Intraday Market Effects in Electronic Soybean Futures Market during Non-Trading and Trading Hour Announcements

Kishore Joseph, Philip Garcia*

*Kishore Joseph (kjoseph5@csuchico.edu) is an Assistant Professor in Agricultural Business in the College of Agriculture at California State University Chico. Philip Garcia is the Thomas A. Hieronymus Distinguished Chair in Futures Markets and Director, Office of Futures and Options Research in the University of Illinois at Urbana-Champaign.

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Abstract

This paper investigates market reactions to major USDA announcements during trading and non-trading hours in the soybean futures market. The findings indicate that report releases during non-trading hours cause a large spike in volatility at the onset of trading which subsides quickly. In contrast, releases during trading hours result in a smaller volatility spike which extends for five to six minutes at a higher magnitude. Adjusting volatility by normal trading volatility indicates that trading hour volatility is higher in both immediate response and persistence. Return correlations provide little evidence to support systematic under- or overreaction in prices regardless of when the report is released, reflecting the efficiency of the market.

Introduction

In May 2012, the Chicago Mercantile Exchange (CME) extended its electronic trading hours. As a result, major United Stated Department of Agriculture (USDA) reports released at 7:30 a.m. central time, including World Agricultural Supply and Demand Estimates (WASDE), Crop Production (CP), Grain Stocks (GS), Acreage (AC), and Prospective Planting and Small Grains Summary (PP), coincided with real-time trading hours.[1] In January 2013, USDA officially shifted these reports releases to 11:00 a.m., formalizing trading hour releases.

The change in release time led to a heated debate. Proponents of pre-opening releases argue that a period without trading contributes to an informative opening price, and quicker and efficient price adjustment. Concerns also emerged that releasing reports during trading hours would lead to extended periods of volatility as traders adjust to new information.[2] In

[1] WASDE reports provide monthly forecast of U.S. and world supply-use balance of soybeans, meal, and oil. CP reports contain U.S. crop production information and are released along with WASDE reports. GS reports provide estimates of stocks at the state and national level, and by on- and off-farm positions. They are released in January, March, June, and September. AC reports provide soybean planted and harvested acreage by state and is released yearly by the end of June. PP reports provide U.S soybean planted acreage and is released annually by the end of March.

[2] On August 3, 2012 USDA published market participants' responses to the proposed change in release time.

contrast, supporters of the change argue that releasing reports during high volume, deeply-liquid trading hours dampens volatility, allowing shocks to be readily absorbed improving price discovery. They also point out that trading time releases can strengthen price discovery in the futures market relative to unregulated over-the-counter (OTC) swap markets.

The debate is rooted in the disparate nature of the market participants and the way they conduct business. Research in financial markets suggests that trading releases are accompanied by less time for decision makers and extended volatility in the face of increased uncertainty (Greene and Watts 1996; Brooks, Patel, and Su 2003). Traditional market participants including grain elevators, processors, agribusiness firms, and producers who use futures markets to hedge price risks often make decisions that require time to evaluate new information. When reports arrive during trading these participants have less time to make informed decisions, and heightened volatility may lead to costly margin calls and increase hedging risks (Kauffman 2013). In contrast, automated trading firms that focus on quick arbitrage opportunities or in providing liquidity services can benefit from the higher volatility which emerge in uncertain market situations (Welch et al. 2012).

The significant impact of USDA reports on agricultural commodity prices is well documented (e.g., Milonas 1987, Sumner and Mueller 1989, Garcia et al. 1997, McKenzie 2008, Isengildina-Massa et al. 2008a, 2008b, Adjemian 2012). More recently, researchers have used market microstructure data to understand the impact of USDA reports. Using intraday corn futures prices, Lehecka, Wang, and Garcia (2014) investigate the announcement effects of major USDA reports (WASDE, CP, GS, AC, and PP) released during non-trading hours. Strongest market reactions to news release are found immediately after the market opens and market reactions persist for about ten minutes. Their assessment of returns using measures of correlation indicates that prices oscillate in the first few minutes following the market open and then decline in volatility with little evidence of systematic under- and overreactions. They conclude that the corn futures market is efficient in incorporating new information. Based on intraday price quotes, Wang, Garcia, and Irwin (2013) find that GS, CP, and WASDE reports have significant effects on corn bid-ask spreads. They suspect that this increase may be due to uncertainty in the direction and magnitude of subsequent price adjustments following report release. Kauffman (2013) also identifies intraday announcement effects. Using intraday corn futures data, he finds that releasing the WASDE report during trading hours increased volatility briefly around the announcement. He points out that the increased volatility did not extend beyond 30 to 60 minutes and argues that producers with longer-term risk management strategies should not be affected by the change in release time. While this work is informative, most of the recent work has focused solely on the corn market and no work has directly compared the differential impact of USDA announcements during trading and non-trading hours.

Using microstructure data, we investigate the speed and magnitude at which soybean futures market adjusts to USDA announcements during trading and non-trading hour releases. The findings indicate that report releases during non-trading hours cause a large spike in volatility at the onset of trading which subsides quickly. In contrast, releases during trading hours result in a relatively smaller volatility spike which extends for five to six minutes at a higher magnitude. On report days, adjusted trading hour volatility is higher in terms of immediate response and persistence. Return correlations provide little evidence to support systematic under- or overreaction in prices regardless of when the report is released, reflecting the efficiency of the market.

USDA Reports and Price Data

The announcement data reflect WASDE, CP, GS, AC, and PP reports from June 2010-May 2014. The reports are separated into two distinct periods. The first period is June 2010-May 2012, where 30 reports were released during non-trading hours (Table 1, Panel A), and the second period is June 2012-May 2014 where 29 reports were released during trading hours (Table 1, Panel B).[3] Prior to the change in release time, these reports were released

[3]The October 2013 report was not released due to a government shut-down.

at 7:30 a.m. after the early morning electronic-only trading session and before the start of the floor or electronic day trading (Figure 1, Panel A). On May 21, 2012, CBOT extended its electronic-only (Globex) trading hours allowing trade when USDA reports are released (Figure 1, Panel B). Since January 2013, reports are released by USDA at 11:00 a.m. during day trading hours. To assess the effects of report release during trading and non-trading hours, we categorize June 2010-May 2012 as one period, and June 2012-May 2014 as the second period. Because of the limited number of release dates and since releases for specific reports can overlap, we pool the reports during each period and focus primarily on the pooled data. While this may attenuate the effects of certain reports, treating both periods in the same manner should allow us to effectively estimate differences between non-trading and trading releases. Nevertheless, we also investigate behavior of prices within the WASDE group of announcements. All report dates are compiled from World Agricultural Outlook Board (WAOB) and National Agricultural Statistical Service (NASS) archives at the USDA Economics, Statistics, and Market Information System located at Albert R. Mann Library, Cornell University.

The price data consist of tick-by-tick transaction prices and volumes on each day of day trading session on report and pre-/post-report days for CBOT soybean futures contracts from June 2010-May 2014. The nearby contract for soybeans is used because they are the most heavily traded and liquid contract and we switch to the next nearby contract prior to the first day of the expiration month (Isengildina-Massa et al. 2008a, 2008b). Prices for soybean futures are specified in cents/bu. with a quarter cent minimum tick size ($12.50 per 5000 bu. contract). The data are from Time and Sales data (Globex prices) from the CME historical data mine. The Globex trading sessions for which prices are available are presented in Figure 1.[4]

[4]The electronic markets for soybean futures reflect new information more quickly compared to floor trading, making Globex the ideal market to assess reactions to news (Martinez et al. 2011).

Research Design and Results

Prices can be observed at very high frequency during report release. We measure aggregate effects at the 15-second interval, which should maintain a reasonable balance between market reactions to the arrival of information and microstructure noise.[5] Average estimates of 15-second return variances are computed for report release days, pre-/post-report release days (five days before and after the report day) and compared using non-parametric procedures. While the focus is on 15-second volatility, it is important to understand that the soybean price levels have varied considerably in the period of analysis, making comparisons across alternate release types more challenging. To make the comparisons more precise, the volatility on report days is standardized by corresponding pre-/post-report day volatilities, computing average normalized volatility which is used to compare volatility across release types. All market effects are measured in a window 15 minutes before and 60 minutes after report release where most market reactions are expected. Finally, the systematic under- and overreactions in returns following report releases are assessed by computing sequential and cumulative return correlations. Combined assessment of return variances and market under- and overreactions for release types will reveal the speed at which information is incorporated into the soybean futures market, reflecting the quality of the price discovery during alternate releases.

We start the analysis by examining returns for nearby soybean futures contracts for alternate release periods. Returns are computed as follows

$$r_{i,t} = ln\left[\frac{P_{i,t}}{P_{i,t-1}}\right] \times 100, \tag{1}$$

with $P_{i,t}$ being the last price of the nearby soybean futures contract in each 15-second interval i, on trading day t. The first return of each trading session is calculated using the last price from the previous trading session. When no trading occurs during an interval, the return is not calculated and the observation is considered as a missing value.

[5] Microstructure noise may arise at higher frequencies due to periods of no trade as well as bid-ask bounce.

Since trading clock times differ in the sample, a common window is used for analysis. Previous studies (Andersen et al. 2007; Christiansen and Ranaldo 2007) use a window 10 minutes before and 90 minutes after news announcement. Prior to report release, Lehecka, Wang, and Garcia (2014) and Kauffman (2013) find significant market reactions in corn markets as traders adjust their positions to manage market exposure. In addition, Kauffman (2013) identifies that volatility may extend over 30 to 60 minutes when USDA reports are released during trading hours. To capture these market reactions, we compute returns from 15 minutes before the report is released to 60 minutes afterwards i.e., 300 15-second intervals. For report releases in the first period (i.e., June 2010-May 2012), this implies concatenating 15 minutes of data closest to report release from the previous electronic-only trading session with sixty minutes of day trading data after the report release. That is, the first return is measured at 7:00:15 and the last return measured at 10:30. For report releases in the second period (June 2012-May 2014) two event windows exist. For reports released at 7:30 a.m. when Globex markets are open (June 2012-December 2012), the first return is computed at 7:15:15 a.m. and the last return is computed at 8:30:00 a.m. For reports released at 11:00 a.m. (January 2011-May 2014), the first return is computed at 10:45:15 a.m. and the last return is computed at 12:00 p.m. We follow the convention used in Sumner and Mueller (1989), Isengildina-Massa et al. (2008a), and Lehecka, Wang, and Garcia (2014) and include pre-/post-report days as a measure of normal market conditions around the report day. Hence, for every report released, 15-second returns are computed from nearby soybean futures contracts for five days before the release date, the day of the release, and five days after the report release.[6]

Summary statistics for 15-second returns on report and pre-/post-report days are presented for non-trading hour releases (Table 2, Panel A) and trading hour releases (Table 2, Panel B). Mean returns are zero across both periods for report and pre-/post-report days. Report day returns in general exhibit higher variance and increased skewness and kurto-

[6]While the number of pre-/post-report days is restricted to five to avoid overlap with previous/subsequent report release days, including all GS, AC, and PP report days cause a few days to overlap.

sis. Returns in the first period (Panel A) exhibit relatively higher variance, skewness, and kurtosis compared to the second period (Panel B). While the standard deviation of returns in Panel A exceeds the standard deviation of returns in panel B, the standardized ratio of report and pre-/post-report day standard deviations is smaller in Panel A (0.13/0.05=2.6) compared to Panel B (0.09/0.03=3). This suggests that once the volatility on report days is standardized by the corresponding average pre-/post-report day volatility (which measures the normal market conditions), market reactions may be more pronounced for trading hour report releases. Returns during report and pre-/post-report days are not normally distributed, suggesting the need to use non-parametric methods to test various hypotheses.

Before analyzing the announcement effect on market prices, we investigate soybean futures returns for missing observations as periods of no trading are correlated with volume which may affect both price variance as well as the speed of price adjustment (Easley and O'Hara 1992; Blume, Easley, and O'Hara 1994). Moreover, a large number of missing observations may affect our modest sample size (particularly for report days) and reduce the accuracy of estimates. In the first period, the 15-second intervals without trading on report and pre-/post-report days amount to 10.8% and 14.6% of the sample respectively. In the second period, missing observations reach 9% and 21.5% for the report and pre-/post-report days. However, for the first 15 trading minutes following report release in the first period, only a negligible 2.6% of observations on report days and 3.5% on pre-/post-report days are missing. For the second period, 2.9% and 18.5% of observations are missing on report and pre-/post-report days respectively during the first 15 minutes post report release. Separating report and pre-/post-report day data in the second period further based on the 7:30 a.m. and 11:00 a.m. release indicates that a larger proportion of missing observations are from the 15 minutes period following the 7:30 a.m. release.[7] The difference can be attributed to the increased trading activity during the more liquid trading hours and may have influenced

[7]The number of missing observations in the 15 minute period after 7:30 a.m. on report days is 7.4% and 36.4% on pre-/post-report days. The corresponding numbers decrease to 0.9% and 10.5% on report and pre-/post-report days for the 11:00 a.m. release.

the USDA decision to move the release of reports into the day trading session at 11:00 a.m. While the large number of missing observations (18.5%) in the pooled sample for pre-/post-report days in the second period appears alarming, this period represents sessions of intraday trading with very little price variation, where the missing observations have only negligible impact on measured volatility.

The market reactions in a futures market may be complicated by limit price moves (Isengildina-Massa et al. 2008a; Adjemian 2012). For a large part of our sample, price limit for CBOT soybean futures contract was \$0.70/bu. expandable to \$1.05/bu. and then to \$1.60/bu. From May 1, 2014, the daily price limit has been variable and reset every six months in May and November (CBOT Rulebook, Chapter 11 Soybean Futures). This variable price limit for soybean futures was \$1/bu. expandable to \$1.50/bu. We examined report days for large moves in soybean futures prices and find three limit move days in the first period and no limit moves in the second period. The small number of limit move days in the first period is unlikely to have a substantial impact on market reaction test results and is left unadjusted (McKenzie, Thompson, and Dixon 2004; Adjemian 2012).

Return Variance on Report and Pre-/Post-Report Days

We now relate USDA report release to the measures of aggregate market activity. Both trade volume and volatility reflects the impact of public information arrival. Since trade volume is construed as a noisy measure of public information arrival, studies have often used return variance to assess market reactions following news release. Moreover, research from the financial markets has identified volatility to be closely associated with information arrival (Ederington and Lee 1993; Fleming and Remonola 1999; Kalev et al. 2004; Riordan et al. 2013). Return variance is first graphically examined and then statistical compared across report and pre-/post-report days for each period.

To measure volatility, we use a measure similar to Entorf, Gross, and Steiner (2012) and Lehecka, Wang, and Garcia (2014). Volatility for time interval i at day t is computed as

(2) $$V_{i,t} = |r_{i,t} - r_i^m|,$$

where $r_{i,t}$ denotes the soybean futures returns for each 15-second time interval i at day t and r_i^m is the median return for time interval i in each period. Volatility on report and pre-/post-report days are computed using the median return (r_i^m) for time interval i, measured separately for those days. The average intraday volatility for each interval I (i=1,..., 300) is formulated as

(3) $$\overline{V}_{i,t} = \frac{1}{T_i}\sum_{t=1}^{T_i} V_{i,t},$$

where T_i is the number of observations in interval i for report and pre-/post-report days separately in the period analyzed.[8]

Figure 2, Panel A compares the volatility on report and pre-/post-report days for non-trading hour report release, and Panel B compares them for trading hour report release. In both periods, volatilities peak immediately following report release and major market reactions persist for about 10 to 15 minutes. The magnitude of volatility at 1.43 is highest for non-trading hour release in the first 15-second interval. However, the high volatility is short-lived, quickly drops to .10, and then stabilizes above .05 in a couple of minutes. In contrast, the volatility during the first 15-seconds for trading hour release peaks at lower magnitude (.51) following report release, but persists at a higher level of .15 for the first 2 minutes and .10 for the next 5 to 6 minutes before dropping to a stable .05 level. The volatilities on pre-/post-report days, immediately after report arrival are .23 and .02 in the first and second periods respectively. The higher volatility during pre-/post-report days in the first period persists for 5 to 6 minutes and then stabilizes. In contrast, the volatility on pre-/post-report days in the second period remains low and more or less stable. Visual comparison of the two plots indicates that report days for trading hour releases exhibit extended volatility relative to pre-/post-report days when compared to non-trading report releases. Both report day and pre-/post-report day volatilities in the first period are measured following the market

[8]The median is used as it is more robust to outliers. However, volatility calculated using the mean, and standard deviation of returns exhibit similar behavior.

open, whereas, in the second period, volatilities are not affected by the market open.

The differences in volatility on report and pre-/post-report days are statistically compared employing non-parametric Kruskal-Wallis tests (Isengildina-Massa et al. 2008a; Lehecka, Garcia, and Wang 2014). Kruskall-Wallis tests the hypothesis that several samples are from the same population (Kruskall and Wallis 1952; 1953). Results of the analysis are presented in Figure 3, Panel A for non-trading hour report releases and Panel B for trading hour report releases. The left vertical axis represents the test statistic which is a Chi-Square statistic here, and the right axis represents the 95% significance level. The p-values values greater than .05 are scaled to .05. A p-value less than .05 represents the statistically different volatility on report and pre-post report days for the interval. The results support visual inspection and indicate that USDA reports produce substantial market reactions on report release days regardless of the timing of information release. The non-parametric tests reveal significant difference between volatility on report days and pre-/post-report days around report release. While, the difference in return variance is short lived for the first period, it is significant in the second period for 30 to 40 minutes after the release and appears to persist intermittently for nearly 60 minutes. The increased persistence in volatility during trading hour report releases corresponds with the notion that full implication of the report is known only after initial search and analysis which is revealed through trading (Ederington and Lee 1993).

Despite their smaller sample sizes, market reactions to report release are also assessed for WASDE only days and for WASDE sub-groups with and without the NASS U.S. production estimates.[9] In general, the pattern of volatility for all groups is similar to those in the pooled analysis already presented. However, the initial impact of the report release varies considerably among the groups. For the WASDE only group, average volatility for the first 15-second interval post report release is 1.24 and .47 for the first and second periods respectively. This is lower than the pooled analysis which also includes the GS reports. The

[9]For the first and second release periods, the sample of report days are 24 and 23 for the WASDE group, 8 and 7 for the WASDE sub-group with NASS production, and 16 each for the WASDE sub-group without NASS production. Plots of these volatilities are not presented, but are available.

reduced impact of the WASDE group compared to the pooled group is consistent with the findings by Wang, Garcia, and Irwin (2014) who report that GS reports have the strongest effect on corn market as reflected in bid and ask spreads. In the WASDE sub-group without NASS U.S. production estimates, the report impacts are .91 and .36 for non-trading and trading hour report releases respectively. For the WASDE sub-group with NASS U.S. production estimates, the report impacts following report release is 1.89 in the first period and .71 for trading release, consistent with the increased impact in these select reports identified by Isengildina-Massa et al. (2008a). The similarity of our findings with previous studies indicate that despite small sample sizes our volatility measure is able to correctly identify differences in market impact across different groups of reports adding to the credibility of approach.[10]

To test the hypothesis that traditional open and close prices do not precisely estimate market effects, we calculate close-to-close returns and open-to-close returns for both periods using prior day Globex close and open prices and report day closing prices. The traditional method overestimates modestly the market impact from news for the first period at 1.43 calculated in the first 15-second interval, with a close-to-close estimate of 1.72 and an open-to-close estimate of 1.88 respectively. For the second period, the volatility estimates using close-to-close returns are 1.48 and 1.73 respectively, which are substantially higher than .51 measured using intraday data. Hence, our evidence suggests that traditional procedures using close and open prices appear to overestimate market impact, particularly in the current trading hour report release environment.

Report Effects across Periods Using Normalized Volatility

Report effects for different release types across periods using return variances may be confounded since it is difficult to determine whether the differences emerge because of the change in release type or due to the inherent volatility differences in the periods. To address this

[10]Further analysis of the reports in the second period, differentiating them into groups released at 7:00 a.m. and 11:00 a.m. identify a volatility pattern similar to the pooled analysis.

point, we compute normalized volatility by standardizing the volatility on each report day by the average pre-/post-report day volatility around it. Pre-/post-report days may not be affected by the change in trading related to information release and reflects normal market conditions prevailing during each period. Similarly, normalizing by the average pre-/post days around the report should permit us to account for the limited market activity that commonly occurs in this market in mid-day trading (see Figure 2, Panel B). Therefore, standardizing with pre-/post-report day volatility should separate volatility effects inherent to the period from report day return variance, making comparisons in market reactions between the different periods more meaningful.[11]

The normalized volatility on report days for the time interval i at day t is computed as

$$NV_{i,t} = \frac{|r_{i,t} - r_i^m|^{Report\ Day}}{\left[\frac{\sum_{n=1}^{N} |r_{i,t} - r_i^m|^{Pre-/Post-Report\ Day}}{n-1}\right]}, \tag{4}$$

where $r_{i,t}$ denotes the soybean futures returns for each 15-second time interval i at day t, r_i^m is the median return for time interval i over all trading days measured separately for report and pre-/post-report days in each period, and n is the number of pre-/post-report days around each report day such that $Min(n) = 1$ and $Max(n) = 10$.[12] When the return on a report day in an interval is missing, the $Min(n) = 1$ criterion is not met for pre-/post-report days, and/or average volatility on pre-/post-report days is zero, the observation is dropped from the sample. The average normalized volatility for each interval I (i=1,..., 300), is computed as

$$\overline{NV}_{i,t} = \frac{1}{T_i} \sum_{t=1}^{T_i} NV_{i,t}, \tag{5}$$

where T_i is the number of observations in interval i for report and pre-/post-report days separately for the period analyzed.

[11] While this approach may not remove all inherent volatility effects during the period, it provides a more reasonable measure of comparing report effects across periods.

[12] We use "$n-1$" instead of "n" in equation due to our small sample size and to better approximate the true variance.

Average normalized volatility represents the standardized volatility on report days during alternate report releases (Figure 4). To facilitate comparison, the figure is provided with a reference line at base value one, which reflects equality between report and pre-/post-report day volatility (Lehecka, Wang, and Garcia 2014). Average normalized volatility above one should reflect the effect from report release relative to normal market conditions. Side-by-side comparison of average normalized volatility on report days suggest volatility during non-trading hour report release is negligible following the first 15-second interval. Whereas, the average normalized volatility on trading hour report release extends to 29.34 in the first 15-second interval and remains persistently higher for thirty to forty minutes following trading hour report release.

Intraday trading hour report release has a larger and more protracted effect relative to the regular volatility observed in the market. This is consistent with the notion that investors need more time to digest information and weigh the price implications of the report when it arrives during trading. In part this is also because the comparison in the second period is made relative to a time with limited information arrival (mid-day trading). The difference in normalized volatility across periods can be attributed to the relatively tranquil pre-/post-report days in the second period. These days during the second period contain a larger number of no-trade intervals (missing observations), reflecting limited information arrival. For instance, the volatility on pre-/post-report days coinciding with the first 15-second interval after report release for the first period is .02 compared to .23 in the second period indicating the lower levels of volatility that prevail during the period. Therefore, normalized volatility has to be interpreted with caution in terms of the market significance for different release types. Regardless, it reflects the current structure of the market and identifies what market participants are likely to face in the future.

Market Under- and Overreaction on Report Days

Report days are characterized by price reversals and continued price adjustments following a report release (Lehecka, Wang, and Garcia 2014). USDA reports comprise several pages of complex summaries that require time to analyze before market participants can trade based on it. The increased persistence of volatility during trading hour report releases identified earlier supports this notion. This added time required to absorb the information may also lead to the market to under- or over-react to the report. Ederington and Lee (1993) argue that it may be possible to make profits by observing initial price response and buying (selling) if the initial return is positive (negative) because of the gradual adjustment of price to the equilibrium level. These characteristic reversals are important because most high frequency trading strategies are based on short-term intra-day reversals (Brogaard 2010). Since major reactions in the soybean futures market stabilize within the first 10 to 15 minutes, we assess whether the market reflects systematic under- or overreaction to news during the first 15 minutes following report release. Market under- and overreactions can be statistically tested by computing correlations between the first return and subsequent returns as well as between cumulative subsequent returns. If soybean market underreacts (overreact), correlation should be positive (negative). The Spearman's rank correlation measure which does not rely on normality assumptions is used to compute correlations.

The results for correlation tests are presented for the first (Table 3A) and second (Table 3B) periods. First, the number of significant correlations is quite small for both periods. For both periods, the first significant interval correlation is negative which raises the possibility that the market overreacts to news within the first minute and then corrects quickly in later periods. A clearly persistent, but not significant pattern of negative cumulative correlation emerges for both periods. For the first period, significant negative correlations are observed towards the end of the first and second minutes, start of the fifth and sixth minutes, and the end of the fourteenth minute. In the case of trading hour report releases, significant negative correlations exist only in the middle of the first minute and at the end of the fourth, ninth, and eleventh minutes. Nevertheless, it is difficult to establish a solid pattern from the results. These results should be interpreted with caution because: 1) the correlations are based on small sample sizes; 2) only a few intervals reflect significant correlations with the first return; and 3) the magnitude of these correlations are not large.

Conclusions

The paper contributes to the literature on intraday USDA announcement effects by examining 15-second return variance in soybean futures market following non-trading and trading hour report releases. The effects of WASDE, CP, GS, PP, and AC reports are assessed during non-trading hour report release for the period June 2010-May 2012, and trading hour report releases from June 2012-May 2014. We follow an event framework using 15-second intervals, focusing on differences in market reactions 15 minutes before and 60 minutes after report releases.

Volatility remains higher for the first 10 to 15 minutes following report release regardless of the timing of report release. For reports released during non-trading hours a large spike in volatility at the onset of trading emerges, which subsides quickly. For releases during trading hours, a relatively smaller spike in volatility arises immediately after the report release that extends for 5 to 6 minutes at a high magnitude. Standardizing the return variances by normal market conditions provides evidence that on a relative basis the trading hour releases generate higher volatility both in terms of immediate response and persistence. These findings are also similar to Kauffman (2013) who finds that corn futures volatility on report days during extended trading hours in 2012 are higher and persist longer relative to non-report days. Higher persistent volatility in the second period is consistent with the notion that information release during trading can cause protracted market effects. Based on the correlation tests on market returns for report days, a definitive characteristic reversal pattern could not be deduced from price reactions 15 minutes following report release in either period. The results in general support earlier studies that indicate soybean futures markets are quick and efficient in incorporating new information into prices irrespective of the timing of release.

We also measured average trade volume and average number of trades at 15-second intervals for the two periods. Volume and volatility appear to be closely related and follow an identical pattern as expected. While the trading volume remains more or less similar on report days, the number of transactions following report release is much higher for trading hour report releases. Hence, relatively more transactions may be needed to incorporate information from reports into the prices during trading hour releases.

Overall, our empirical results are consistent with the notion that the soybean futures market incorporates public information in scheduled USDA announcements quickly. Our findings identify the report effects that market participants are most likely to expect in the future under the new trading hour report release regime. Finally, we provide a measure for market volatility for USDA announcements that is not clouded by the market open.

References

Adjemian, M.K. 2012. "Quantifying the WASDE Announcement Effect." *American Journal of Agricultural Economics* 94(1): 238-256.

Andersen, T.G., T. Bollerslev, F.X. Diebold, and C. Vega. 2007. "Real-Time Price Discovery in Stock, Bond and Foreign Exchange Markets." *Journal of International Economics* 73(2): 251-277.

Baaron, M., J. Brogaard, and A. Kirilenko. 2012. "The Trading Profits of High Frequency Traders." Working Paper. Princeton University.

Blume, L., D. Easley, and M. O'Hara. (1994). "Market Statistics and Technical Analysis: The Role of Volume." *The Journal of Finance* 49(1): 153-181.

Brogaard, J. 2010. "High Frequency Trading and its Impact on Market Quality." Northwestern University Kellogg School of Management Working Paper, 66.

Brooks, R.M., A. Patel, and T. Su. 2003. "How the Equity Market Responds to Unanticipated Events." *The Journal of Business* 76(1): 109-133.

Christiansen, C. and A. Ranaldo. 2007. "Realized Bond-Stock Correlation: Macroeconomic Announcement Effects." *Journal of Futures Markets* 27(5): 439-469.

D'Agostino, R.B., A. Belanger, and R.B. D'Agostino Jr. 1990. "A Suggestion for Using Powerful and Informative Tests of Normality." *The American Statistician* 44(4): 316-321.

Easley, D. and M. O'Hara. 1992. "Time and the Process of Security Price Adjustment." *The Journal of Finance* 47(2): 577-605.

Ederington, L.H. and J.H. Lee. 1993. "How Markets Process Information: News Releases and Volatility." *The Journal of Finance* 48(4): 1161-1191.

Entorf, H., A. Gross, and C. Steiner. 2012. "Business Cycle Forecasts and their Implications for High Frequency Stock Market Returns." *Journal of Forecasting* 31(1): 1-14.

Fleming, M.J. and E.M. Remolona. 1999. "Price Formation and Liquidity in the U.S. Treasury Market: The Response to Public Information." *The Journal of Finance* 54(5): 1901-1915.

Garcia, P., S.H. Irwin, R.M. Leuthold, and L. Yang. 1997. "The Value of Public Information in Commodity Futures Markets." *Journal of Economic Behavior and Organization* 32(4): 559-570.

Greene, J.T. and S.G. Watts. 1996. "Price Discovery on the NYSE and the NASDAQ: The Case of Overnight and Daytime News Releases." *Financial Management* 25(1): 19-42.

Isengildina-Massa, O., S.H. Irwin, D.L. Good, and J.K. Gomez. 2008a. "The Impact of Situation and Outlook Information in Corn and Soybean Futures Markets: Evidence from WASDE Reports." *Journal of Agricultural and Applied Economics* 40(1): 89-103.

____. 2008b. "Impact of WASDE Reports on Implied Volatility in Corn and Soybean Markets." *Agribusiness* 24(4): 473-490.

Kalev, P.S., W.M. Liu, P.K. Pham, and E. Jarnecic. 2004. "Public Information Arrival and

Volatility of Intraday Stock Returns." *Journal of Banking and Finance* 28(6): 1441-1467.

Kauffman, N.S. 2013. "Have Extended Trading Hours Made Agricultural Commodity Markets More Risky?" *Economic Review Federal Reserve Bank of Kansas City.*

Kruskal, W.H. and W.A. Wallis. 1952. "Use of Ranks in One-Criterion Variance Analysis." *Journal of the American Statistical Association* 47(260): 583-621.

____. 1953. "Errata: Use of Ranks in One-Criterion Variance Analysis." *Journal of the American Statistical Association* 48(264): 907-911.

Lehecka, G.V., X. Wang, and P. Garcia. 2014. "Gone in Ten Minutes: Intraday Evidence of Announcement Effects in the Electronic Corn Futures Market." *Applied Economic Perspectives and Policy* 0(0): 1-23.

Martinez, V., P. Gupta, Y. Tse, and J. Kittiakarasakun. 2011. "Electronic Versus Open Outcry Trading in Agricultural Commodities Futures Markets." *Review of Financial Economics* 20(1): 28-36.

McKenzie, A.M. 2008. "Pre-Harvest Price Expectations for Corn: The Information Content of USDA Reports and New Crop Futures." *American Journal of Agricultural Economics* 90(2): 351-366.

McKenzie, A.M. and N. Singh. 2011. "Hedging Effectiveness around U.S. Department of Agriculture Crop Reports." *Journal of Agricultural and Applied Economics* 43(1): 77-94.

McKenzie, A.M., M.R. Thomsen, and B.L. Dixon. 2004. "The Performance of Event Study Approaches using Daily Commodity Futures Returns." *Journal of Futures Markets* 24(6): 533-555.

Milonas, N.T. 1987. "The Effects of USDA Crop Announcements on Commodity Prices." *Journal of Futures Markets* 7(5): 571-589.

Riordan, R., A. Storkenmaier, M. Wagener, M., and S.S. Zhang. 2013. "Public Information Arrival: Price Discovery and Liquidity in Electronic Limit Order Markets." *Journal of Banking and Finance* 37(4): 1148-1159.

Summer, D.A. and R.A. Mueller. 1989. "Are Harvest Forecasts News? USDA Announcements and Futures Market Reactions." *American Journal of Agricultural Economics* 71(1): 1-8.

Wang, X., P. Garcia, and S.H. Irwin. 2013. "The Behavior of Bid-Ask Spreads in the Electronically-Traded Corn Futures Market." *American Journal of Agricultural Economics* 96(2): 557-577.

Welch, M., D. Anderson, J. Robinson, D. Vedenov, and M. Waller. 2012. "What to Expect from Expanded Trading Hours." *Food and Fiber Economics* 41(1): 1-3. Texas AgriLife Extension Service.

Table 1. Select USDA Reports and Soybeans Futures Contracts, June 2010-May 2014

Calendar Month	Reports	Dates of Report Release		Soybean Futures Contract
Panel A. Reports released during non-trading hours				
June	WASDE, CP	6/10/2010	6/9/2011	July
–	GS, AC	6/30/2010	6/30/2011	July
July	WASDE, CP	7/9/2010	7/12/2011	August
August	WASDE, CP	8/12/2010	8/11/2011	September
September	WASDE, CP	9/10/2010	9/12/2011	November
–	GS	9/30/2010	9/30/2011	November
October	WASDE, CP	10/8/2010	10/12/2011	November
November	WASDE, CP	11/9/2010	11/9/2011	January
December	WASDE, CP	12/10/2010	12/9/2011	January
January	WASDE, CP, GS	1/12/2011	1/12/2012	March
February	WASDE, CP	2/9/2011	2/9/2012	March
March	WASDE, CP	3/10/2011	3/9/2012	May
–	GS, PP	3/31/2011	3/30/2012	May
April	WASDE, CP	4/8/2011	4/10/2012	May
May	WASDE,CP	5/11/2011	5/10/2012	July
Panel B. Reports released during trading hours				
June	WASDE, CP	6/12/2012	6/12/2013	July
–	GS, AC	6/29/2012	6/28/2013	July
July	WASDE, CP	7/11/2012	7/11/2013	August
August	WASDE, CP	8/10/2012	8/12/2013	September
September	WASDE, CP	9/12/2012	9/12/2013	November
–	GS	9/28/2012	9/30/2013	November
October	WASDE, CP	10/11/2012	*	November
November	WASDE, CP	11/9/2012	11/8/2013	January
December	WASDE, CP	12/11/2012	12/10/2013	January
January	WASDE, CP, GS	1/11/2013	1/10/2014	March
February	WASDE, CP	2/8/2013	2/10/2014	March
March	WASDE, CP	3/8/2013	3/10/2014	May
–	GS, PP	3/28/2013	3/31/2014	May
April	WASDE, CP	4/10/2013	4/9/2014	May
May	WASDE, CP	5/10/2013	5/9/2014	July

Notes: The reports above are World Supply and Demand Estimates (WASDE), Crop Production (CP), Grain Stocks (GS), Acreage (AC), and Prospective Plantings and Small Grains Summary (PP). Futures Contracts listed above are Chicago Board of Trade (CBOT) traded with respective expirations months. *USDA reports were not released in October 2013 due to government shut-down.

Table 2. Summary Statistics for Intraday Soybean Fifteen-Second Returns on Report and Pre-/Post-Report Days, June 2010-May 2014

	Report Days		Pre-/Post-Report Days	
Panel A. Non-trading hour report release				
Mean	0		0	
Median	0		0	
Minimum	-3.52		-1.17	
Maximum	5.69		0.99	
Std. Dev.	0.13		0.05	
Variance	0.02		0	
Skewness	14.18	**	-0.39	**
Kurtosis	698.21	**	35.77	**
Normality	15,419.78	**	24,189.10	**
No. of Missing Observations	972		13,165	
Panel B. Trading hour report release				
Mean	0		0	
Median	0		0	
Minimum	-1.57		-0.53	
Maximum	1.6		0.36	
Std. Dev.	0.09		0.03	
Variance	0.01		0	
Skewness	0.59	**	-0.02	*
Kurtosis	64.41	**	12.82	**
Normality	3,296.40	**	12,131.30	**
No. of Missing Observations	814		19,418	

Notes: Returns are computed as the difference in the natural logarithms of nearby soybean prices multiplied by 100. Returns are computed at 15-second intervals during 15 minutes before and 60 minutes after report release. Tests on skewness, kurtosis, and normality are D'Agostino, Belanger, and D'Agostino (1990) test for normal samples. **Significant at α = 0.01, *Significant at α = 0.05

Table 3A. Intraday Under-/Overreaction Results for Soybean Futures Return Reactions to Non-Trading Hour Report Release, June 2010-May 2012

Spearman's Correlation							
Interval	Cumulative	Per interval		Interval	Cumulative		Per interval	
T1	0.18	0.18		T31	-0.18		0.02	
T2	0.10	0.10		T32	-0.17		-0.05	
T3	0.06	-0.12		T33	-0.18		0.03	
T4	-0.07	-0.42	*	T34	-0.18		0.10	
T5	-0.10	-0.23		T35	-0.20		-0.20	
T6	-0.05	0.14		T36	-0.19		0.09	
T7	-0.09	-0.43	*	T37	-0.26		-0.23	
T8	-0.09	0.01		T38	-0.27		0.27	
T9	-0.05	0.16		T39	-0.24		0.13	
T10	-0.02	-0.01		T40	-0.22		0.31	
T11	-0.23	-0.30		T41	-0.23		-0.19	
T12	-0.14	-0.08		T42	-0.23		0.28	
T13	-0.10	0.15		T43	-0.24		-0.10	
T14	-0.07	0.19		T44	-0.27		-0.35	
T15	-0.05	-0.05		T45	-0.31		0.01	
T16	-0.10	0.04		T46	-0.29		0.15	
T17	-0.14	-0.02		T47	-0.30		-0.04	
T18	-0.18	-0.20		T48	-0.27		0.09	
T19	-0.18	-0.09		T49	-0.28		-0.06	
T20	-0.10	0.22		T50	-0.29		-0.06	
T21	-0.12	-0.49	**	T51	-0.28		0.40	*
T22	-0.15	-0.33		T52	-0.28		-0.13	
T23	-0.18	-0.05		T53	-0.31		0.03	
T24	-0.14	-0.06		T54	-0.36		-0.48	*
T25	-0.18	-0.47	**	T55	-0.36	*	-0.21	
T26	-0.19	-0.10		T56	-0.34		0.12	
T27	-0.19	-0.04		T57	-0.32		0.29	
T28	-0.18	0.00		T58	-0.33		0.14	
T29	-0.18	-0.19		T59	-0.33		-0.04	
T30	-0.19	-0.27		T60	-0.34		-0.26	

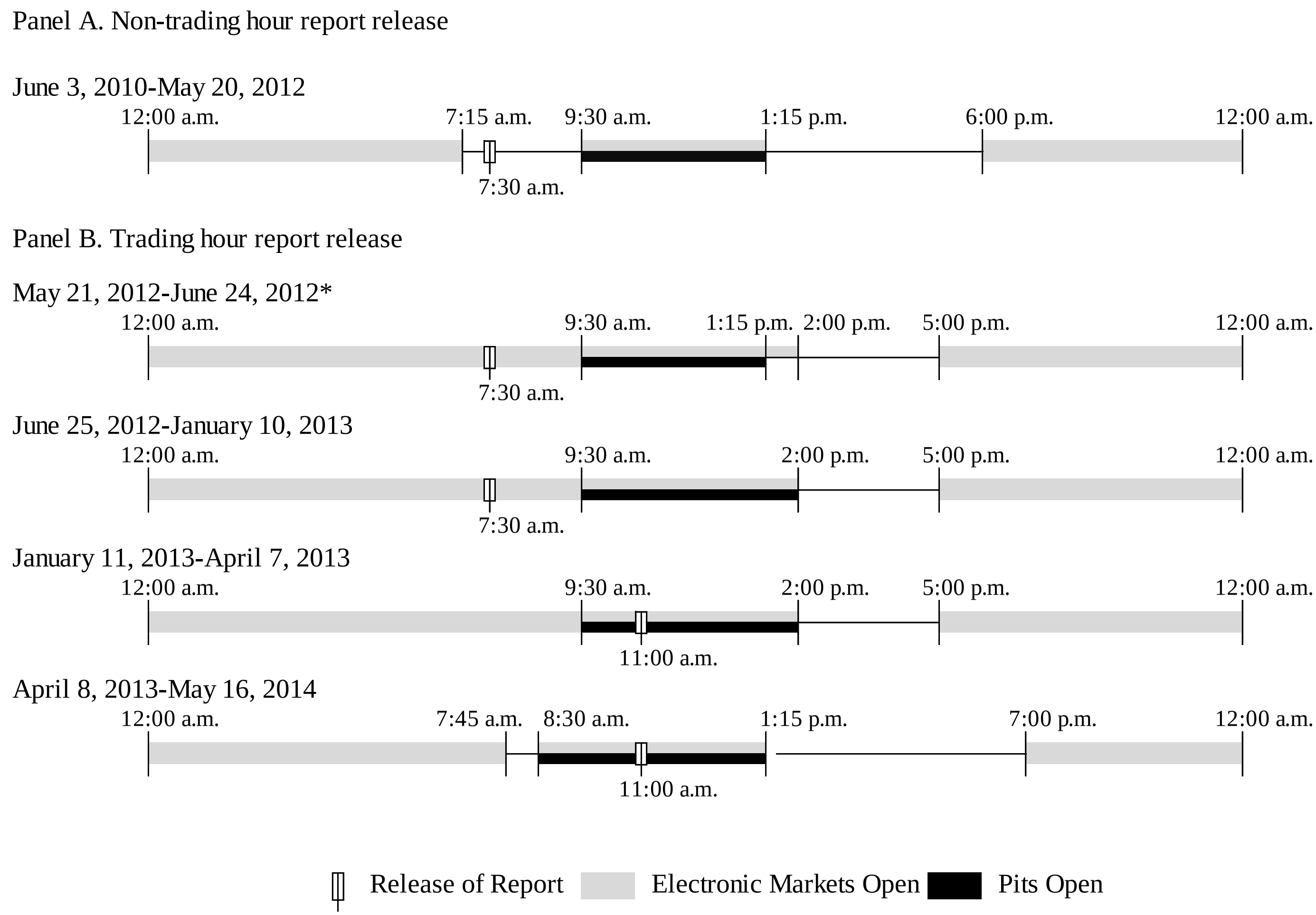
Notes: Intervals represent correlation between the first 15-second return post-USDA report release and subsequent 15-second returns as well as cumulative returns for up to 15 minutes. **Significant at α = 0.01, *Significant at $\alpha = 0.05$.

Table 3B. Intraday Under-/Overreaction Results for Soybean Futures Return Reactions to Trading Hour Report Release, June 2012-May 2014

Spearman's Correlation							
Interval	Cumulative	Per interval		Interval	Cumulative	Per interval	
T1	0.27	0.27		T31	-0.26	0.16	
T2	-0.02	-0.38	*	T32	-0.25	0.35	
T3	-0.29	-0.36		T33	-0.23	0.19	
T4	-0.29	-0.03		T34	-0.22	0.19	
T5	-0.13	0.24		T35	-0.26	-0.39	*
T6	-0.19	0.05		T36	-0.26	-0.12	
T7	-0.16	0.05		T37	-0.25	0.16	
T8	-0.13	0.25		T38	-0.21	0.01	
T9	-0.21	-0.19		T39	-0.19	0.09	
T10	-0.21	0.03		T40	-0.18	0.07	
T11	-0.20	-0.08		T41	-0.17	-0.01	
T12	-0.19	0.13		T42	-0.20	0.07	
T13	-0.20	-0.04		T43	-0.20	-0.03	
T14	-0.17	0.09		T44	-0.18	0.28	
T15	-0.12	0.34		T45	-0.18	0.05	
T16	-0.10	0.08		T46	-0.16	-0.03	
T17	-0.07	0.15		T47	-0.22	-0.40	*
T18	-0.06	-0.22		T48	-0.23	0.06	
T19	-0.13	-0.38	*	T49	-0.25	0.20	
T20	-0.16	-0.28		T50	-0.22	0.07	
T21	-0.16	0.07		T51	-0.24	-0.11	
T22	-0.19	-0.32		T52	-0.24	0.07	
T23	-0.18	0.01		T53	-0.23	0.15	
T24	-0.19	-0.15		T54	-0.20	0.00	
T25	-0.20	0.09		T55	-0.21	-0.09	
T26	-0.19	-0.31		T56	-0.20	-0.16	
T27	-0.19	0.21		T57	-0.22	0.29	
T28	-0.18	0.09		T58	-0.19	0.00	
T29	-0.26	-0.17		T59	-0.23	-0.11	
T30	-0.27	-0.05		T60	-0.21	0.27	

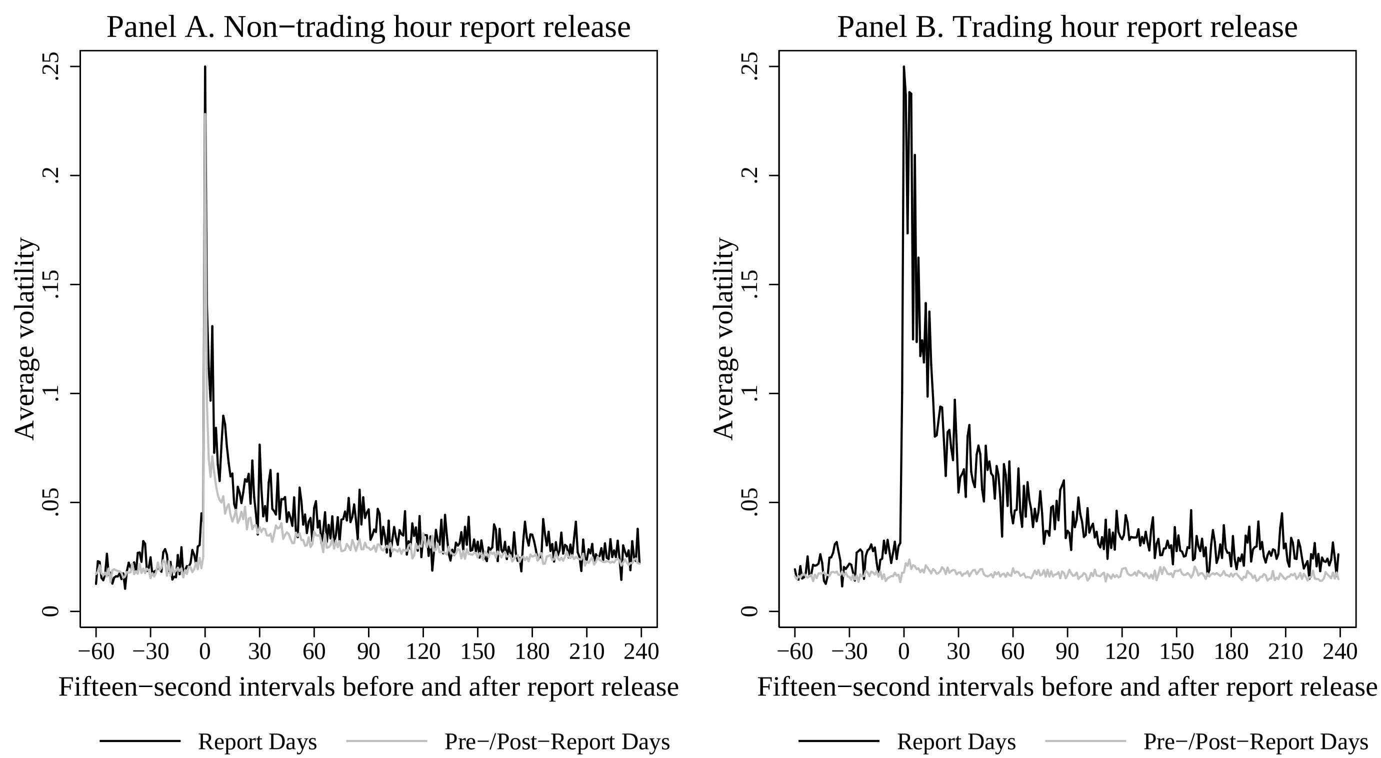
Notes: Intervals represent correlation between the first 15-second return post-USDA report release and subsequent 15-second returns as well as cumulative returns for up to 15 minutes. **Significant at $\alpha = 0.01$, *Significant at $\alpha = 0.05$.

Figure 1. CME Trading Hours and Select USDA Report Release Times, June 2010-May2014



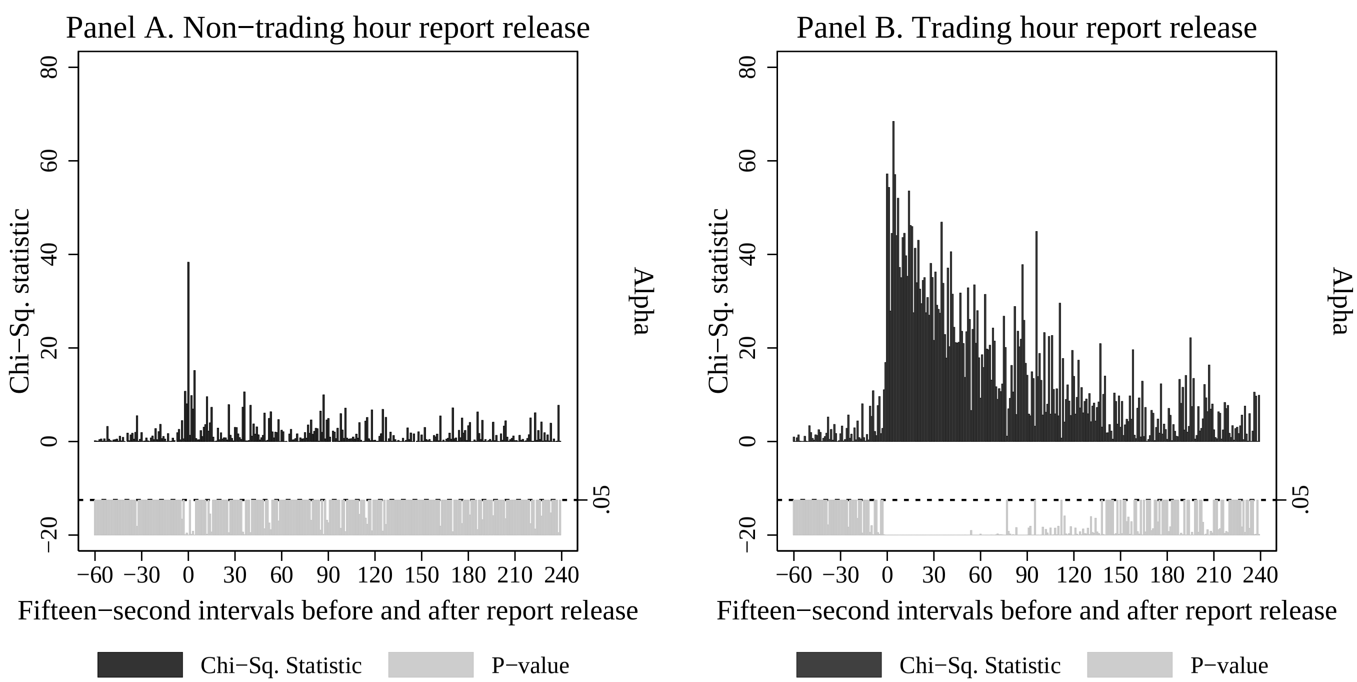
Notes: Time in Central Standard Time (CST). *From June 2012-December 2012, pits were open at 7:20 a.m. on USDA report days.

Figure 2. Volatility Evolution on Report and Pre-/Post-Report Days, June 2010-May 2014



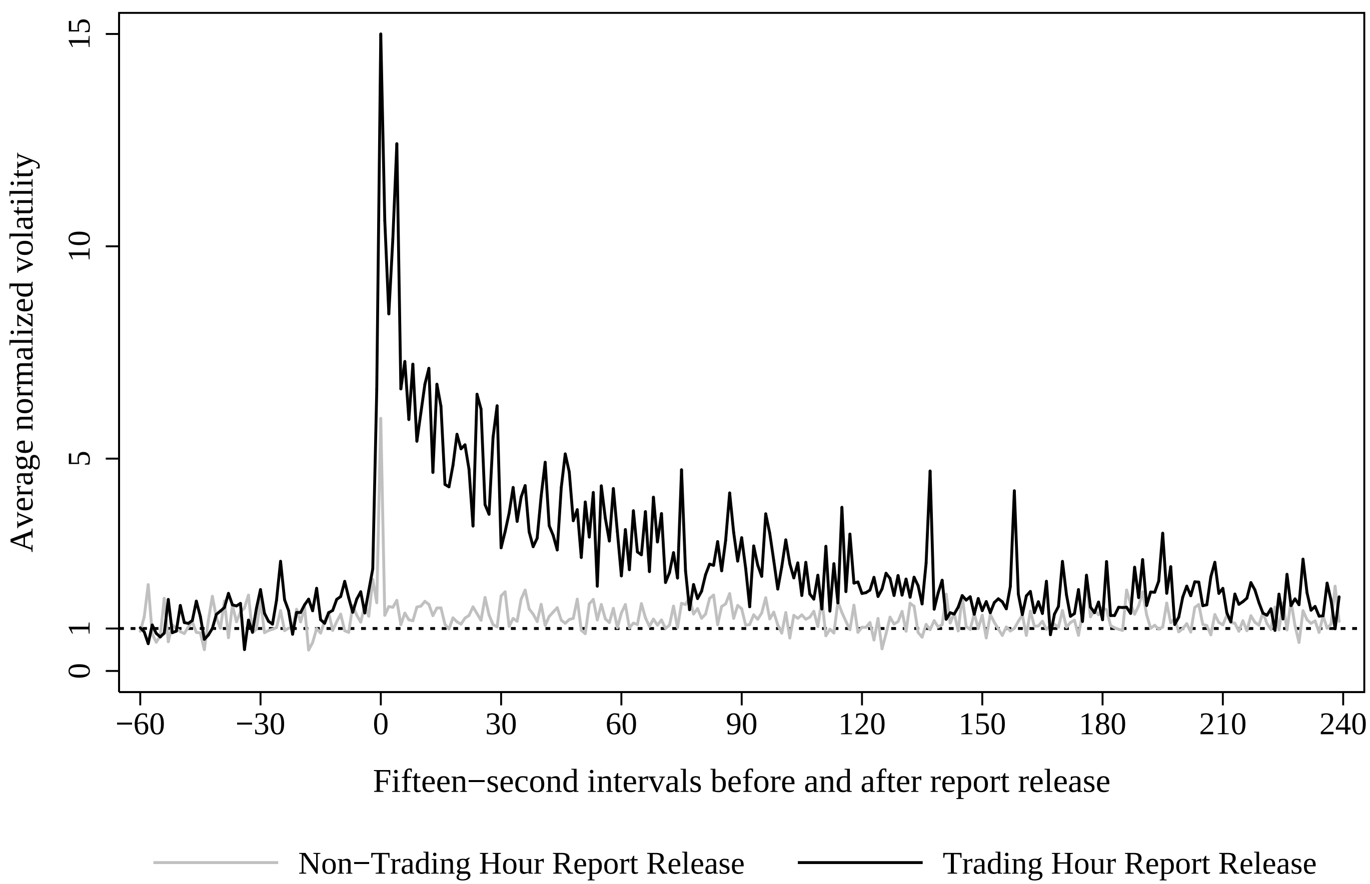
Notes: Panel A: June 2010-May 2012, Panel B: June2012-May 2014. Both plots are drawn to similar scale and the Y-axis is restricted to .25 to facilitate comparison. Zero on the X-axis represents the first 15-second interval post report release. In the first 15-second trading interval post report release, average volatility extends to 1.43 in panel A and .51 in panel B.

Figure 3. Kruskall-Wallis Test for Difference in Volatility on Report and Pre-/Post-Report Days, June 2010-May 2014



Notes: Panel A: June 2010-May 2014, Panel B: June 2012-May 2014. On the Y-axis, the left scale represents the Chi-Square statistic and the right scale represents the 95% significance level. The p-values greater than .05 are scaled to .05. Zero on the X-axis represents the first 15-second interval post report release.

Figure 4. Average Normalized Volatility For Non-Trading and Trading Hour Report Releases, June 2010-May 2014



Notes: The Y-axis is restricted to 15 to facilitate comparison. Zero on the X-axis represents the first 15-second interval post report release. In the first 15-second interval post report release, average normalized volatility extends to 29.34 in the first 15-second interval post trading hour report release. To facilitate comparison, the figure is provided with a reference line at the base value one, which reflects equality between report and pre-/post-report day volatility.