ask spread, based on Equation (2) is a random variable with mean $p_t^a - p_t^b = 2(\theta + \phi)$, and thus the bid-ask spread reflects both information asymmetry costs (θ) and liquidity provision costs (ϕ).

Given that trades are executed at either bid or ask, the transaction price process is given as

$$p_t = \mu_{t-1} + \theta(x_t - E[x_t|x_{t-1}]) + \phi x_t + \epsilon_t. \tag{3}$$

To estimate Equation (3), we must complete this Equation by providing a specification for $E[x_t|x_{t-1}]$. As in MRR, we assume a general Markov process for the trade indicator variable, x_t. This implies that the conditional expectation of the trade indicator variable given the public information can be expressed as a first-order autoregressive process, $E[x_t|x_{t-1}] = \rho x_{t-1}$, where ρ is the autocorrelation in order flow. Substituting this into Equation (3) we can re-write Equation (3) in first differences as

$$p_t - p_{t-1} = (\phi + \theta)x_t - (\phi + \rho\theta)x_{t-1} + \epsilon_t. \tag{4}$$

Equation (4) expresses the transaction price change as a linear function of contemporaneous and past order flow.

We estimate the parameters in Equation (4) by Generalized Method of Moments (GMM). Specifically, let $u_t = p_t - p_{t-1} - (\phi + \theta)x_t + (\phi + \rho\theta)x_{t-1}$. Then, the following moment conditions can be employed to exactly identify the parameters of interest $\beta = \{\theta, \phi, \lambda, \rho\}$ and a constant drift, α, i.e.,

$$E\begin{pmatrix} x_t x_{t-1} - x_t^2\rho \\ |x_t| - (1-\lambda) \\ u_t - \alpha \\ (u_t - \alpha)x_t \\ (u_t - \alpha)x_{t-1} \end{pmatrix} = 0.$$

The first equation is simply the definition of the autocorrelation in order flow, the second equation defines the crossing probability (trades at the midpoint), the third equation defines the drift term as the average pricing error, and the last two equations are the OLS normal equations.

3. Data

In this section, we discuss the data we employ in this study. Our sample covers the period January 1, 2013 to July 31, 2016, and we focus on three large agricultural commodities: corn, wheat and soybean. The start of the sample is chosen to match the change in the USDA announcement time from 8:30am to 11:00am CST.[4] We first describe the data we collect on the USDA announcements and then describe the transaction-level data we obtain on the agricultural futures.

3.1. USDA Announcements, News Surprises and Analyst Dispersion

We focus on major USDA reports such as the World Agricultural Supply and Demand Estimates (WASDE), Grain Stocks Report (GSR), Prospective Planting Report (PPR), and Acreage Report (AR).[5] The WASDE report provides monthly USDA forecasts of U.S. and global supply-use balances of major agricultural commodities. The GSR is issued quarterly in January, March, June and September (the January report is released together with January WASDE), and contains estimated agricultural stocks on a state and national level, as well as on- and off-farm storage. The PPR and AR are announced annually in March and June, respectively, (both reports are released together with the March and June GSRs, respectively) and contain the expected plantings as of March 1 and acreage by planted and/or harvested areas, respectively, for crops such as corn, wheat and soybean.

To measure news surprises and analyst forecast dispersion, we collect data on analyst forecasts. In particular, we obtain analyst forecasts and actual end inventories figures for the USDA reports from Bloomberg. Bloomberg conducts surveys of various analyst firms which cover these agricultural commodities. These surveys are conducted one week prior to the announcement of the USDA reports, covering as many as 32 analysts per survey. Appendix A lists all analysts that have participated in the Bloomberg survey over our sample period along

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[4]In January 2013, the release time of major USDA reports was changed to occur during the most active trading session at 11:00am CST, allowing markets the best chance to absorb news at a time of ordinarily high liquidity (Abbott, 2012). This change allows us to assess the impact of news since market participants can rapidly adjust their positions during this time.

[5]We do not consider the weekly Crop Progress Report because it is released at 4:00pm (CST) when the corn, wheat and soybean futures markets are closed.

with the number of responses they provide.[6] The market expectation is then calculated as the median estimate across these surveys. We follow Andersen et al. (2003) and compute the standardized news surprise by subtracting the market expectation from the actual end-inventories and dividing this by its in-sample standard deviation. Hence, the standardized news surprise associated with report type i = *{WASDE, GSR, PPR, AR}* at announcement time t is

$$S_{i,t} = \frac{A_{i,t} - E_{i,t}}{\sigma_i}, \quad (5)$$

where $A_{i,t}$ and $E_{i,t}$ are the actual and expected value of report i, respectively, and σ_i is the standard deviation of $A_{i,t} - E_{i,t}$.

Apart from providing a consensus view, the surveys also allow us to compute a measure of analyst dispersion in expectations. To measure this dispersion, we compute the interquartile range among the different forecasts at time t, $IQR_{i,t}$, and normalize this by the average inventories forecast, $\mu_{i,t}$, i.e.,

$$DISP_{i,t} = \frac{IQR_{i,t}}{\mu_{i,t}}. \quad (6)$$

Table 1 provides an overview of the USDA announcements, including the time of the release, the frequency of the release, the number of observations, and summary statistics on the

[6]Isengilda et al. (2016) focus on two companies that provide private crop forecasts to capture the unanticipated news in the USDA announcement. We focus on analyst forecast, as we need a wider range of forecast in order to calculate a meaningful measure of forecast dispersion. In addition, the properties of the Bloomberg News have been investigated, for example, by Gay et al. (2009) and Chen et al. (2013), who find that, on average, Bloomberg forecasts are more consistent with the market consensus view for natural gas futures and E-mini S&P 500 futures, respectively.

content of the announcements. In total, there are 902 trading days in our sample. Of these, 53 contain USDA announcements. For the majority of the announcements, surprises are non-zero, suggesting that there is unanticipated news in the USDA announcements. Table 1 also reports the analyst forecast dispersion. The average degree of dispersion varies across the different announcements, but appears to be highest for the WASDE (between 0.0459 and 0.1135) and lowest for the AR (between 0.0067 and 0.0084), reflecting a lower degree of consensus in end inventories forecasts on the former.

INSERT TABLE 1 HERE

One issue that we may face with USDA announcement data is that of potential seasonalities, i.e., the predictability of the USDA announcement may depend on the time of the season. To address this issue, we run regressions of the news surprises and analyst forecast dispersion on monthly dummies. We find evidence of seasonalities for both news surprises and forecast dispersion. For news surprises, the seasonalities are relatively weak (F-tests for the joint significance of monthly dummies to capture the seasonal effect produce test statistics of 2.03 (p-value 0.05), 2.32 (p-value 0.03) and 3.15 (p-value 0.00) for corn, wheat and soybean, respectively). However, for the dispersion measure, we find a considerable seasonal pattern (F-statistics for the joint significance of monthly seasonal dummies are 8.16 (p-value 0.00), 9.30 (p-value 0.00), and 8.19 (p-value 0.00), for corn, wheat and soybean, respectively). For all three commodities, we observe that particularly in the months of May, July and August, dispersion tends to be high. High dispersion in May is due to the end of the planting season, which makes inventory level more difficult to forecast (Lehecka, 2014). Dispersion is also high in July and August because crop yields during this time are sensitive to northern-hemisphere summer weather conditions (Tannura et al., 2008; Lehecka, 2014). In contrast, dispersion is decreasing from October to November during the harvesting season when analysts have greater degree of certainty about their crop inventory forecasts. Finally, the lowest dispersion is during the months of December and January when the current crop season ends. We control for both seasonalities in news surprise and analyst dispersion in our regression analyses.

3.2. Futures Contracts Data

To assess the impact of USDA announcement on the BAS, we focus on the three most actively traded agricultural commodities futures at the Chicago Mercantile Exchange (CME): corn, wheat and soybean futures. These futures are electronically traded on the Chicago Board of Trade's GLOBEX trading platform. Trading in these futures is divided into a daytime (8:30am to 13:20pm) and an evening session (19:00pm to 7:45am). We focus on the daytime session as the majority of trading (approximately 90%) occurs during this period (see Wang et al., 2014; Lehecka et al., 2014). Corn and wheat futures contracts have five maturities a year: March, May, July, September, and December, while soybean futures contracts have seven maturities: January, March, May, July, August, September and November. Each futures contract is for 5,000 bushels to be delivered on the second business day following the last trading day of the delivery month. On each trading day, about 10 to 20 maturities are traded with different levels of activity. We focus on the nearby contracts as they are the most liquid, which should allow for a more accurate assessment of market response (Isengildina-Massa et al., 2008; Karali, 2012). Each contract is rolled over to the second-nearby contract when the volume of the second-nearby contract exceeds the volume of the front-end contract.

We obtain transaction-level data for prices, volume, bid-ask quotes and bid-ask depths from Thomson Reuters Tick History maintained by the Securities Industry Research Centre of Asia-Pacific. This data contains all activity observed at the top of the limit order book. This includes transactions and revisions in bid and ask prices and depths, time-stamped to the nearest millisecond. We treat multiple trades which are executed at the exact same time as one trade, as these typically reflect a trade that is initiated by one market participant but executed against the limit orders of multiple market participants. In this case, we use the value-weighted average price and aggregate the traded volume. We also clean our data from obvious outliers using the filters of Chordia et al. (2001): (i) Quoted Spread > $5; (ii) Effective Spread/Quoted Spread > 4.0; (iii) Quoted Spread/Transaction Price > 40%; (iv) Price is higher (lower) than the daily mean plus (minus) 5 times the daily standard deviation.[7]

Table 2 presents summary statistics for the futures contracts in our sample. It reports the average contract price, quoted spread, effective spread, daily number of trades, daily trading volume, volume per trade and the bid and ask depths. As can be seen from this table, the average quoted and effective spreads are comparable for the different contracts. The average number of trades is highest for soybean futures at 9,979 trades per day. The average daily trading volume and volume per trade are highest for corn futures at 67,651 and 8.6 contracts, respectively. Finally, we note that the average quantity offered at the bid and ask prices are roughly equal for wheat and soybean, but higher for corn, suggesting greater liquidity for the corn contracts.

INSERT TABLE 2 HERE

[7]Quoted spread is defined as the difference between the ask and bid prices, while effective spread is defined as two times the absolute difference between the transaction price and the quote midpoint.

4. Empirical Results

In this section, we present our empirical results. First, we focus on comparing the BAS surrounding the USDA announcement time on days with versus days without announcements. Second, we decompose the BAS and assess how the different components of the spread are affected by the USDA announcements. Third, we conduct regression analyses to study the effects of news surprises and analyst forecast dispersion on the information asymmetry components of bid-ask spread. Finally, we provide some robustness tests.

4.1. Spreads and USDA Announcements

To assess whether the BAS reacts to USDA announcements, we first plot the bid-ask spread during the daytime session on days with USDA announcements in Figure 1. Specifically, we show the average abnormal BAS, which is the average difference between the spread during announcement and non-announcement days, along with the 95% confidence interval. We observe that abnormal spreads are relatively constant throughout the trading day except during the period surrounding the USDA announcements. Spreads widen shortly prior to the news releases and peak at 11:00am CST when the USDA reports are released. Following the announcement, spreads decline gradually. Given the window surrounding the USDA announcements in which we observe the reaction in BAS, we focus our subsequent analysis on the period that lasts from about 20 minutes before the announcement to 20 minutes after.

INSERT FIGURE 1 HERE.

In Table 3, we present averages for various variables on non-announcement and announcement days. We also report difference in means tests and Wilcoxon tests for the difference in medians between announcement and non-announcement days. Panel A reports the statistics for the 40-minute window surrounding the USDA announcement (20-minute before and after). We find that quoted spreads increase significantly during this period by 0.027 cents, 0.042 cents and 0.058 cents for corn, wheat, and soybean futures, respectively. Similarly, average effective spreads increase during the same period. The number of trades and trading volume also increase significantly across all commodities. However, there is no significant change in the average volume per trade, indicating that trade size is not affected by the USDA announcements. The last two rows in Panel A show that bid and ask depths decrease during announcement periods. In the case of corn futures, the bid (ask) depth decreases by a 100 (92) contracts, a significant decrease compared to the wheat and soybean futures. This observation suggests that market participants provide less volume at the best quotes during announcement periods.

Panels B and C report the statistics for the 20-minute period before and after the announcement. We observe that while both quoted and effective spreads increase during the announcement period, the increase is stronger after the news release. We also find an increase for both the number of trades and volume in both periods, with the increase being stronger after the announcement. These observations indicate that trading and quoting activity is affected significantly in both periods.

INSERT TABLE 3 HERE

To decompose the bid-ask spread, we estimate the parameters in Equation (4) by GMM for each day over the 40-minute window surrounding the announcement time of 11:00am.[8] Table 4 presents statistics for the average quoted spread, the effective spread and the implied spreads, IS_t, computed as $IS_t = 2(\phi_t + \theta_t)$ during days with and without USDA announcements. The implied spread consists of an information asymmetry and a liquidity provision cost, which we report in U.S. cents, as well as in percentages.[9] We also provide the difference in means and medians, along with their respective test statistics.[10]

INSERT TABLE 4 HERE

Panel A of Table 4 presents the results for the period from 10:40am to 11:20am. The first two rows show the average quoted and effective spreads as the basis for comparison. Both spreads are significantly higher (at the 1% level) during days with announcements compared to days without announcements. For instance, the average quoted spread for corn futures increases by 0.027 cents while the average effective spread increases by 0.020 cents. These results are consistent with Figure 1. The third row reports the implied spread estimated using the MRR model. Similar to the quoted and effective spreads, implied spreads are significantly higher during announcement days. When we consider the two components of the spread, we observe that the increase in spread is largely due to increase in the information asymmetry component (an increase of 0.050 cents in the case of corn futures). The liquidity provision component decreases by 0.036 cents during announcement days, which is expected as the increased trading activity around the announcement times leads to a lower per-trade cost of

[8]We also consider information asymmetry and order processing components during the day before and after the announcement days with non-announcement days. On these days, we find no significant differences between the components from those pre/post-announcement days and the rest of the days, excluding announcement days.
[9]We only report the percentage spread due to information asymmetry, that is $\theta_t/(\phi_t + \theta_t)$, as the percentage of liquidity costs makes up the remainder of the spread.
[10]We conduct a similar analysis for the four different USDA announcements, separately. In general, those findings are consistent with results reported in Table 4, and are available on request.

processing a transaction (Copeland and Stoll, 1990). In percentage terms, we observe that the information asymmetry component of the BAS increases from 9.1% to 31.7%, 34.1% to 53.3%, and 35.6% to 51.4% for corn, wheat and soybean futures, respectively. Overall, these results are in line with studies in financial markets (see, for example, Krinsky and Lee, 1995; Riordan et al., 2013), where information asymmetry increases surrounding important news events.

Panel B reports the results for the period before the news release (10:40am – 11:00am).[11] We observe that the quoted, effective and implied spreads increase significantly during this period. This increase is attributed to information asymmetry (the average information asymmetry component increases by 0.009 cents, 0.024 cents and 0.022 cents for corn, wheat and soybean futures, respectively). The liquidity provision component remains relatively unchanged in the period before the USDA announcement. These results indicate an increase in trades based on private signals in the period just before the announcement, and these private signals are reflected in the BAS prior to the news announcement.

Panel C reports the results for the period after the news release (11:00am – 11:20am). We observe that the increase in BAS after the USDA news release is larger than in the period before the release. Again, this increase in BAS is driven by the increase in the asymmetric information component of the BAS. However, we also observe a significant decrease in the liquidity costs in the period after the USDA announcement. In the case of corn futures, the information asymmetry component increases by 0.057 cents while the order processing component decreases by 0.046 cents. This leads to an overall increase in the implied spread

[11]Release dates and times are published on the USDA website. Using the Bloomberg news platform as source of precise news release (considering the precise release time as the first time when the news is mentioned in Bloomberg), we observe that the 90% of news releases of our sample are during the first second after 11am. There are no news releases before 11:00am.

of 0.012 cents. The increase in information asymmetry after the USDA announcement can be attributed to divergent speeds at which market participants process new information (see e.g. Kim and Verrechia, 1994), where some market participants process this information faster than others. The decrease in liquidity provision costs can be attributed to the decline in order processing costs after the announcement, i.e. since trading volume is considerably higher post-announcement, the per-trade cost of a transaction declines, and this is factored into the BAS.

4.2. Determinants of Increased Information Asymmetry

We have demonstrated that the increase in the BAS surrounding the USDA announcements is primarily driven by the increase in information asymmetry. In this section, we consider the information content of news. Specifically, we assess the impact of two important aspects of news on information asymmetry: (i) the news surprise; and (ii) the dispersion in analyst forecasts.

We study the impact of news surprise and analyst forecast dispersion on information asymmetry using OLS regressions.[12] The regressions are estimated using the full sample period, which includes USDA announcement and non-announcement days. In the first specification, we examine the impact of news surprises measured by the absolute value of the surprise, $|S_t|$.[13] In the second specification, we separate the positive and negative news surprises. We do this by constructing a dummy variable I_t^+ which is equal to +1 if the surprise is positive and 0 otherwise, and I_t^- which is equal to -1 if the surprise is negative and

[12]Prior to estimating the regression model, we test for non-stationarity of the dependent variable using Augmented Dickey-Fuller tests. We find that the information asymmetry component, θ_t is stationary.
[13]Given that the quarterly GSR is released together with WASDE, PP or AR in some quarters, we use the surprises and analysts' dispersion of GSR on those days, as Wang et al. (2014) found that GSR reports have the biggest influence on the bid-ask spread.

0 otherwise. Here, a positive (negative) surprise reflects an inventory announcement which is bigger (smaller) than expected by analysts. For the third specification, we examine the impact of analyst forecast dispersion, $DISP_t$, on information asymmetry. Finally, for the fourth and fifth specification, we include both the news surprise and analyst forecast dispersion variables in the same equation.[14]

We include several control variables in our regressions. First, we control for time effects similar to Frank and Garcia (2011) and Wang et al. (2014). Specifically, we control for seasonalities and day-of-the-week effects by including monthly and daily dummies. We also include roll-day dummies (5^{th} to 9^{th} day of the month prior to maturity). Second, to control for market conditions, we include lagged information asymmetry, θ_{t-1}, and the roll returns (log front-end futures settlement price minus log second-nearby futures settlement price). We also include the lagged daily depth difference (average daily ask depth minus average daily bid depth), the lagged (log) daily volume and lagged (log) daily realized volatility (at 1-minute frequency) volatility, all lagged by one day to avoid endogeneity issues as pointed out in Wang et al. (2014).

Table 5 reports the results for the period surrounding the news release (10:40am to 11:20am). In the first column, we observe that the coefficients for the absolute surprises, $|S_t|$, are positive and significant at 1% level (0.029, 0.026, and 0.023 for corn, wheat and soybean futures, respectively), indicating that the bigger the surprise, the larger the information asymmetry component. In the second column, we observe that both positive and negative surprises increase the information asymmetry component at the 1% level.[15] In the third

[14]The correlation between the absolute news surprises and the forecast dispersion variables are 24% (*p*-value = 0.0462) for corn, 0% (*p*-value = 0.9840) for wheat, and 32% (*p*-value = 0.0099) for soybean.

[15]We conduct Wald tests to assess whether the impacts of positive and negative surprises are significantly different. In all cases we do not reject the null hypothesis of symmetric impact of news surprises.

column, we replace news surprises with the dispersion in analyst forecasts. We observe that the coefficients for the forecast dispersion variables are positive and highly significant, suggesting that a higher dispersion in analyst forecast prior to the USDA announcement leads to increased information asymmetry surrounding the USDA announcements. In the fourth and fifth columns, we add back the news surprise. With the addition of the analyst dispersion variable, we note that the magnitudes of the news surprise coefficients decline substantially, and in the case of soybean futures lose their significance. The analyst dispersion measure remains a highly significant determinant of information asymmetry.

INSERT TABLE 5 HERE

With regards to the control variables, we observe that the coefficient for the lagged information asymmetry is positive and significant, suggesting that there is persistence in information asymmetry across days. The roll-returns coefficient is positive and significant, in line with Wang et al. (2014). We also observe that lagged volume and lagged realized volatility are significant determinants of information asymmetry.

INSERT TABLE 6 HERE.

In Table 6, we split the period surrounding the USDA announcement into a pre-announcement period covering the 20 minutes prior to the USDA announcement (Panel A), and a post-announcement period covering the 20 minutes after the USDA announcement (Panel B).[16] Turning first to the pre-announcement period, we find that the coefficients for the news surprise is positive and significant across all commodities. This observation, that the

[16]All control variables and seasonality dummies are included in these regressions, but not reported for the sake of brevity.

surprise in the news is related to the degree of information asymmetry prior to the release of that news, suggests that some market participants could be informed about the content of the announcement before its release. When we consider the differential impact of positive and negative surprises, we find no evidence that positive or negative news has a bigger impact. When we introduce the analyst forecast dispersion measure to the regressions in columns 3-5 for each commodity, we observe that the dispersion measure is highly significant, i.e. if there is high dispersion in forecasts about the upcoming USDA announcement, then the information asymmetry prior to the news announcement is higher. The most striking result of Panel A is that when we include both the news surprise and dispersion variables, the significance of the news surprise coefficients disappears almost completely (only the significant effect of news surprises on information asymmetry for corn remains). This finding suggests that it is not the surprise in the news announcement that drives the degree of information asymmetry prior to the announcement, but the degree of dispersion among analysts, and is a finding that is in line with McNichols and Trueman (1994) who show that it pays for market participants to engage in the acquisition of private information when dispersion among analyst beliefs is high.

Panel B of Table 6 reports the regression results for the information asymmetry component of the three commodities for the 20 minute period following the USDA announcement. The results suggest that both news surprise and forecast dispersion are important determinants of information asymmetry in the period after the USDA announcement. These findings suggest that a large news surprise, or a high dispersion lead to a temporary informational asymmetry, where some market participants are faster at interpreting the information than other market participants (see Kim and Verrecchia, 1994). A large news surprise, in this case, can be seen as a large informational shock that takes time to be incorporated into prices, whereas a large dispersion can be interpreted about divergent views, which can lead to information asymmetry.

The results reported in Tables 5 and 6 are based on the full sample, including days with and without USDA announcements. As the increased information asymmetry can be due to an announcement day effect rather than surprise and/or analyst forecast dispersion effects, we also conduct our analysis focusing on days with news releases, i.e. the 53 USDA announcement days. To save degrees of freedom in this analysis, we control for the seasonality effects in both surprises and analysts dispersion by first running regressions of $|S_t|$ and $DISP_{i,t}$ on monthly dummy variables. We collect the deseasonalized residuals from these regressions, which we refer to as the *deseasonalized absolute news surprises*, $|DS_t|$ and the *deseasonalized analyst forecast dispersion*, $DDISP_{i,t}$. We then use $|DS_t|$ and $DDISP_{i,t}$ in the regressions similar to Tables 5 and 6.[17, 18]

Table 7 reports the results of the announcement day regressions, and shows that the results are, in general, consistent with those reported in Tables 5 and 6. In particular, the coefficients for the analyst dispersion variable are positive and highly significant across all periods. This observation suggests that the increase in information asymmetry on announcement days is mainly driven by the dispersion in analyst forecast. In contrast, the news surprises which are significant on their own accord, lose significance when analyst dispersion is included.

INSERT TABLE 7 HERE.

[17]Unlike the dispersion variable, we do not observe seasonality effect in the information asymmetry component when we consider only those 53 USDA announcement days. Hence, we only deseasonalize the news surprises and the analyst forecast dispersion.
[18]We also deseasonalize the news surprises (DS_t) using monthly dummies before discretizing them among positive and negative surprises.

5. Conclusion

In this paper, we assess the impact of USDA announcement on changes in the BAS for the agricultural commodities futures contracts on corn, wheat and soybean. We employ the spread decomposition model of Madhavan et al. (1997) to decompose BAS into information asymmetry and a liquidity provision components. When we compare these components during days with and without USDA announcements, we find that information asymmetry is significantly higher during USDA announcement days. More importantly, we find that the increase in information asymmetry prior to the news announcements is driven by the divergence in private information possessed by market participants (proxied by the dispersion of analyst forecast one week prior to the USDA announcement release), suggesting that market participants engage in private information acquisition, when uncertainty about the upcoming signal is large (McNichols and Trueman, 1994). Once the news is released, both analyst forecast dispersion and news surprises (the difference between actuals and market expectations) contribute to increased information asymmetry and widening of the BAS. This is in line with Kim and Verrecchia (1994), who suggest that some traders have an informational advantage due to their speed of processing information.

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Appendix A. Analyst Forecast in the Bloomberg's Survey

Panel A: Forecasts for Corn

Corn									
	WASDE	GSR	PP	AR		WASDE	GSR	PP	AR
A/C Trading	37	8	4	2	GlobalEqon LLC	0	0	0	0
ABN Amro	3	2	1	0	Goldman, Sachs & Co.	0	0	0	1
ADM Investor Services	42	13	4	3	Grain Service	24	13	3	3
Advance Trading Inc	2	0	0	0	Hightower Report	9	4	3	2
Advanced Economic Solutions	2	2	1	1	Hueber Report	13	3	0	1
Advanced Market Concepts	39	15	4	4	INTL FCStone	41	13	3	4
AgResource	10	3	2	1	Jefferies Bache	27	10	3	2
AgriSource	34	2	3	0	Jefferies Llc	1	0	0	0
AgriVisor Services	34	15	4	4	Linn Group	33	12	4	4
Allendale Inc.	24	6	3	3	Love Consulting	42	15	4	4
Bennett Consulting	8	4	1	2	Macquarie Bank Ltd.	1	0	0	0
Brock Associates	1	0	0	1	Macquarie Group	20	8	2	2
Brugler Marketing	35	11	0	2	Mckeaney-Flavell	35	11	3	3
CHS Hedging Inc	21	8	2	2	Midco Commodities	6	0	0	0
CHS Hedging Llc	11	2	1	1	Morgan Stanley	1	1	0	1
Citi Futures Perspective	5	0	0	0	NewEdge	20	7	2	2
Citigroup	19	7	3	3	Northstar Commodity	41	13	4	4
Citigroup Global Markets Inc	0	1	0	1	Pira Energy Group	12	3	4	3
Commodity Information Systems	29	11	4	4	Price Futures Group	40	15	4	3
Corn & Soybean Advisor	0	0	0	0	Prime Agriculture Consulting	36	15	4	4
Country Hedging	3	1	0	0	R.J. O'Brien & Associates	41	14	4	4
Daniels Trading	1	1	0	1	Rabobank	5	0	2	1
DC Analysis Llc	6	2	1	1	Rabobank Nederland	0	0	1	0
Deutsche Bank Securities	4	1	0	1	Risk Management Commodities	13	1	1	0
Doane Agricultural Services	42	15	2	4	Roach AG	1	0	0	0
ED&F MAN Capital Markets Inc	36	13	3	4	Societe Generale	3	0	3	2
EFG Group	41	14	4	4	Stewart-Peterson Group	38	12	4	4
Farm Direction Llc	7	3	2	1	U.S. Commodities Inc.	36	12	4	3
Farm Futures	39	13	4	4	Vantage RM	36	12	3	4
FC Stone Inc	4	1	0	0	Walsh Trading	14	0	2	1
Fimat Futures	0	1	0	0	Water Street Solutions Inc	3	1	1	1
Fintec Group Inc	4	2	1	0	Western Milling	15	5	2	2
Futures International LLC	35	12	3	3	Zaner Group Llc	29	11	3	3
Global Commodity A&C	7	0	1	0					

Note: This table reports the analysts that provide forecasts for the various USDA announcements for corn. The table reports the name of the analyst firm as well as the number of forecasts that the analyst produced over the sample period.

Panel B: Forecasts for Wheat

Wheat									
	WASDE	GSR	PP	AR		WASDE	GSR	PP	AR
A/C Trading	26	3	0	0	Grain Service	23	13	2	1
ABN Amro	3	2	1	0	Hightower Report	9	4	3	1
ADM Investor Services	42	13	4	2	Hueber Report	11	3	0	0
Advanced Economic Solutions	2	2	1	1	INTL FCStone	41	13	3	2
Advanced Market Concepts	41	15	4	2	Jefferies Bache	27	10	3	1
AgResource	5	3	2	0	Jefferies Llc	1	0	0	0
AgriSource	28	1	1	0	Linn Group	28	11	4	2
AgriVisor Services	35	15	4	2	Love Consulting	42	15	4	2
Allendale Inc.	25	6	3	1	Macquarie Bank Ltd.	0	1	0	0
Bennett Consulting	5	2	1	1	Macquarie Group	21	7	2	1
Brock Associates	1	0	0	1	Mckeaney-Flavell	32	11	3	2
Brugler Marketing	31	8	0	0	Midco Commodities	6	0	0	0
CHS Hedging Inc	21	8	2	1	NewEdge	20	7	2	1
CHS Hedging Llc	11	2	1	1	Northstar Commodity	41	12	4	2
Citi Futures Perspective	5	0	0	0	Pira Energy Group	5	1	3	1
Citigroup	17	6	3	1	Price Futures Group	39	13	4	1
Commodity Information Systems	18	3	4	1	Prime Agriculture Consulting	35	15	3	2
Country Hedging	3	1	0	0	R.J. O'Brien & Associates	41	13	4	2
Daniels Trading	1	1	0	1	Rabobank	0	0	2	0
DC Analysis Llc	6	2	1	1	Risk Management Commodities	2	1	0	0
Deutsche Bank Securities	1	0	0	0	Roach AG	1	0	0	0
Doane Agricultural Services	35	12	2	2	Societe Generale	3	0	3	0
ED&F MAN Capital Markets Inc	36	13	3	2	Stewart-Peterson Group	38	12	4	2
EFG Group	41	14	4	2	U.S. Commodities Inc.	10	4	2	0
Farm Direction Llc	7	2	2	0	Vantage RM	36	12	2	2
Farm Futures	38	14	4	2	Walsh Trading	14	0	1	0
FC Stone Inc	4	1	0	0	Water Street Solutions Inc	3	1	1	1
Fintec Group Inc	5	2	1	0	Western Milling	14	5	2	1
Futures International LLC	35	12	3	1	Zaner Group Llc	29	11	3	2
Global Commodity A&C	7	0	1	0					

Note: This table reports the analysts that provide forecasts for the various USDA announcements for wheat. The table reports the name of the analyst firm as well as the number of forecasts that the analyst produced over the sample period.

Panel C: Forecasts for Soybean

Soybean									
	WASDE	GSR	PP	AR		WASDE	GSR	PP	AR
A/C Trading	37	8	4	2	GlobalEqon LLC	0	1	0	0
ABN Amro	3	2	1	0	Goldman, Sachs & Co.	0	0	0	1
ADM Investor Services	42	13	4	3	Grain Service	24	12	3	3
Advance Trading Inc	1	0	0	1	Hightower Report	9	4	3	2
Advanced Economic Solutions	2	2	1	1	Hueber Report	13	3	0	1
Advanced Market Concepts	40	15	4	3	INTL FCStone	41	13	3	4
AgResource	8	3	2	1	Jefferies Bache	27	10	3	2
AgriSource	35	2	3	0	Jefferies Llc	1	0	0	0
AgriVisor Services	35	15	4	4	Linn Group	33	12	4	4
Allendale Inc.	24	6	3	3	Love Consulting	42	15	4	4
Bennett Consulting	8	4	1	2	Macquarie Bank Ltd.	2	0	0	0
Brock Associates	1	0	0	1	Macquarie Group	19	8	2	2
Brugler Marketing	35	11	0	2	Mckeaney-Flavell	35	11	3	3
CHS Hedging Inc	21	8	2	2	Midco Commodities	6	0	0	0
CHS Hedging Llc	11	2	1	1	Morgan Stanley	1	1	0	1
Citi Futures Perspective	5	0	0	0	NewEdge	20	7	2	2
Citigroup	19	7	3	3	Northstar Commodity	41	13	4	4
Citigroup Global Markets Inc	0	1	0	1	Pira Energy Group	12	3	4	3
Commodity Information Systems	28	10	4	4	Price Futures Group	40	15	4	3
Corn & Soybean Advisor	1	0	0	0	Prime Agriculture Consulting	36	15	4	4
Country Hedging	3	1	0	0	R.J. O'Brien & Associates	41	14	4	4
Daniels Trading	1	1	0	1	Rabobank	5	1	2	1
DC Analysis Llc	6	2	1	1	Rabobank Nederland	0	0	1	0
Deutsche Bank Securities	4	1	0	1	Risk Management Commodities	13	1	1	0
Doane Agricultural Services	42	14	2	4	Roach AG	1	0	0	0
ED&F MAN Capital Markets Inc	36	13	3	4	Societe Generale	3	0	3	2
EFG Group	41	14	4	4	Stewart-Peterson Group	38	12	4	4
Farm Direction Llc	7	3	2	1	U.S. Commodities Inc.	36	12	4	3
Farm Futures	39	14	4	4	Vantage RM	36	12	3	4
FC Stone Inc	4	1	0	0	Walsh Trading	14	0	2	1
Fintec Group Inc	4	2	1	0	Water Street Solutions Inc	3	1	1	1
Futures International LLC	35	12	3	3	Western Milling	15	5	2	2
Global Commodity A&C	7	0	1	0	Zaner Group Llc	29	11	3	3

Note: This table reports the analysts that provide forecasts for the various USDA announcements for soybean. The table reports the name of the analyst firm as well as the number of forecasts that the analyst produced over the sample period.

Table 1. US Department of Agriculture (USDA) Announcements

This table provides summary statistics for the USDA announcement releases for the period January 1, 2013 to July 31, 2016. It reports the time of the release (in Central Standard Time), the frequency of the release, and the total number of releases in the sample period. The table also reports statistics for the surveys, actuals, and surprises for each of the agricultural commodities, along with the standard deviation of the surprises and the average analyst forecast dispersion.

Agricultural Announcements	CST	Frequency	Obs	Survey (in millions)	Actual (in millions)	Surprises (in millions)	Non-zero surprises	Surprises std dev	$DISP_t$
World Agricultural Supply and Demand Estimate	11:00	Monthly							
- Corn			42	1,722.3	1,699.3	-22.98	40	96.22	0.0644
- Wheat			42	734.6	739.3	4.64	40	37.87	0.0459
- Soybean			42	325.8	327.7	1.95	37	26.78	0.1135
Grain Stocks Report	11:00	Quarterly							
- Corn			15	5,877.7	5,893.8	16.13	15	181.66	0.0245
- Wheat			15	1,339.9	1,338.1	-1.80	15	33.77	0.0289
- Soybean			15	1,140.3	1,131.2	-9.07	15	48.96	0.0516
Prospective Plantings Report	11:00	Annually							
- Corn			4	92.4	92.9	0.52	4	2.20	0.0094
- Wheat			4	54.8	54.3	-0.50	4	0.67	0.0117
- Soybean			4	82.2	81.4	-0.86	4	0.98	0.0140
Acreage Report	11:00	Annually							
- Corn			4	92.2	93.0	0.79	4	1.03	0.0071
- Wheat			2	52.9	55.0	2.11	2	1.55	0.0084
- Soybean			4	82.3	82.8	0.53	4	0.19	0.0067
Total Announcements Days (adjusted)			53						
Total Non-Announcement Days			849						
Total Sample Days			902						

Table 2. Summary Statistics

This table provides summary statistics for the agricultural futures contracts. The reported figures are based on activities observed during daytime trading (8:30am and 11:00am), averaged over the sample period from January 1, 2013 to July 31, 2016.

	Corn	Wheat	Soybean
Price per bushel (in cents)	513.8	620.1	1214.3
Quoted Spread (in cents)	0.253	0.261	0.262
Effective spread (in cents)	0.255	0.261	0.265
Trades per day	8,129	5,642	9,979
Volume per day	67,651	26,999	46,658
Volume per Trade	8.6	4.9	4.8
Bid Depth	173	28	28
Ask Depth	177	28	27

Table 3. Summary Statistics Surrounding News Announcements Period

This table provides summary statistics for the agricultural futures contracts during the period surrounding USDA report announcements. The reported figures are the average values over the sample period from January 1, 2013 to July 31, 2016. "*NA*" and "*A*" denote Non-Announcement and Announcement days, respectively. Panel A reports the summary statistics during the full 40-minute period surrounding the announcement (10:40am to 11:20am). Panel B reports the summary statistics for the 20-minute period prior to the announcement (10:40am to 11:00am). Panel C reports the summary statistics for the 20-minute period following the announcement (11:00am to 11:20am). Figures in parentheses are the t-statistics corrected using Newey-West correction. ***, ** and * denote statistical significance at 1%, 5% and 10% level, respectively.

	Corn Futures						**Wheat Futures**						**Soybean Futures**					
	NA	*A*	*Mean Diff*	*T-stat*	*Median Diff*	*Wilcoxon*	*NA*	*A*	*Mean Diff*	*T-stat*	*Median Diff*	*Wilcoxon*	*NA*	*A*	*Mean Diff*	*T-stat*	*Median Diff*	*Wilcoxon*
Panel A: Full Period (10:40 – 11:20)																		
Quoted Spread	0.252	0.279	0.027***	(18.51)	0.021***	(11.37)	0.259	0.301	0.042***	(13.08)	0.041***	(10.73)	0.260	0.318	0.058***	(19.80)	0.058***	(10.99)
Effective Spread	0.249	0.269	0.020***	(20.65)	0.015***	(11.39)	0.252	0.284	0.032***	(19.14)	0.025***	(11.57)	0.253	0.299	0.046***	(25.21)	0.039***	(11.67)
Trade	1,502	7,028	5,526***	(9.93)	5,608***	(10.13)	1,092	4,012	2,919***	(10.55)	3,006***	(10.95)	1,883	8,063	6,179***	(12.04)	6,321***	(12.50)
Volume	12,376	58,814	46,438***	(11.14)	47,436***	(11.47)	5,206	17,917	12,711***	(11.24)	13,303***	(12.12)	8,833	38,248	29,415***	(11.56)	30,282***	(12.05)
Volume per Trade	8.4	9.0	0.6	(1.34)	1.1**	(2.35)	4.8	4.6	-0.2	(-1.36)	0.0	(-0.04)	4.8	4.9	0.1	(1.03)	0.2**	(2.01)
Average Bid Depth	176	77	-100***	(-5.92)	-85***	(-5.82)	29	17	-12***	(-11.19)	-10***	(-9.51)	28	19	-9***	(-5.93)	-7***	(-5.35)
Average Ask Depth	178	86	-92***	(-4.53)	-77***	(-3.87)	29	16	-12***	(-12.16)	-11***	(-11.56)	27	17	-11***	(-4.85)	-9***	(-4.71)
Panel B: 20-minute before (10:40 – 11:00)																		
Quoted Spread	0.252	0.258	0.006***	(6.33)	0.004***	(8.01)	0.259	0.270	0.011***	(3.92)	0.008***	(5.89)	0.260	0.273	0.013***	(5.93)	0.014***	(7.46)
Effective Spread	0.249	0.253	0.002***	(6.00)	0.004***	(6.56)	0.252	0.259	0.008***	(5.78)	0.005***	(6.35)	0.253	0.263	0.011***	(8.69)	0.009***	(9.21)
Trade	667	1,018	352***	(8.40)	415***	(10.13)	488	575	86***	(3.23)	143***	(5.28)	827	1,135	308***	(4.16)	395***	(5.42)
Volume	5,431	7,915	2,484***	(7.12)	3,358***	(9.70)	2,345	2,635	290*	(1.91)	605***	(4.05)	3,888	5,030	1,142***	(3.72)	1,625***	(5.39)
Volume per Trade	8.2	8.1	0.0	(-0.09)	0.5	(1.57)	4.8	4.7	-0.1	(-0.67)	0.1	(0.42)	4.8	4.5	-0.2**	(-1.97)	-0.1	(-0.50)
Average Bid Depth	173	123	-50***	(-5.85)	-31***	(-5.30)	29	21	-7***	(-3.83)	-5***	(-2.63)	27	20	-8***	(-5.82)	-6***	(-4.76)
Average Ask Depth	173	130	-44***	(-4.41)	-26***	(-2.76)	28	21	-8***	(-5.45)	-6***	(-4.64)	27	21	-6***	(-4.57)	-4***	(-3.56)
Panel C: 20-min after (11:00 – 11:20)																		
Quoted Spread	0.252	0.283	0.031***	(19.79)	0.025***	(11.56)	0.307	0.259	0.048***	(14.15)	0.039***	(10.95)	0.326	0.260	0.066***	(21.09)	0.066***	(11.14)
Effective Spread	0.249	0.272	0.024***	(21.81)	0.017***	(11.51)	0.288	0.251	0.037***	(20.01)	0.028***	(11.65)	0.305	0.253	0.052***	(26.28)	0.049***	(11.70)
Trade	648	5,798	5,149***	(9.90)	5,213***	(10.00)	457	3,306	2,849***	(10.92)	2,891***	(11.15)	832	6702	5,870***	(12.82)	5,972***	(12.92)
Volume	5,400	49,237	43,837***	(11.19)	44,703***	(11.36)	2,169	14,705	12,536***	(11.94)	12,832***	(12.33)	3,882	32,263	28,380***	(12.42)	28,948***	(12.68)
Volume per Trade	8.3	9.3	0.9	(1.57)	1.5***	(2.71)	4.8	4.6	-0.1	(-1.00)	0.1	(1.02)	4.8	5.0	0.2*	(1.88)	0.4***	(2.88)
Average Bid Depth	180	62	-118***	(-5.65)	-98***	(-5.49)	29	15	-13***	(-9.55)	-11***	(-8.12)	28	18	-10***	(-4.84)	-8***	(-4.52)
Average Ask Depth	181	67	-114***	(-4.45)	-95***	(-4.12)	29	15	-14***	(-10.18)	-12***	(-9.75)	27	16	-12***	(-4.25)	-10***	(-3.99)

Table 4. Spread Decomposition during Announcements

This table reports the estimates from the MRR decomposition model. It includes the quoted, effective and implied spreads, and the various spread components during USDA report announcements (A), non-announcement days (NA), and their mean and median differences. Panel A reports the components during the full 40-minute period surrounding the announcement (10:40am to 11:20am). Panel B reports the components for the 20-minute period prior to the announcement (10:40am to 11:00am). Panel C reports the components for the 20-minute period following the announcement (11:00am to 11:20am). Figures in parentheses are the t-statistics corrected using Newey-West correction. ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

	Corn Futures						**Wheat Futures**						**Soybean Futures**					
	NA	*A*	*Mean Diff*	*T-stat*	*Median Diff*	*Wilcoxon*	*NA*	*A*	*Mean Diff*	*T-stat*	*Median Diff*	*Wilcoxon*	*NA*	*A*	*Mean Diff*	*T-stat*	*Median Diff*	*Wilcoxon*
Panel A: Full Period (10:40 - 11:20)																		
Quoted spread	0.252	0.279	0.027***	(18.51)	0.021***	(11.37)	0.259	0.301	0.042***	(13.08)	0.041***	(10.73)	0.260	0.318	0.058***	(19.80)	0.058***	(10.99)
Effective Spread	0.249	0.269	0.020***	(20.65)	0.015***	(11.39)	0.252	0.284	0.032***	(19.14)	0.025***	(11.57)	0.253	0.299	0.046***	(25.21)	0.039***	(11.67)
Implied spread	0.189	0.203	0.014**	(2.51)	0.009**	(2.31)	0.161	0.215	0.054***	(7.86)	0.047***	(9.35)	0.171	0.247	0.076***	(12.95)	0.078***	(10.57)
-Information asymmetry, θ (in cents)	0.016	0.066	0.050***	(12.64)	0.026***	(11.48)	0.054	0.116	0.062***	(9.41)	0.068***	(10.54)	0.061	0.129	0.068***	(8.70)	0.069***	(10.46)
-Liquidity provision, φ (in cents)	0.173	0.137	-0.036***	(-3.65)	-0.021***	(-7.48)	0.107	0.099	-0.008	(-1.03)	-0.009*	(-1.86)	0.110	0.118	0.008	(1.11)	0.010**	(1.97)
-Information asymmetry, θ (in %)	9.1%	31.7%	22.6%***	(9.57)	24.9%***	(11.17)	34.1%	53.3%	19.2%***	(5.13)	20.4%***	(8.56)	35.6%	51.4%	15.8%***	(3.81)	16.1%***	(8.11)
Panel B: 20-minutes before (10:40 - 11:00)																		
Quoted spread	0.252	0.258	0.006***	(6.33)	0.004***	(8.01)	0.259	0.270	0.011***	(3.92)	0.008***	(5.89)	0.260	0.273	0.013***	(5.93)	0.014***	(7.46)
Effective Spread	0.249	0.253	0.002***	(6.00)	0.004***	(6.56)	0.252	0.259	0.008***	(5.78)	0.005***	(6.35)	0.253	0.263	0.011***	(8.69)	0.009***	(9.21)
Implied spread	0.187	0.197	0.009*	(1.81)	0.011**	(2.14)	0.161	0.179	0.018***	(2.61)	0.019***	(4.13)	0.170	0.191	0.021***	(3.69)	0.024***	(5.78)
-Information asymmetry, θ (in cents)	0.016	0.025	0.009**	(2.39)	0.009***	(3.79)	0.054	0.078	0.024***	(3.49)	0.029***	(4.51)	0.060	0.082	0.022***	(2.78)	0.020***	(4.90)
-Liquidity provision, φ (in cents)	0.171	0.172	0.000	(0.02)	-0.005	(-0.23)	0.107	0.101	-0.006	(-0.72)	-0.001	(-0.68)	0.110	0.109	-0.001	(-0.07)	0.003	(0.17)
-Information asymmetry, θ (in %)	9.3%	12.9%	3.5%	(1.64)	3.8%***	(3.08)	34.4%	42.8%	8.4%**	(2.02)	10.6%***	(3.13)	35.6%	42.6%	6.9%	(1.61)	4.9%***	(3.11)
Panel C: 20-minutes after (11:00 - 11:20)																		
Quoted spread	0.252	0.283	0.031***	(19.79)	0.025***	(11.56)	0.307	0.259	0.048***	(14.15)	0.039***	(10.95)	0.326	0.260	0.066***	(21.09)	0.066***	(11.14)
Effective Spread	0.249	0.272	0.024***	(21.81)	0.017***	(11.51)	0.288	0.251	0.037***	(20.01)	0.028***	(11.65)	0.305	0.253	0.052***	(26.28)	0.049***	(11.70)
Implied spread	0.191	0.203	0.012**	(1.99)	0.004	(1.53)	0.161	0.221	0.060***	(13.39)	0.053***	(9.14)	0.172	0.257	0.085***	(13.98)	0.086***	(10.63)
-Information asymmetry, θ (in cents)	0.015	0.074	0.057***	(14.09)	0.061***	(11.54)	0.054	0.122	0.069***	(9.76)	0.073***	(10.73)	0.061	0.137	0.076***	(9.27)	0.080***	(10.69)
-Liquidity provision, φ (in cents)	0.176	0.129	-0.046***	(-4.63)	-0.048***	(-8.21)	0.107	0.098	-0.009	(-1.14)	-0.009**	(-1.99)	0.110	0.119	0.009	(1.17)	0.009**	(2.05)
-Information asymmetry, θ (in %)	8.8%	35.9%	26.5%***	(10.96)	28.5%***	(11.33)	34.2%	55.0%	20.9%***	(5.35)	22.9%***	(8.55)	35.8%	52.8%	17.0%***	(3.95)	17.6%***	(8.29)

Table 5. The Impact of News Surprises and Analyst Forecast Dispersion on Information Asymmetry (Full Period)

This table reports the regression coefficients of news surprises and analyst forecast dispersion on the information asymmetry component of spread over the sample period from January 1, 2013 to July 31, 2016. $|S_t|$ denotes the absolute news surprises. $(I_t^+ * S_t)$ and $(I_t^- * S_t)$ denote positive and negative news surprises, respectively. $DISP_{i,t}$ denotes the dispersion variable of Equation (6). The control variables included are lagged information asymmetry component, lagged market depths, roll returns, lagged (log) daily volume, lagged (log) daily realized volatility, roll days and dummies for seasonalities (month of the year and day of the week effects). Newey-West consistent t-statistics are presented in parentheses. ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

	Corn Futures					Wheat Futures					Soybean Futures				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Constant	0.053***	0.053***	0.056***	0.055***	0.055***	0.087***	0.086***	0.090***	0.092***	0.092***	0.127***	0.126***	0.135***	0.133***	0.130***
	(4.93)	(4.89)	(5.22)	(5.56)	(5.52)	(3.35)	(3.31)	(3.57)	(3.70)	(3.65)	(4.42)	(4.36)	(4.56)	(4.60)	(4.53)
$\lvert S_t \rvert$	0.029***			0.016***		0.026***			0.013***		0.023***			0.005	
	(10.22)			(5.48)		(7.81)			(3.25)		(4.03)			(0.80)	
$I_t^+ * S_t$		0.027***			0.013***		0.025***			0.012***		0.021***			0.001
		(6.13)			(3.46)		(5.37)			(2.74)		(2.76)			(0.10)
$I_t^- * S_t$		0.031***			0.018***		0.028***			0.015***		0.026***			0.010
		(8.62)			(4.80)		(6.13)			(2.90)		(3.72)			(1.47)
$DISP_t$			0.325***	0.217***	0.219***			0.539***	0.361***	0.360***			0.246***	0.214***	0.222***
			(9.29)	(5.89)	(6.36)			(6.56)	(4.12)	(4.14)			(8.16)	(7.38)	(6.59)
θ_{t-1}	0.175***	0.179***	0.177***	0.187***	0.192***	0.278***	0.277***	0.263***	0.269***	0.269***	0.366***	0.367***	0.361***	0.364***	0.367***
	(3.59)	(3.66)	(3.45)	(3.86)	(3.95)	(6.02)	(6.03)	(5.67)	(5.87)	(5.88)	(9.03)	(8.87)	(8.97)	(9.17)	(9.10)
$Depth_{t-1}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.10)	(0.09)	(-0.33)	(-0.16)	(-0.17)	(0.25)	(0.20)	(0.83)	(0.68)	(0.63)	(1.41)	(1.39)	(0.94)	(0.97)	(0.92)
$Roll\_Ret_t$	0.065***	0.065***	0.066***	0.064***	0.063***	0.198***	0.195***	0.192***	0.194***	0.191***	0.036	0.037	0.017	0.021	0.022
	(8.11)	(8.12)	(7.18)	(7.46)	(7.43)	(3.38)	(3.37)	(3.69)	(3.59)	(3.55)	(1.08)	(1.10)	(0.57)	(0.71)	(0.74)
Vol_{t-1}	-0.003***	-0.003***	-0.003***	-0.003***	-0.003***	-0.005***	-0.005***	-0.005***	-0.005***	-0.005***	-0.007***	-0.007***	-0.007***	-0.007***	-0.007***
	(-4.63)	(-4.65)	(-5.02)	(-5.27)	(-5.35)	(-3.19)	(-3.15)	(-3.29)	(-3.46)	(-3.42)	(-4.12)	(-4.11)	(-4.10)	(-4.13)	(-4.09)
$RVol_{t-1}$	0.002*	0.002*	0.002*	0.002**	0.002*	0.003	0.003	0.004	0.004	0.004	0.006**	0.006**	0.007***	0.007***	0.007***
	(1.87)	(1.80)	(1.93)	(2.05)	(1.95)	(1.26)	(1.23)	(1.40)	(1.52)	(1.49)	(2.48)	(2.41)	(2.84)	(2.84)	(2.75)
$Roll\_Day_t$	0.001	0.001	0.000	0.000	0.000	-0.001	-0.001	-0.001	-0.001	-0.002	0.001	0.001	-0.002	-0.002	-0.002
	(1.27)	(1.21)	(-0.08)	(-0.20)	(-0.32)	(-0.35)	(-0.39)	(-0.54)	(-0.84)	(-0.87)	(1.06)	(1.02)	(-1.63)	(-1.45)	(-1.55)
Month of year dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Day of week dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R2	0.52	0.52	0.55	0.60	0.61	0.30	0.30	0.32	0.34	0.34	0.33	0.33	0.40	0.40	0.41

Table 6. The Impact of News Surprises and Analyst Forecast Dispersion on Information Asymmetry (Before and After)

This table reports the regression coefficients of news surprises and analyst forecast dispersion on the information asymmetry component of spread over the sample period from January 1, 2013 to July 31, 2016. $|S_t|$ denotes the absolute news surprises. $(I_t^+ * S_t)$ and $(I_t^- * S_t)$ denote positive and negative news surprises, respectively. $DISP_{i,t}$ denotes the dispersion variable of Equation (6). The *Control* variables include the lagged information asymmetry component, the lagged market depths, the roll returns, the lagged (log) daily volume and the lagged (log) daily realized volatility. The *Time Effects* variables include the dummies for month, day-of-the-week and roll days. Newey-West corrected t-statistics are reported in parentheses. ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

	Corn Futures					**Wheat Futures**					**Soybean Futures**				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Panel A: 20-minute before (10:40 - 11:00)															
Constant	0.05***	0.05***	0.05***	0.05***	0.05***	0.08***	0.08***	0.08***	0.08***	0.08***	0.07***	0.07***	0.08***	0.08***	0.08***
	(4.79)	(4.79)	(4.97)	(4.98)	(4.98)	(3.11)	(3.05)	(3.26)	(3.29)	(3.23)	(2.98)	(2.96)	(3.09)	(3.09)	(3.06)
$\vert S_t \vert$	0.01***			0.002**		0.01***			0.00		0.01***			0.00	
	(4.96)			(2.20)		(3.54)			(0.57)		(3.54)			(0.28)	
$I_t^+ * S_t$		0.01***			0.00*		0.01**			0.00		0.01***			0.00
		(4.19)			(1.75)		(2.42)			(-0.21)		(4.12)			(-0.57)
$I_t^- * S_t$		0.01***			0.00*		0.01***			0.01		0.01**			0.00
		(3.51)			(1.82)		(2.84)			(1.06)		(2.00)			(0.70)
$DISP_t$			0.08***	0.06***	0.06***			0.21***	0.19***	0.19***			0.08***	0.08***	0.08***
			(6.18)	(4.21)	(4.18)			(4.42)	(2.77)	(2.79)			(5.77)	(3.72)	(3.84)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.42	0.42	0.43	0.43	0.43	0.18	0.19	0.20	0.20	0.20	0.31	0.31	0.32	0.32	0.32
Panel B: 20-minute after (11:00 - 11:20)															
Constant	0.06***	0.06***	0.06***	0.06***	0.06***	0.13***	0.13***	0.13***	0.13***	0.13***	0.20***	0.20***	0.21***	0.21***	0.21***
	(4.82)	(4.79)	(5.06)	(5.41)	(5.40)	(3.99)	(3.97)	(4.10)	(4.24)	(4.21)	(6.35)	(6.32)	(6.51)	(6.54)	(6.51)
$\vert S_t \vert$	0.03***			0.02***		0.03***			0.01***		0.03***			0.01	
	(10.39)			(5.46)		(7.57)			(3.25)		(4.04)			(0.72)	
$I_t^+ * S_t$		0.03***			0.01***		0.03***			0.01***		0.02***			0.00
		(6.11)			(3.26)		(5.17)			(2.69)		(2.71)			(0.06)
$I_t^- * S_t$		0.03***			0.02***		0.03***			0.02***		0.03***			0.01
		(8.87)			(4.87)		(6.06)			(2.88)		(3.91)			(1.47)
$DISP_t$			0.37***	0.25***	0.25***			0.60***	0.40***	0.40***			0.27***	0.24***	0.25***
			(9.12)	(5.81)	(6.24)			(6.63)	(4.27)	(4.28)			(8.10)	(7.55)	(6.67)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R2	0.47	0.47	0.51	0.56	0.56	0.26	0.25	0.28	0.30	0.30	0.29	0.29	0.37	0.37	0.37

Table 7. The Impact of News Surprises and Analyst Forecast Dispersion on Information Asymmetry (Announcement Days Sample)

This table reports the regression coefficients of news surprises and analyst forecast dispersion on the information asymmetry component of spread over the 53 announcement days. $|DS_t|$ denotes the deseasonalized absolute news surprises. $(I_t^+ * DS_t)$ and $(I_t^- * DS_t)$ denote deseasonalized positive and negative news surprises, respectively. $DDISP_t$ denotes the deseasonalized analyst forecast dispersion variable. White corrected t-statistics are presented in parentheses. ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

	Corn Futures					Wheat Futures					Soybean Futures				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Panel A: Full Period (10:40 - 11:20)															
Constant	0.033***	0.029***	0.033***	0.033***	0.03***	0.058***	0.056***	0.058***	0.058***	0.056***	0.065***	0.064***	0.065***	0.065***	0.065***
	(18.72)	(10.68)	(18.94)	(19.45)	(11.48)	(24.42)	(15.85)	(24.88)	(24.89)	(16.08)	(25.04)	(18.88)	(27.00)	(27.01)	(20.25)
$\|DS_t\|$	0.013**			0.009*		0.001			0.001		0.003			-0.000	
	(2.42)			(1.67)		(0.17)			(0.27)		(1.01)			(-0.09)	
$I_t^+ * DS_t$		0.004			0.003		-0.001			0.000		0.005			0.001
		(0.90)			(0.72)		(-0.23)			(0.03)		(0.96)			(0.15)
$I_t^- * DS_t$		0.012***			0.010**		0.005			0.006		-0.002			-0.002
		(2.70)			(2.25)		(1.35)			(1.41)		(-0.90)			(-0.68)
$DDISP_t$			0.197***	0.153**	0.173***			0.212**	0.214**	0.213**			0.170***	0.172***	0.164***
			(3.15)	(2.39)	(2.72)			(2.17)	(2.17)	(2.12)			(3.20)	(3.14)	(2.70)
Adj-R2	0.09	0.06	0.11	0.14	0.13	-0.02	-0.01	0.02	0.00	0.01	-0.01	-0.01	0.13	0.12	0.10
Panel B: 20-minute before (10:40 - 11:00)															
Constant	0.013***	0.011***	0.013***	0.013***	0.012***	0.039***	0.042***	0.039***	0.039***	0.041***	0.041***	0.042***	0.041***	0.041***	0.043***
	(10.49)	(5.91)	(10.74)	(11.00)	(6.41)	(13.99)	(9.07)	(14.31)	(14.42)	(9.26)	(19.21)	(13.62)	(19.92)	(20.09)	(14.59)
$\|DS_t\|$	0.009**			0.006*		-0.005			-0.005		-0.001			-0.003	
	(2.33)			(1.66)		(-1.42)			(-1.22)		(-0.47)			(-1.30)	
$I_t^+ * DS_t$		0.003			0.002		-0.009*			-0.008*		-0.001			-0.003
		(0.82)			(0.69)		(-1.92)			(-1.70)		(-0.35)			(-1.12)
$I_t^- * DS_t$		0.003			0.002		0.001			0.002		-0.002			-0.002
		(1.15)			(0.59)		(0.18)			(0.29)		(-0.63)			(-0.49)
$DDISP_t$			0.145**	0.116**	0.140***			0.322**	0.315**	0.288**			0.097***	0.112***	0.108***
			(2.57)	(2.06)	(2.54)			(2.34)	(2.26)	(2.16)			(2.59)	(2.77)	(2.80)
Adj-R2	0.09	-0.02	0.13	0.15	0.10	0.00	0.03	0.04	0.04	0.06	-0.02	-0.03	0.05	0.05	0.03
Panel C: 20-minute after (11:00 - 11:20)															
Constant	0.036***	0.032***	0.036***	0.036***	0.033***	0.061***	0.059***	0.061***	0.061***	0.059***	0.069***	0.068***	0.069***	0.069***	0.069***
	(19.24)	(11.38)	(19.45)	(19.83)	(12.02)	(24.97)	(16.94)	(25.36)	(25.37)	(17.09)	(25.70)	(19.80)	(27.72)	(27.73)	(21.22)
$\|DS_t\|$	0.012**			0.008		0.001			0.001		0.003			-0.001	
	(2.05)			(1.36)		(0.23)			(0.31)		(0.84)			(-0.19)	
$I_t^+ * DS_t$		0.004			0.002		0.000			0.001		0.004			0.001
		(0.82)			(0.62)		(-0.03)			(0.22)		(0.89)			(0.12)
$I_t^- * DS_t$		0.013***			0.011**		0.005			0.005		-0.003			-0.002
		(2.72)			(2.28)		(1.29)			(1.34)		(-1.05)			(-0.85)
$DDISP_t$			0.189***	0.148**	0.163***			0.200**	0.201**	0.204*			0.175***	0.179***	0.168***
			(3.00)	(2.23)	(2.54)			(1.98)	(1.99)	(1.93)			(2.98)	(3.00)	(2.53)
Adj-R2	0.06	0.06	0.08	0.10	0.11	-0.02	-0.02	0.01	-0.01	0.00	-0.01	-0.01	0.13	0.11	0.10

Figure 1. Abnormal Quoted Spreads

This figure plots the abnormal quoted spread (quoted spread during USDA report announcement less non-announcement days) for the agricultural futures contracts, along with the 95% confidence intervals. The plots are the average spreads across the sample period from January 1, 2013 to July 31, 2016.

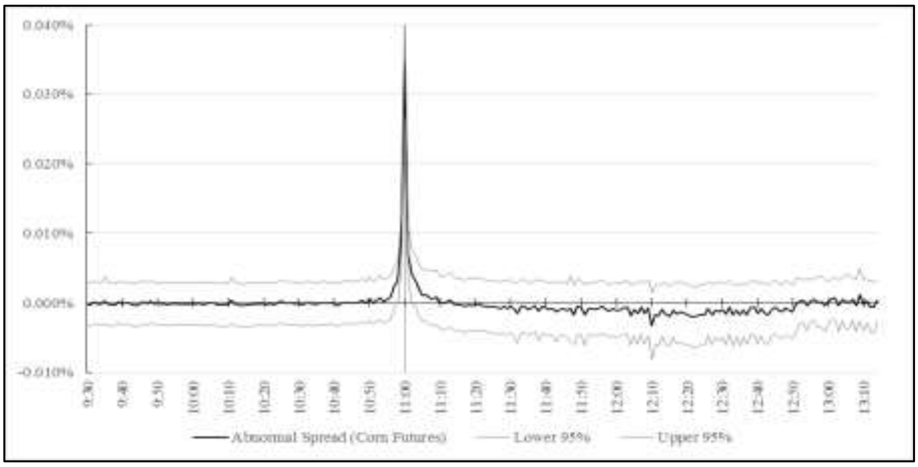

Figure 1.A: Corn Futures Abnormal Quoted Spread

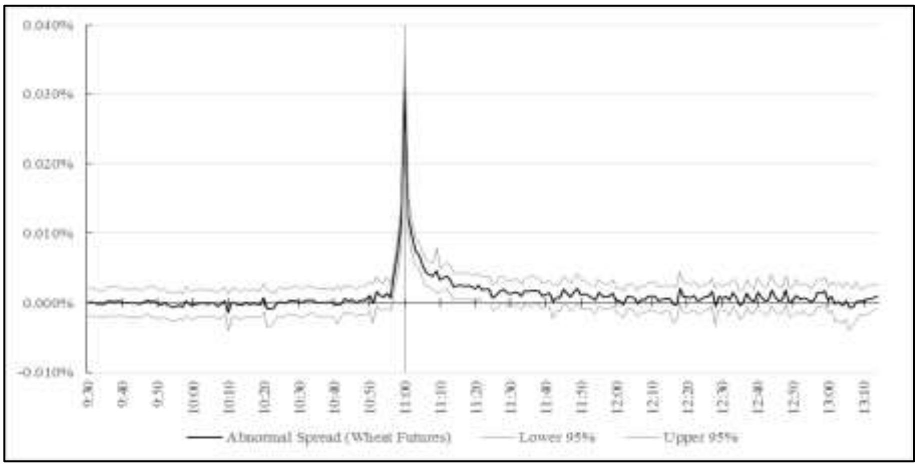

Figure 1.B: Wheat Futures Abnormal Quoted Spread

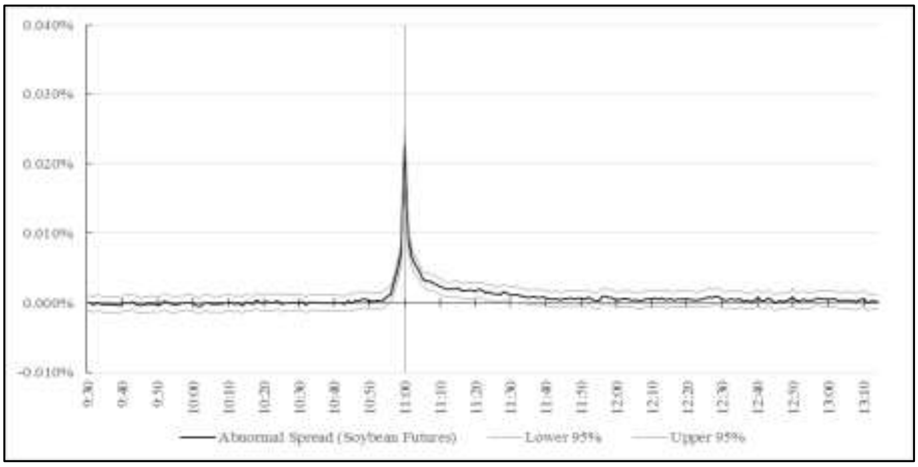

Figure 1.C: Soybean Futures Abnormal Quoted Spread