

INTERCOMMODITY EFFECTS OF USDA ANNOUNCEMENTS ON MARKET
UNCERTAINTY

by

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DEDICATION

To my lovely niece, Aiya.

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ABSTRACT

This paper investigates the intercommodity effects of USDA's World Agricultural Supply and Demand Estimates (WASDE) and Cattle on Feed (COF) reports on market uncertainty, using implied volatility of one month synthetic at-the-money options. WASDE and COF reports are released monthly and provide fundamental information on grains and oilseeds and livestock markets.

Prior studies have documented the reports' impact on price movements and their role in reducing uncertainty in the underlying commodity markets. However, limited attention has been given to how these reports influence market uncertainty across commodities.

To address this gap, we utilize an event-study approach with t-test, Z-test, and nonparametric Wilcoxon test to assess whether USDA announcements reduce uncertainty in agricultural markets. Additionally, we estimate OLS regression to examine whether the unexpected components of USDA announcements affect changes in implied volatility related to those announcements.

Our results show that implied volatility declines on WASDE announcement days for corn and soybeans, with bullish surprises influencing the corresponding change in implied volatility. We also find that the implied volatility for live cattle and feeder cattle decreases on WASDE announcement day while no pronounced effect is observed for lean hogs. These results provide evidence of intercommodity effects, where USDA announcements in input markets (corn and soybeans) influence market uncertainty in related livestock markets.

INTRODUCTION

On January 10, 2025, agricultural market participants closely watched the USDA's World Agricultural Supply and Demand Estimates (WASDE) report, which had significantly moved U.S. agricultural markets (Potter & Blythe, 2025). With lower-than-expected yield and production estimates for corn and soybeans, futures prices significantly increased. This WASDE report is just one of many examples of USDA reports significantly influencing the market.

A vast body of literature explores the effect of USDA announcement through the lens of agricultural commodity futures prices (Sumner and Mueller, 1989; Fortenberry and Sumner, 1993; Isengildina-Massa et al., 2008a; Dorfman and Karali, 2015; Ying, et al., 2019; Isengildina-Massa et al., 2021). These studies find that futures prices react in response to the fundamental information released by USDA, demonstrating that USDA reports carry valuable information for market participants.

A smaller body of literature focuses on the effect of USDA releases on market uncertainty. Issengildina-Massa et al. (2008b) find that WASDE led to decreased implied volatility in corn and soybean markets between 1985 and 2002. Cao and Robe (2022) extend the research by Issengildina-Massa et al. (2008b) by incorporating private analysts' expectations on the USDA announcement content and macroeconomic uncertainty. They find that market uncertainty decreases after the USDA releases, with the unexpected contents of the reports (market surprises) affecting market uncertainty in corn and soybean markets. These two papers serve as a foundation for the current research paper.

This research aims to broaden previous research by looking at intercommodity effects of USDA releases on market uncertainty. Given that corn is one of the most used concentrates and

soybeans are a major protein source in the cattle feed (Star Blends, 2023) and soybean meal being a major source of protein in hogs' diets, it is valuable to explore whether the USDA announcements containing fundamental information on corn and soybean commodities affect market uncertainty in livestock markets. Additionally, we investigate whether reverse effects exist, specifically whether Cattle on Feed (COF) reports influence uncertainty in corn and soybean markets.

The existing literature provides mixed evidence of the intercommodity effects of USDA announcements. Dorfman and Karali (2015), find evidence that the distribution of daily returns for feeder cattle on WASDE days is different compared to non-WASDE days. Isengildina, Irwin, and Good (2006) find statistically significant effects of both WASDE and COF report releases on live cattle futures returns, while Karali (2012) saw no impact of either WASDE or COF reports on live cattle futures prices. This thesis aims to contribute to this body of literature by studying market uncertainty and its intercommodity relationship with USDA releases.

We focus on WASDE and Cattle on Feed (COF) reports due to their frequency and the fact that they contain fundamental information on grains and oilseeds and livestock markets. Using NASDAQ one-month synthetic at-the-money options data, USDA reports and Bloomberg private analysts' estimates, we explore whether the release of fundamental information on grains and oilseeds (via WASDE) affects uncertainty in the cattle and lean hogs markets, while also revisiting the effects on corn and soybean markets as documented in previous literature. In addition to that we study the COF report effect on both livestock and grains and oilseeds market uncertainty and look at the role of unexpected information of USDA reports on market uncertainty, proxied by options implied volatility. We use synthetic one-month options to capture short-term market

uncertainty while ensuring consistency of maturity. Synthetic one-month options are built using data of listed options with similar days to expiration (DTE) metric.

We utilize an event-study approach with t-test, Z-test, and nonparametric Wilcoxon test to assess whether USDA announcements lead to decreased uncertainty in agricultural markets. We also employ OLS regression to determine whether the unexpected components of USDA announcements affect changes in implied volatility related to those announcements. Our findings align with those of Cao and Robe, showing that implied volatility declines on WASDE announcement days for corn and soybeans, with bullish surprises influencing the corresponding change in implied volatility.

Regarding the intercommodity effects of USDA announcements, our results show that the implied volatility for live cattle and feeder cattle decreases on WASDE announcement day while no pronounced effect is observed for lean hogs. Bearish corn WASDE surprises affect change in implied volatility on announcement day for live cattle and feeder cattle. The role of corn, but not soybeans, may be linked to the shifting production of soybeans from the U.S. to South America. These results provide evidence of intercommodity effects, where USDA announcements in input markets (corn and soybeans) influence market uncertainty in related livestock markets.

Interestingly, we find no significant change in implied volatility following the release of the COF report. Several factors may explain this lack of market reaction. First, COF reports are released on Fridays after the market closes, allowing market participants to process the information before trading resumes. Second, the livestock market is more vertically integrated compared to the grain market. Third, liquidity constraints in livestock options markets, relative to grain markets,

may play a role. Lower trading volume and open interest in cattle options compared to grains like corn and soybeans may limit the extent to which implied volatility responds to new information.

The paper proceeds as follows. Section 2 will provide background and a literature review. Section 3 discusses the empirical methodology, and Section 4 describes data sources and provides data summary. Section 5 presents our empirical results. Section 6 concludes and discusses opportunities for further research.

BACKGROUND

WASDE Report

The monthly WASDE reports provide a commodity-by-commodity and country-by-country (selected countries) balance sheet of supply, consumption, and stocks for numerous crops. Post-2013, WASDE reports have been uniformly released at 12:00 PM Eastern Time between 9th and 12th of each month.

Estimates for corn and soybean production—staples of US agriculture, with corn and soybeans making up 87% of US grain and oilseed production in 2023 (Zulauf et al., 2023) - are particularly closely watched. However, not all WASDE reports carry the same importance, as their significance varies with the agricultural calendar. For instance, the May WASDE is highly anticipated because it provides the first estimates for domestic commodity supply and demand for the upcoming marketing year. Similarly, the August WASDE is closely watched for including the first National Agricultural Statistics Service (NASS) production forecasts for corn and soybeans. This seasonality makes certain WASDE reports especially critical in shaping market expectations.

COF Report

The Cattle on Feed report provides a comprehensive monthly summary of the cattle and calves on feed in the United States. It includes data on placements, marketings, and other disappearances, broken down by class and feedlot capacity for selected states. Additionally, the report provides the number of feedlots and fed cattle marketings categorized by size groups in specific states. The COF report is typically released on the third Friday of each month, with

inventory data corresponding to the first day of the release month. The report is published at 3:00 PM Eastern Time (ET).

USDA Reports and Agricultural Markets

Public data has potential to reduce information asymmetry, leading to more efficient markets and therefore, increased social welfare. Very few studies attempted to directly measure the welfare benefits associated with the release of USDA announcements (Antonovitz and Roe, 1984; Abbott et al., 2016; Gouel, 2020). However, a broader body of literature has focused on examining the price impact of USDA announcements.

To assess welfare benefits, it is essential to account for price impact, which, in combination with quantity responses and various elasticities, is effective for welfare analysis (Isengildina-Massa et al., 2024). Studies examining the price impact of USDA announcements widely used the event study approach, treating the release of reports as discrete events (Sumner and Mueller, 1989; Fortenberry and Sumner, 1993; Isengildina-Massa et al., 2008b; Dorfman and Karali, 2015; Ying, et al., 2019; Isengildina-Massa et al., 2021). The underlying assumption in these studies is that if reports carry valuable information for market participants and the market is efficient, futures prices should adjust in response to the announcement. These studies test the hypothesis that futures price variability increases around significant scheduled news events compared to variability on non-announcement days.

Isengildina-Massa et al. (2008b) applied both parametric (two-tailed F-test, Bartlett test, Levene test, and Brown-Forsythe test) and non-parametric tests (Mann-Whitney, Kruskal-Wallis, chi-square, and Van der Waerden tests) to test whether return variability on WASDE release sessions differs significantly from pre- and post-announcement sessions. Their findings showed

that the return variance on report days was 7.38 times greater than normal return variance in corn futures and 6.87 times greater in soybean futures. Extending this work, Isengildina-Massa et al. (2021) examined the impact of report clusters, accounting for multiple reports released on the same day. They found statistical significance between daily returns of nearby futures contracts and WASDE releases. However, they also discovered that the live cattle markets had stopped significantly reacting to COF reports between 1990 and 2018, despite a modest but significant reaction (about 1.5 times the normal volatility) in the period from 1985 to 2003. They attributed this change to increased vertical integration in the livestock market.

Market Surprises

It is important to acknowledge that WASDE and COF reports are not released in an information vacuum. Before the USDA announcements, companies like Bloomberg and Reuters have conducted and published surveys of market analysts' expectations regarding the upcoming reports. Those news organizations typically release the details of their surveys 3-7 days before the USDA announcement.

Market expectations for COF reports by Bloomberg analysts typically include three estimates: 1) the number of cattle and calves on feed for the slaughter market in US feedlots with a capacity of 1,000 or more head as of the first day of the release month; 2) placements in feedlots during the previous month; 3) marketings of fed cattle during the previous month. All three indicators are expressed as a percentage relative to the same period in the previous year. The content of private analysts' expectations for WASDE reports varies by month. For instance, from May to August, private analysts try to forecast figures on yields and production of new crops in addition to usually reported estimates of ending stocks. Across the literature, the median

estimate of ending stocks is the most commonly used metric of a market consensus (Cao and Robe, 2022; Plante and Dhaliwal, 2017; Du and Kane, 2019).

In analyzing the impact of public announcements, market expectations are accounted for through the concept of market surprise. Market surprise is commonly defined as the difference between the officially reported estimate and the market consensus. Some studies further refine this definition by normalizing the surprise, dividing it by the standard deviation of these differences to account for variability (Kurov et al., 2019; Cao and Robe, 2022). This approach allows for a standardized comparison of surprises across different commodities with varying levels of variability in their estimates.

Schaefer, Myers, and Koontz (2004) regressed the proportional price change in closing live cattle futures on both anticipated and unanticipated information from the report. Their findings indicated that COF reports still contained new information that moved prices, even after accounting for private industry expectations. Plante and Dhaliwal (2017) and Du and Kane (2019) examined the effect of market surprises from WASDE reports and found a statistically significant impact of unanticipated information on corn and soybean futures prices.

USDA Announcement and Market Uncertainty

McNew and Espinoza (1994) argued that focusing solely on futures prices may overlook how information affects uncertainty levels in the market. According to their view, if USDA announcements provide valuable information, they should lead to greater certainty among market participants, reflected by a drop in implied volatility on the announcement day as new information is absorbed. Implied volatility is a forward-looking measure of volatility that reflects changes in expectations of market participants about future uncertainty.

Several studies have used implied volatility to analyze the effect of USDA announcements on uncertainty in agricultural markets (McNew and Espinoza, 1994; Isengildina-Massa et al., 2008a; Cao and Robe, 2022; McKenzie et al., 2022). McNew and Espinoza (1994) used nonparametric tests (Van der Waerden and Wilcoxon) to compare implied volatility around Crop Production reports. Their results indicated a significant reduction in implied volatility the day after the report, with a residual decline in the implied volatility occurring beyond the first day after the report. Similar findings were shown by Isengildina-Massa and others (2008a). The researchers used t-tests, z-statistics, and the Wilcoxon signed rank test to compare implied volatility prior and on release dates and found that WASDE report releases reduced uncertainty in corn and soybean markets about 70% of the time.

Extending the work of Isengildina-Massa et al. (2008a), Cao and Robe (2022) incorporated market surprise into their analysis of the effects of USDA announcements on market uncertainty. Along with using the event study approach that demonstrated that uncertainty in corn and soybean markets stayed on a lower level after the USDA reports (WASDE, Grain Stocks, Prospective Plantings, and Acreage), the authors investigated factors influencing changes in implied volatility, including market surprises, experts sentiment, expectation dispersion, and overall market volatility (CBOE Volatility Index: VIX) through linear regression. They found a significant effect of bullish WASDE surprises, expectation dispersion and VIX returns on changes in market uncertainty.

McNew and Espinoza (1994), Isengildina-Massa et al. (2008a), and Cao and Robe (2022) used the implied volatility of at-the-money (ATM) options on the nearest futures contracts to assess market uncertainty. This approach is effective because ATM options typically have the highest

trading volume, making them the best instruments to capture changes in market sentiment regarding volatility (Isengildina-Massa et al., 2008). On the other hand, McKenzie et al. (2022) analyzed the entire implied volatility function. Their findings showed no evidence that the Cattle on Feed reports reduced market uncertainty.

Role of Corn and Soybeans in Livestock Production

Corn and soybeans are the important ingredients of livestock feed. Corn provides carbohydrates in animal feed, while soybeans provide the protein. By some estimates, a beef cow can eat a ton of corn if raised in a feedlot (Capehart and Proper, 2019). Simultaneously, soybean meal constitutes 10-20% of the total diet during the finishing phase (Soy Meal Info Center, 2018) for beef cattle. Consequently, the availability and price of corn and soybeans directly influence the cost of raising livestock.

The strong relationship between corn, soybeans, and livestock feed has led to several studies examining the intercommodity effects of USDA announcements. Dorfman and Karali (2015), using non-parametric Kolmogorov-Smirnov and Henriksson–Merton tests to compare announcement and non-announcement days, found significant differences in the distribution of daily returns for feeder cattle on WASDE release days but not for live cattle. They also observed no statistical difference in daily returns on COF release days.

Other studies investigating cross-commodity effects, such as Isengildina, Irwin, and Good (2006) and Karali (2012), controlled for volatility dynamics in the markets. Isengildina, Irwin, and Good (2006) used the TARCH-in-mean model and found statistically significant effects of both WASDE and COF report releases on live cattle futures returns (feeder cattle was not studied). In contrast, Karali (2012), using the GARCH model, found a significant effect of

WASDE on corn but no impact of either WASDE or COF reports on live cattle futures prices (feeder cattle was not studied).

This thesis aims to further explore the cross-commodity effects of USDA announcements. Building on the work of Isengildina-Massa et al. (2008a), Cao and Robe (2022), and Dorfman and Karali (2015), this study seeks to examine how USDA announcements influence market uncertainty across commodities and the role that market surprises play in shaping these effects. This research aims to extend the work of Dorfman and Karali (2015) by examining market uncertainty rather than daily futures return, specifically focusing on the effects of WASDE announcements on livestock market uncertainty. Additionally, it will investigate how Cattle on Feed releases influence uncertainty in both livestock markets and corn and soybean markets, building upon the research by Isengildina-Massa et al. (2008a) and Cao and Robe (2022).

METHODOLOGY

The following methodology will include three main parts. First, it will define the concept of market surprise. The second part will involve statistical tests to evaluate whether USDA reports resolve uncertainty, evidenced by a decrease in implied volatility after their release. The third will describe regression analysis to identify the factors that influence changes in implied volatility on day-of-events.

Market Surprise

Following Kurov et al. (2019), we calculate the market surprise as the difference between the actual figure from USDA announcements, $A_{j,a,t}$, for report j , its attribute a released on the t -th event in our sample, and the market expectation of the announcement, $E_{j,a,t}$. Here, $j \in \{WASDE, COF\}$, $a \in \{Corn\ Ending\ Stocks, Soybean\ Ending\ Stocks, Placements, On\ Feed, Marketings\}$. For COF report and corresponding livestock related announcements, $t \in \{1, 2, 3, \dots, 149\}$, with 1 indicating the Cattle on Feed report from January 2012, and 149 indicating the COF report from August 2024. For WASDE report and corresponding announcements, $t \in \{1, 2, 3, \dots, 92\}$, with 1 indicating WASDE from January 2017, and 92 indicating the report from September 2024. We define the difference between expectations and actual figure as $D_{j,a,t}$:

$$D_{j,a,t} = A_{j,a,t} - E_{j,a,t} \quad (1)$$

We further standardize the difference by dividing it by its standard deviation. The goal of the standardization process is to make surprises across attributes consistent. The standard deviation and corresponding surprise for attribute a , report j released on the t -th event in the

sample are defined the following way, where $\sigma_{j,a}$ is the standard deviation and $S_{j,a,t}$ is the surprise:

$$\sigma_{j,a} = \frac{1}{N-1} \sqrt{\frac{1}{N-1} \sum_{t=1}^N (D_{j,a,t} - \overline{D_{j,a,t}})^2} \quad (2)$$

$$S_{j,a,t} = \frac{D_{j,a,t}}{\sigma_{j,a}} \quad (3)$$

Surprise is measured in standard deviations and therefore if surprise is equal to 2 it would mean the actual value deviates from the expected value by twice the standard deviation, assuming normal distribution, it would correspond to the most extreme 2.5% of surprises. We further divide surprises into bullish $S_{j,a,t}^-$ and bearish $S_{j,a,t}^+$ surprises, following Cao and Robe (2022). A price-bullish surprise occurs when the USDA-announced figure is lower than the market consensus, indicating that private analysts overestimated the actual figure $A_{j,a,t}$. Conversely, a price-bearish surprise arises when private analysts underestimated the actual figure. We define a bullish surprise according to Equation (4) and a bearish surprise according to Equation (5).

$$S_{j,a,t}^- = \begin{cases} S_{j,a,t} & \text{if } S_{j,a,t} < 0 \\ 0, & \text{otherwise} \end{cases} \quad (4)$$

$$S_{j,a,t}^+ = \begin{cases} S_{j,a,t} & \text{if } S_{j,a,t} > 0 \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

Therefore, all bullish surprises are negative, and all bearish surprises are positive. This categorization will be used to examine whether markets respond in a similar manner to both types of surprises.

Uncertainty on Announcement Days

Based on Issengildina-Massa et al. (2008b) and Cao and Robe (2022), we hypothesize that WASDE and COF announcements resolve uncertainty in the agricultural commodities. We measure market uncertainty with implied volatility. If implied volatility decreases, it might be interpreted as an overall decline in market uncertainty. Building on the empirical methods described by Issengildina-Massa et al. (2008b), we use Z-test, paired t-test and non-parametric Wilcoxon test.

Z-test

Z-test will compare the changes in implied volatility between the days affected by WASDE and COF reports and previous trading sessions. The null hypothesis is that the change in implied volatility is 0, which might imply that the market uncertainty does not change after the USDA announcements. To conduct the Z-test, we define the indicator variable $I_{p,j,t}$:

$$I_{p,j,t} = \begin{cases} 1 & \text{if } \Delta IVOL_{p,j,t} < 0 \\ 0 & \text{if } \Delta IVOL_{p,j,t} \geq 0 \end{cases} \quad (6)$$

We further define $\Delta IVOL_{p,j,t} = IVOL_{0,p,j,t} - IVOL_{-1,p,j,t}$ which represent the difference between the announcement-affected trading session denoted with 0 and the previous trading session denoted with -1. $IVOL_{0,p,j,t}$ presents implied volatility for product $p \in \{\text{Corn, Soybean, Live Cattle, Feeder Cattle and Lean Hogs}\}$ on t -th event for report j . We further calculate Z-statistics using Equation 7.

$$Z_{p,j} = \frac{\frac{\sum_{t=1}^N I_{p,j,t}}{N_j} - 0.5}{\sqrt{\frac{0.25}{N_j}}}$$

(7)

For the Z-statistics calculation we use 0.5 as the null hypothesis proportion as there is a 50% chance of the market uncertainty dropping compared to any previous day. We will reject the null hypothesis if $|Z_{p,j}| > Z_a$ where a is the significance level.

Paired t-test

Paired t-test allows us to compare implied volatility of options on days of USDA announcements (or days directly affected) versus previous trading days. The null hypothesis for this test is that there is no statistically significant difference between the implied volatility vector of an agricultural product p options on the event days of the USDA report j and the implied volatility vector of the previous trading session. The corresponding t-value is computed using Equation 8, where $\sigma_{\Delta IVOL_{p,j,t}}^2$ indicates variance of the vector of implied volatility differences. We test the null hypothesis if $|t_{p,j}| > t_a$ where a is the significance level.

$$t_{p,j} = \frac{\overline{\Delta IVOL_{p,j,t}}}{\sqrt{\sigma_{\Delta IVOL_{p,j,t}}^2}} \quad (8)$$

Wilcoxon signed rank test

A limitation of the matched-sample paired t-test is its assumption that the underlying population of implied volatilities follows a normal distribution. However, according to Issengildina-Massa et al. (2008b), it is widely recognized that the sampling distribution of variance or standard deviation estimators is non-normal. The non-parametric Wilcoxon signed rank test addresses this concern by not assuming normality. We use the built-in Wilcoxon signed-

rank test in R to assess the differences between paired samples and report the p-value associated with the corresponding W statistic.

Determinants of change in implied volatility on USDA
announcements days

After exploring the hypothesis that USDA announcements reduce market uncertainty, we will investigate the determinants of the changes in implied volatility on announcement days, closely following Cao and Robe (2022) and using the baseline model shown in Equation 9.

$$\begin{aligned} \% \Delta IVOL_{p,j,t} = & \beta_0 + \sum_a \alpha_a S_{j,a,t}^- + \sum_a \omega_a S_{j,a,t}^+ + \sum_a \gamma_a Range_{j,a,t} + \sum_a \theta_a Sentiment_{j,a,t} \\ & + \phi \Delta VIX_{j,t} + \pi \% \Delta VIX_{-1,j,t} + \mu FR_{-1,p,j,t} + \vartheta Controls_{j,t} + \epsilon_{p,j,t} \end{aligned} \quad (8)$$

The dependent variable $\% \Delta IVOL_{p,j,t}$ measures the percentage change in implied volatility of agricultural product p on report j announcement day t compared to previous trading day. It is important to reiterate that for Cattle on Feed report, the Y-variable will indicate the difference between the market uncertainty measure the next day after the announcement and the day of the announcement since the report is released after the market closure time. Negative $\% \Delta IVOL_{p,j,t}$ would indicate decrease in market uncertainty on the USDA announcement-affected dates.

Our main variables of interest are $S_{j,a,t}^-$ and $S_{j,a,t}^+$ which measure bullish and bearish surprises. For example, $S_{j=WASDE,a=Corn E / S,t=2}^-$ represents the bullish surprise for corn ending stocks from the second WASDE announcement in our sample, which corresponds to WASDE of February 2017. The regression coefficients $\sum_a \alpha_a$ and $\sum_a \omega_a$ show how the change in implied volatility varies with each additional one standard deviation increase in market surprises.

Because of the way we define bullish surprises, the effect of one-unit absolute increase in bearish surprise (stronger bearish surprises) on the change in implied volatility will be indicated by $-\sum_a \alpha_a$. By comparing $\sum_a \alpha_a$ and $\sum_a \omega_a$, we will be able to test whether there is an asymmetry in the reaction of volatility expectations to WASDE and COF surprises.

We control for the range of analysts' estimates, indicated by $Range_{j,a,t}$ in Equation 9. We hypothesize that a market surprise may impact the change in implied volatility differently depending on whether analysts largely agreed on the estimate or displayed significant variance. According to Cao and Robe (2022, p. 260), this approach will help to avoid issues related to outliers. Additionally, the regressor variables include experts' sentiment for report's j release t for attribute a . We define the private analysts' estimates sentiment to be "pessimistic" when the average forecast predicts a decrease in the indicator value compared to the previous month's announcement figure. Alternatively, when analysts expect an increase, we rate the sentiment as "optimistic". For instance, if June WASDE reported corn's ending stocks of 1800 million bushels and expert's consensus figure for July is 1678 million bushels, the sentiment is rated as pessimistic. We set $Sentiment_{j,a,t}$ equal to 1 if the private analysts' forecast is pessimistic, and 0 otherwise.

In addition to accounting for pre-announcement market uncertainty through the range of analysts' estimates, we also control for global market uncertainty using changes and lagged returns of the VIX—formally known as the Chicago Board Options Exchange Volatility Index—which reflects professional investors' expectations of S&P 500 index volatility over the next 30 days. We also add lagged futures returns $FR_{-1,p,j,t}$ to control for the impact of past price movements on current volatility.

The set of control variables depends on the USDA report studied. For WASDE reports, we use the following set of control variables:

- Seasonality dummies: Planting (April–June), Pollination (July and August), and Harvest (September–November). The baseline season is the period when the land lays fallow (i.e., December to the following March). Seasonality dummies are important to account for the fact that agricultural commodities exhibit seasonal patterns, and that market uncertainty might be related to the seasonal patterns.
- Report Day of Week dummies. The dummies will assist in controlling different market reactions depending on the day when the USDA report is released.

For COF reports, we include seasonality dummies: Winter (December – February), Spring (March – May), Summer (June – August). The baseline season is Fall. Including seasonality dummies for Winter, Spring, and Summer helps account for the natural cycles in cattle markets, such as breeding, variations in feed placement and market conditions throughout the year.

DATA

In this Section, we first provide a description of sources of the data used in the research, followed by the summary of the data.

Data Sources

To estimate the impact of WASDE and COF announcements on market uncertainty for corn, soybeans, live cattle, feeder cattle, and lean hogs, we utilize four primary data sources: USDA, NASDAQ, Bloomberg, and CBOE. The USDA WASDE and COF reports provide the public announcement dates and official estimates for corn, soybeans, and livestock fundamentals. Bloomberg offers private analysts' estimates of the USDA figures. The NASDAQ API gives us access to implied volatility from options and underlying futures returns data. CBOE supplies data on the VIX index over time. The four data sources are then merged based on their date values. Table 1 summarizes the data sources utilized in this research paper.

Table 1. Data sources summary

Data Source	Data	Time Span
USDA WASDE report	Corn E/S; Soybean E/S	Jan 2017 – Sep 2024
USDA COF report	Placements; On Feed; Marketings	Jan 2012 – Aug 2024
Bloomberg	Private analysts estimates for WASDE and COF reports	Jan 2017 – Sep 2024; Jan 2012 – Aug 2024
Nasdaq	IVOL, futures prices for C, S, LC, and FC	Jan 2007 – September 2024
Cboe	VIX	Jan 1990 - Today

USDA Data

We analyze the WASDE report, which provides fundamental information on grain and oilseed markets, focusing on releases from January 2017 to September 2024. This period is chosen based on the availability of private analysts' estimates, resulting in 92 reports included in the analysis. The January 2019 WASDE release is excluded since it was never published due to a partial government shutdown. Our analysis centers on corn and soybean ending stocks, as these figures reflect both supply and demand factors. Ending stocks are reported in millions of bushels.

In addition to the WASDE report, we examine USDA's Cattle on Feed Report which provides information on fundamentals of the U.S. livestock market. We focus on the reports released between January 2012 and August 2024 due to the availability of Bloomberg estimates discussed further, resulting in 149 releases. We mainly focus on the three figures from the COF report: on feed, placements, and marketing, expressed in percentages of previous years' figures.

Bloomberg Data

WASDE and COF reports have been consistently released alongside analyst surveys conducted and published by Bloomberg. Approximately a week before the USDA announcements, Bloomberg releases the average of the expected values of the USDA figures by a group of private analysts along with the minimum and maximum of the forecast values. We construct the range of the estimates subtracting the minimum value from the maximum.

We also construct the standardized surprise measure to account for the unexpected portion of the information from each of the USDA releases, described by Equation 3. We find the difference between the actual USDA figure and the expected value by merging Bloomberg and USDA data by commodity, attribute, and date of the release. In total, we have 92 observations for

each of the WASDE surprises (92 for corn and 92 for soybeans) and 149 observations for each attribute of the COF report. Table 1 provides summary statistics on the standardized surprises and estimates ranges and Figure 1 illustrates distribution of the standardized surprises.

From Table 2, we observe that the median WASDE surprises for both corn and soybeans are negative, meaning that most forecasts tend to overestimate actual USDA figures. For COF reports, based on the median statistics, private analysts tend to overestimate on feed figures while underestimate marketing and placement values. The range of estimates is significantly larger for corn compared to soybeans and for placement figures compared to on feed and marketings. From Figure 1, we observe that the distributions for different attributes generally resemble a normal distribution. However, the on-feed surprises from COF reports exhibit slight right skewness.

Table 2. Summary statistics of WASDE and COF surprises and Bloomberg private analysts' forecast estimates' ranges for WASDE and COF reports.

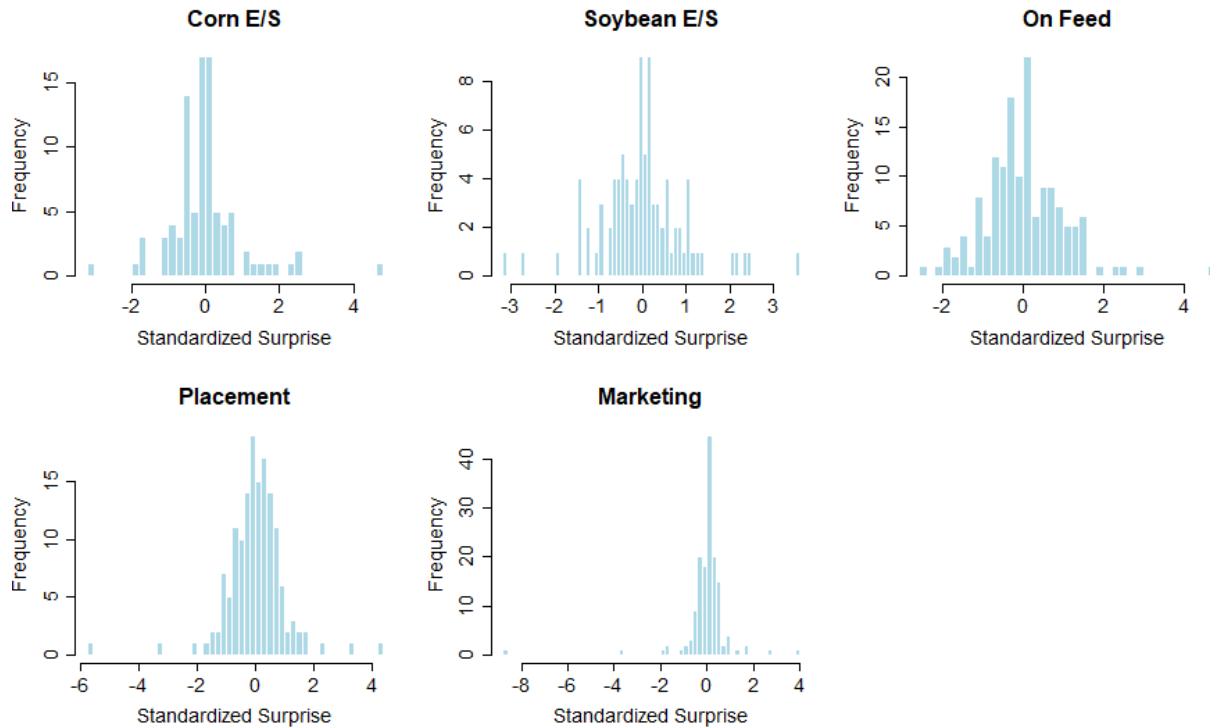
Report	Variable	ID	Median	Mean	SD	Min	Max	Units	#Obs
WASDE	Standardized Surprise	Corn-E/S	-0.08	0.00	1	-3.05	4.73	St dev	92
WASDE	Standardized Surprise	Soybean-E/S	-0.02	0.00	1	-3.12	3.53	St dev	92
COF	Standardized Surprise	On Feed	-0.11	0.00	1	-2.55	4.77	St dev	149
COF	Standardized Surprise	Placement	0.01	0.00	1	-5.60	4.23	St dev	149
COF	Standardized Surprise	Marketing	0.08	0.00	1	-8.78	3.86	St dev	149
WASDE	Estimates range	Corn-E/S	400.00	428.55	226.09	68.0	1271.00	Million Bushels	92
WASDE	Estimates range	Soybean-E/S	141.00	176.93	133.05	30.0	738.00	Million Bushels	92
COF	Estimates range	On Feed	1.70	1.99	1.06	0.50	6.00	Percentage	149
COF	Estimates range	Placement	8.40	9.19	4.18	2.40	31.50	Percentage	149

Table 2 Continued

COF	Estimates range	Marketing	2.60	3.15	2.04	0.30	12.70	Percentage	149
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Note: For WASDE estimates, time span is January 2017 – September 2024. For COF estimates, time span is January 2012 – August 2024.

Figure 1. Frequency histogram of WASDE and COF standardized surprises.



NASDAQ Data

We use the NASDAQ API to access options implied volatility data, focusing on corn, soybeans, live cattle, feeder cattle, and lean hogs. For corn and soybeans, we analyze options listed on the Chicago Board of Trade (CBOT), while for livestock and hogs, we use options from the Chicago Mercantile Exchange (CME). Our analysis relies on synthetic at-the-money one-month options, which maintain a fixed maturity by automatically rolling forward, ensuring consistency in time to expiration.

In our research, synthetic one-month at-the-money options are constructed financial instruments that estimate the implied volatility of an option with 30 days to expiration (DTE) and a strike price equal to the underlying asset's market price. A synthetic option is derived by using real listed options with different expiration dates. Using synthetic options allows us to analyze options' implied volatility without accounting for DTE and the possibility that the open interest has rolled over to the second nearest contract when DTE is small enough.

We calculate daily percentage changes in implied volatility and underlying futures returns. Tables 3 and 4 present summary statistics for implied volatility, daily percentage changes in IVOL, and futures returns, comparing announcement days and non-announcement days for WASDE and Cattle on Feed reports.

From Table 3, it is evident that the percentage change in implied volatility is lower on WASDE days compared to non-WASDE days for corn and soybeans, suggesting that market uncertainty may decrease following the release of the WASDE report. However, the difference in IVOL is not as pronounced for live cattle, feeder cattle, and lean hogs. These summary statistics may indicate a potential reduction in market uncertainty for grain and oilseed markets on WASDE days, though further statistical tests are needed to confirm this trend. The levels of IVOL and futures returns do not appear to be significantly different on WASDE days compared to non-WASDE days.

From Table 4, the percentage change in IVOL is higher on COF report days compared to non-COF days for live cattle and feeder cattle. This might indicate that the release of COF reports is likely to contribute to increased uncertainty in the cattle markets.

Table 3. Implied volatility, percentage change in implied volatility, and underlying futures returns summary on WASDE and non-WASDE days.

	Median	Mean	SD	Min	Max	# Obs	# Obs <0
<i>Corn</i>							
IVOL	0.21	0.23	0.08	0.10	0.60	1908	NA
IVOL (WASDE)	0.21	0.23	0.07	0.10	0.46	92	NA
IVOL % change	0.00	0.01	0.06	-0.24	0.39	1908	930
IVOL % change (WASDE)	-0.08	-0.08	0.07	-0.30	0.08	92	80
futures returns	0.00	0.00	0.01	-0.16	0.07	1908	917
futures returns (WASDE)	0.00	0.00	0.02	-0.07	0.05	92	43
<i>Soybean</i>							
IVOL	0.18	0.18	0.05	0.10	0.42	1908	NA
IVOL (WASDE)	0.17	0.18	0.04	0.10	0.31	92	NA
IVOL % change	0.00	0.00	0.01	-0.08	0.07	1908	920
IVOL % change (WASDE)	-0.06	-0.06	0.05	-0.21	0.04	92	84
futures returns	0.00	0.00	0.01	-0.08	0.07	1908	919
futures returns (WASDE)	0.00	0.00	0.02	-0.05	0.05	92	39
<i>Live Cattle</i>							
IVOL	0.15	0.17	0.06	0.08	0.73	1908	NA
IVOL (WASDE)	0.15	0.16	0.05	0.08	0.47	92	NA
IVOL % change	0.00	0.00	0.06	-0.48	0.93	1908	1031
IVOL % change (WASDE)	-0.02	-0.02	0.05	-0.15	0.14	92	63
futures returns	0.00	0.00	0.01	-0.16	0.09	1908	941
futures returns (WASDE)	0.00	0.00	0.01	-0.04	0.05	92	42
<i>Feeder Cattle</i>							
IVOL	0.14	0.15	0.05	0.08	0.60	1908	NA
IVOL (WASDE)	0.14	0.14	0.04	0.09	0.37	92	NA
IVOL % change	-0.01	0.00	0.08	-0.38	0.84	1908	1077
IVOL % change (WASDE)	-0.02	-0.02	0.05	-0.18	0.16	92	68

Table 3 continued.

futures returns	0.00	0.00	0.01	-0.06	0.05	1908	923
futures returns (WASDE)	0.00	0.00	0.01	-0.03	0.03	92	36
<i>Lean Hogs</i>							
IVOL	0.24	0.26	0.09	0.14	0.97	1908	NA
IVOL (WASDE)	0.23	0.26	0.09	0.14	0.77	92	NA
IVOL % change	-0.01	0.00	0.09	-0.25	0.81	1908	1072
IVOL % change (WASDE)	-0.01	0.02	0.12	-0.11	0.57	92	50
futures returns	0.00	0.00	0.02	-0.19	0.09	1908	916
futures returns (WASDE)	0.00	0.00	0.02	-0.13	0.06	92	44

Note: (WASDE) indicates measures on the days of WASDE announcements. The variables without parenthesis indicate non-WASDE days between January 2017 and September 2024.

Table 4. Implied volatility, percentage change in implied volatility, and underlying futures returns summary on COF and non-COF days.

	Median	Mean	SD	Min	Max	# Obs	# Obs <0
<i>Corn</i>							
IVOL	0.23	0.24	0.07	0.10	0.60	3139	NA
IVOL (COF)	0.22	0.24	0.08	0.11	0.51	149	NA
IVOL % change	0.00	0.00	0.06	-0.46	0.79	3139	1601
IVOL % change (COF)	0.01	0.02	0.05	-0.12	0.21	149	57
futures returns	0.00	0.00	0.02	-0.16	0.08	3139	1526
futures returns (COF)	0.00	0.00	0.02	-0.05	0.07	149	65
<i>Soybean</i>							
IVOL	0.19	0.19	0.05	0.10	0.44	3139	NA
IVOL (COF)	0.18	0.19	0.05	0.10	0.41	149	NA
IVOL % change	0.00	0.00	0.05	-0.25	0.61	3139	1624
IVOL % change (COF)	0.01	0.01	0.06	-0.15	0.19	149	61
futures returns	0.00	0.00	0.01	-0.08	0.09	3139	1547
futures returns (COF)	0.00	0.00	0.01	-0.04	0.05	149	61

Table 4 continued.

<i>Live Cattle</i>							
IVOL	0.15	0.16	0.06	0.07	0.68	3139	NA
IVOL (COF)	0.15	0.16	0.07	0.07	0.73	149	NA
IVOL % change	0.00	0.00	0.06	-0.48	0.93	3139	1707
IVOL % change (COF)	0.01	0.02	0.08	-0.17	0.47	149	57
futures returns	0.00	0.00	0.01	-0.16	0.09	3139	1543
futures returns (COF)	0.00	0.00	0.01	-0.03	0.04	149	73
<i>Feeder Cattle</i>							
IVOL	0.13	0.14	0.05	0.03	0.60	3139	NA
IVOL (COF)	0.14	0.14	0.05	0.06	0.40	149	NA
IVOL % change	-0.01	0.00	0.08	-0.57	0.98	3139	1782
IVOL % change (COF)	0.02	0.03	0.07	-0.12	0.34	149	49
futures returns	0.00	0.00	0.01	-0.06	0.05	3139	1500
futures returns (COF)	0.00	0.00	0.01	-0.03	0.05	149	72
<i>Lean Hogs</i>							
IVOL	0.21	0.23	0.09	0.09	0.97	3139	NA
IVOL (COF)	0.23	0.24	0.08	0.10	0.59	149	NA
IVOL % change	-0.01	0.00	0.09	-0.25	0.81	3139	1722
IVOL % change (COF)	0.01	0.01	0.06	-0.15	0.23	149	64
futures returns	0.00	0.00	0.02	-0.22	0.09	3139	1499
futures returns (COF)	0.00	0.00	0.02	-0.04	0.08	149	65

Note: (COF) indicates measures on the days of COF announcements. The variables without parenthesis indicate non-COF days between January 2012 and August 2024.

CBOE Data.

To account for macroeconomic uncertainty, we use CBOE's VIX data, which reflects the market's expectations for the near-term changes in the variability of the S&P 500 index (SPX), using SPX index options. CBOE provides data from January 2nd, 1990, and we calculate VIX

daily percentage changes using close-to-close values. Table 5 provides summary statistics for VIX index values and its daily percentage changes comparing announcement days versus non-announcement days. From Table 5, it is evident that the index levels for VIX are slightly lower on the announcement days for COF report, while the average percentage change in VIX is slightly higher on the announcement days. For WASDE reports, we observe higher VIX values on non-WASDE days and higher percentage change in VIX changes on the USDA announcement days. However, the observed differences are small, which might imply that USDA announcement days and non-announcement days are comparable from the stock market uncertainty perspective.

Table 5. VIX and VIX percentage changes summary statistics.

	Median	Mean	SD	Min	Max	# Obs	# Obs <0
VIX (non-COF)	15.80	17.61	6.71	9.14	82.69	3054	NA
VIX (COF)	15.76	17.68	6.73	9.43	61.59	149	NA
VIX % change (non-COF)	-0.01	0	0.08	-0.28	1.16	3054	1656
VIX % change (COF)	0.01	0.02	0.1	-0.26	0.47	149	69
VIX (non-WASDE)	16.98	18.81	7.9	9.14	82.69	1874	NA
VIX (WASDE)	16.62	18.77	7.47	9.91	47.3	92	NA
VIX % change (non-WASDE)	-0.01	0	0.08	-0.28	1.16	1874	1030
VIX% change (WASDE)	0	0.01	0.1	-0.16	0.48	92	50

Note: COF indicates measures on the days of COF announcements. Non-COF indicates non-COF days between January 2012 and August 2024. WASDE indicates measures on the days of WASDE announcements. Non-WASDE indicates non-WASDE days between January 2017 and September 2024.

RESULTS

In this section, we first discuss how the implied volatility changes around WASDE and COF days, followed by the discussion of determinants of the change in market uncertainty.

Implied Volatility on WASDE Days

Table 6 presents the results for Z-test, paired t-test and Wilcoxon test. The null hypothesis for the tests is that the implied volatility on a WASDE announcement day is not statistically different compared to the previous trading session. We report the results for the full sample of all WASDE reports, as well as for subsets of reports with large surprises and those that include NASS estimates. We define large surprises as those with an absolute value greater than 1.96, indicating a statistically significant deviation from expectations at the 5% level under a normal distribution. Additionally, we separately analyze WASDE reports that include NASS estimates, as these reports include survey-based production and yield estimates, potentially leading to stronger market reactions. Figure 2-Figure 6 depict average implied volatility relative to WASDE announcement days for corn, soybean, live cattle, feeder cattle and lean hogs. Previous literature has found that implied volatility decreases on WASDE days for corn and soybeans (Cao and Robe, 2022; Issengildina-Massa et al., 2008b).

Panel 1 of Table 6 presents the statistical test results for corn. The findings indicate a statistically significant decrease in implied volatility on WASDE days compared to the previous trading sessions, with significance at the 1% level. Figure 2 illustrates the average implied volatility over a 10-day window surrounding WASDE announcements, showing that market uncertainty peaks the day before the release and reaches its lowest point on the announcement

day. These results suggest that the WASDE report resolves uncertainty in the corn market upon its release.

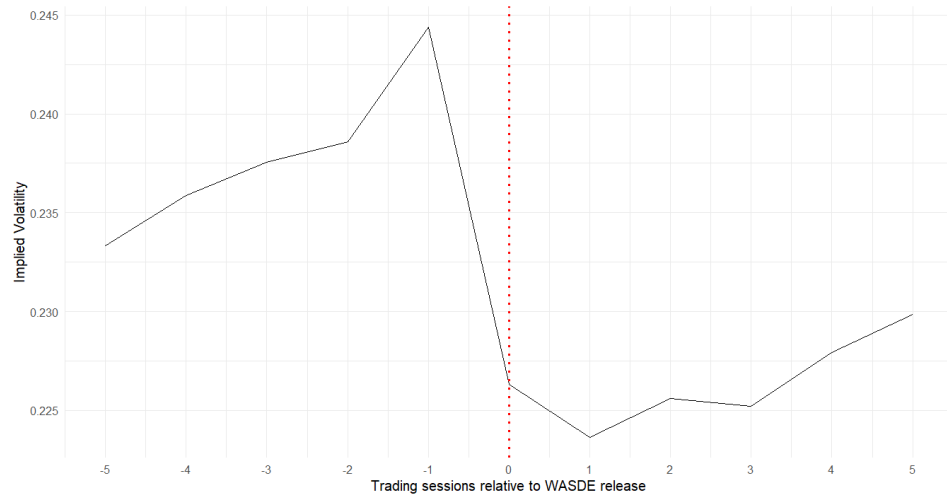
Table 6. Changes in Implied Volatility Between the WASDE Release Session and the Session Before Release, January 2017 - September 2024

Report Group	Proportion when IVOL decreases	Z statistics	Mean difference in IVOL	t-value	Wilcoxon p-value	N
Panel 1: Corn						
All WASDE	0.87	7.09***	-0.02	-9.27***	0.00***	92
WASDE and NASS	1.00	5.48***	-0.03	-11.22***	0.00***	30
Big Surprises WASDE	0.92	2.87***	-0.02	-4.24***	0.00***	12
Panel 2: Soybean						
All WASDE	0.91	7.92***	-0.01	-12.14***	0.00***	92
WASDE and NASS	0.93	4.75***	-0.02	-9.01***	0.00***	30
Big Surprises WASDE	0.83	2.31**	-0.01	-4.70***	0.00***	12
Panel 3: Lean Hogs						
All WASDE	0.54	0.83	0.00	1.46	0.58	92
WASDE and NASS	0.40	-1.10	0.02	2.44**	0.10*	30
Big Surprises WASDE	0.42	-0.58	0.01	0.65	0.97	12
Panel 4: Live Cattle						
All WASDE	0.68***	3.54***	0.00***	-3.40***	0.00***	92
WASDE and NASS	0.63	1.46	0.00	-1.02	0.14	30
Big Surprises WASDE	0.50	0.00	0.00	-0.12	0.91	12
Panel 5: Feeder Cattle						
All WASDE	0.74	4.59***	0.00	-4.28***	0.00***	92
WASDE and NASS	0.70	2.19**	0.00	-1.23	0.07*	30
Big Surprises WASDE	0.67	1.15	0.00	-1.05	0.23	12

Note: IVOL denotes implied volatility. N indicates the number of observations. One star indicates significance at the 10% level. Two stars indicate significance at the 5% level. Three stars indicate significance at the 1% level. The All WASDE group includes WASDE reports released from January 2017 until September 2024. The WASDE and NASS

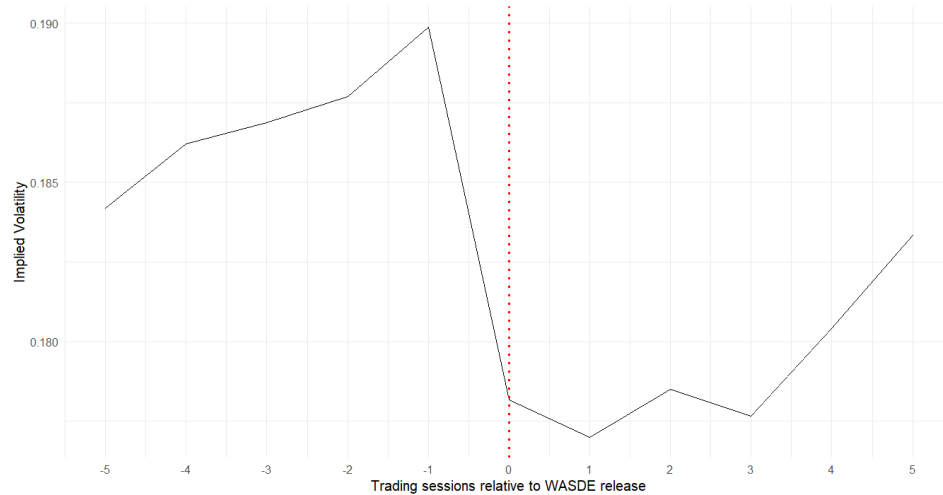
group includes WASDE reports released in January and in August through November. Big Surprises WASDE group includes WASDE releases with absolute value of standardized ending stocks surprises exceeding 1.96.

Figure 2. Average Implied Volatility relative to WASDE release across days for Corn, January 2017 - August 2024.



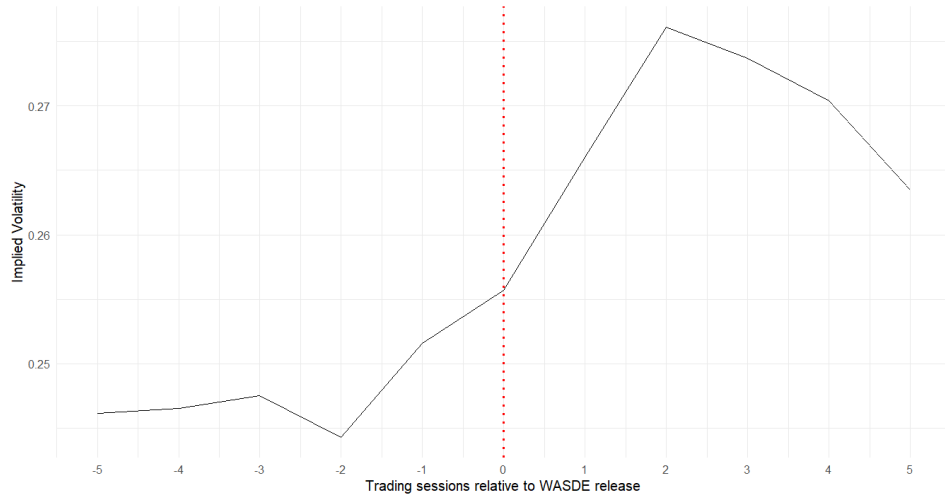
Panel 2 of Table 6 and Figure 3 present the statistical test results and illustrate the average implied volatility for soybeans, respectively. More than 90% of WASDE reports are associated with a decline in soybean implied volatility, with results consistently significant at the 1% level across tests. Figure 3 reveals a pattern similar to that of corn, where implied volatility peaks the day before the WASDE release and reaches its lowest point on the announcement day. This suggests that the WASDE report helps resolve market uncertainty

Figure 3. Average Implied Volatility relative to WASDE release across days for Soybean, January 2017 - August 2024.



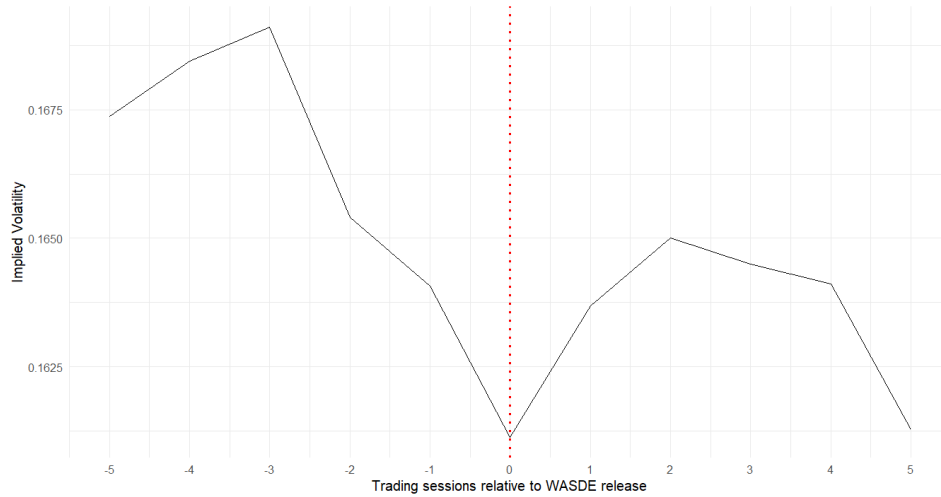
Panel 3 and Figure 4 show the results of the tests for lean hogs' options. The behavior of implied volatility for lean hogs is different from that of corn and soybean. On average, the implied volatility increases on WASDE day compared to the previous day for lean hogs. The results of the tests are mostly insignificant. It is interesting to note that t-test and Wilcoxon test indicate that implied volatility on WASDE days is statistically different from the implied volatility during previous days when the sample is restricted to WASDE with NASS estimates. From Figure 4, we observe implied volatility increasing days before the report and continuing to climb after, possibly indicating that the USDA announcement is not related to the changes in market uncertainty.

Figure 4. Average Implied Volatility relative to WASDE release across days for Lean Hogs, January 2017 - August 2024.



Next, we test whether implied volatility decreases for live cattle on WASDE days. Based on Panel 4 Table 6, implied volatility drops on WASDE announcement days, compared to the previous day. Notably, we cannot reject the null for the restricted samples of WASDE with NASS inputs and of releases with big surprises. In addition to that, Figure 5 shows that implied volatility starts to drop 3 days before WASDE release, on average, reaching its minimum on WASDE announcement day. The findings from Panel 4 and Figure 5 might imply that live cattle market participants may anticipate the WASDE announcement, leading to a gradual decline in implied volatility in the days leading up to the release. The fact that implied volatility reaches its minimum on the announcement day suggests that uncertainty resolves once the report is published.

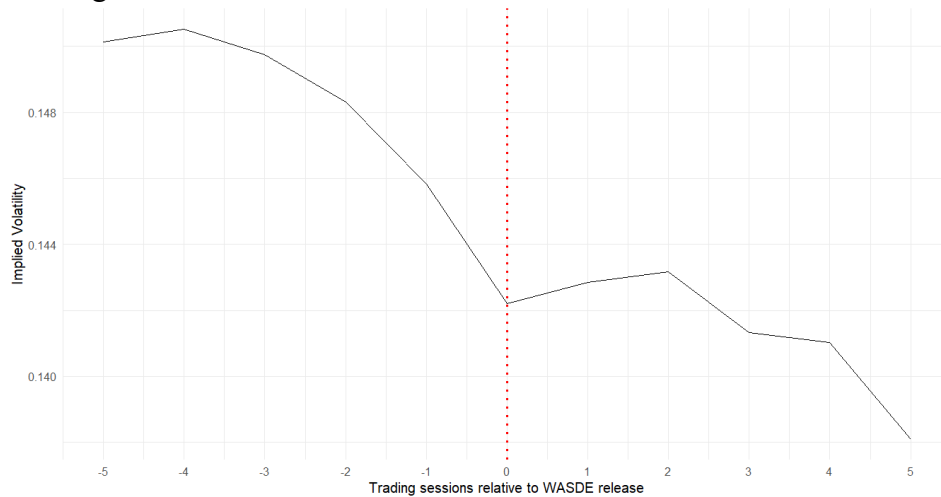
Figure 5. Average Implied Volatility relative to WASDE release across days for Live Cattle, January 2017 - August 2024.



Panel 5 in Table 6 and Figure 6 show how implied volatility changes on WASDE days for feeder cattle options. We can reject the null for the full sample of WASDE releases, meaning that the implied volatility is significantly lower on WASDE release days compared to the previous day; however, the difference is very close to 0. Figure 6 reveals an interesting pattern where implied volatility gradually declines leading up to the release date, reaching a local minimum, and then hitting its absolute lowest point five days after the announcement. However, given the broader time frame, this decline may be unrelated to the WASDE release.

In summary, WASDE reports are statistically significantly associated with a decrease in market uncertainty for corn, soybeans, live cattle, and feeder cattle markets. No significant effect is observed for lean hogs. This may suggest that soybean market dynamics play a greater role in hog feed, with production gradually shifting from the U.S. to Brazil.

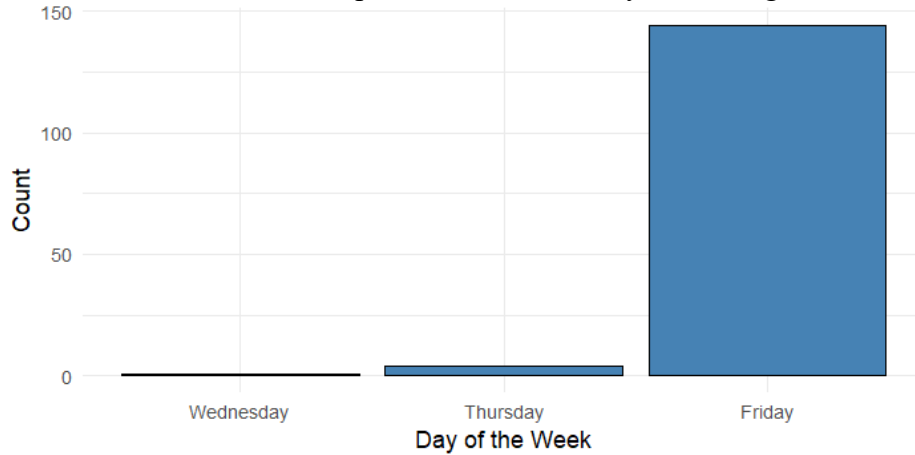
Figure 6. Average Implied Volatility relative to WASDE release across days for Feeder Cattle, January 2017 - August 2024.



Implied Volatility on COF Days

Before discussing COF, it is important to note that Cattle on Feed reports are released on the third Friday of each month at 3:00 PM ET, following the schedule (with the exception of holidays). The distribution of COF reports is shown in Figure 7. Therefore, since the report is released after market closure, comparing implied volatility on the day of the report to the previous trading session may not accurately capture market reactions, as the information is not accessible to market participants during trading hours and would not be reflected in their behavior. Given this, we compare the implied volatility of the next trading session to that of the day of the announcement. We would further use COF-affected and previous trading sessions terms to describe the results of the statistical tests.

Figure 7. Distribution of COF reports between January 2012-August 2024.



This approach presents a challenge, as the first trading session after a COF release typically falls on a Monday, except when the release date coincides with an official holiday. As a result, any distinct behavior in implied volatility observed the day after a COF release may be influenced by the fact that it occurs on a Monday. To determine whether changes in implied volatility are driven by the COF release itself rather than the day of the week, we conduct robustness checks by comparing post-COF report changes in implied volatility to those observed on non-report Mondays.

Table 7 presents the results for the Z-test, paired t-test and Wilcoxon test. The null hypothesis for the tests is the implied volatility on a COF-affected day is not statistically different compared to the previous trading session. We report the results for the full sample of all COF reports, as well as for subsets of reports with large. Similarly, we define large surprises as those with an absolute value greater than 1.96. Table 8 provides results of robustness checks. We perform 3 robustness checks: first, we compare changes in implied volatility on COF days and non-COF Mondays (1), second, we compare absolute price changes on COF-affected days compared to previous trading sessions (2), and third we compare changes in absolute price

changes on COF days and non-COF Mondays (3). Figure 7-Figure 11 illustrate average implied volatility relative to COF-affected announcement days for corn, soybean, live cattle, feeder cattle and lean hogs.

Panel 1 of Table 7 presents the statistical test results for corn. The findings indicate a statistically significant increase in implied volatility on COF-affected days compared to the previous trading sessions, with significance at the 1% level. Figure 8 illustrates the average implied volatility over a 10-day window surrounding COF announcements, which does not indicate a clear pattern in the market uncertainty. Further robustness checks evidence that the increase in market uncertainty is robust, meaning that COF releases, on average, led to an increase in corn market uncertainty. We do not observe similar patterns in the behavior of absolute price change of corn futures, possibly suggesting that the impact of COF reports may be more pronounced in volatility rather than actual price shifts.

Table 7. Changes in Implied Volatility Between the COF Release Session and the Session Before Release, January 2017 – August 2024

Report Group	Proportion when IVOL decreases	Z statistics	Mean difference in IVOL	t-value	Wilcoxon p-value	N
Panel 1: Corn						
All COF	0.33	-4.18***	0.01	4.57***	0.00***	149
Big Surprises COF	0.11	-2.33**	0.02	2.96**	0.01***	9
Panel 2: Soybean						
All COF	0.36	-3.36***	0.00	3.19***	0.00***	149
Big Surprises COF	0.44	-0.33	0.01	1.03	0.43	9
Panel 3: Live Cattle						
All COF	0.32	-4.51***	0.00	3.02***	0.00***	149
Big Surprises COF	0.44	-0.33	0.00	0.88	0.65	9

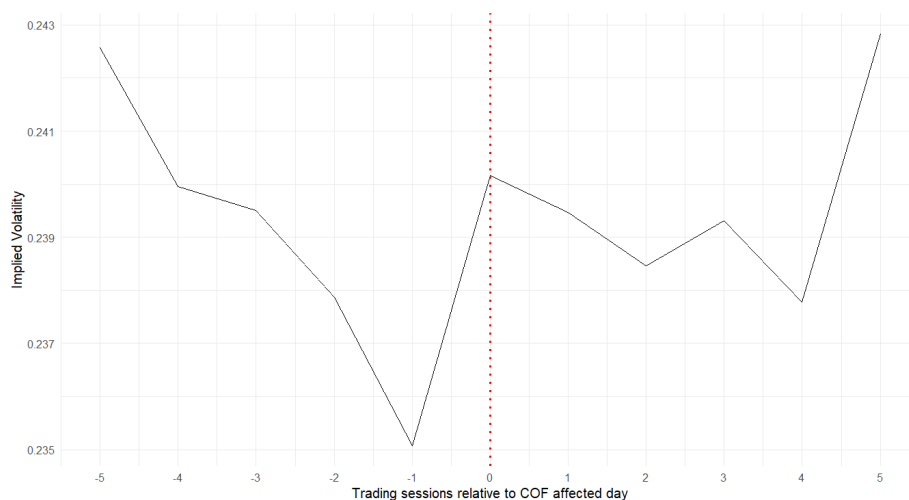
Table 7 continued.						
Panel 4: Feeder Cattle						
All COF	0.26	-5.98***	0.00	5.64***	0.00***	149
Big Surprises COF	0.11	-2.33**	0.00	1.66	0.07*	9
Panel 5: Lean Hogs						
All COF	0.37	-3.20***	0.00	2.65***	0.00***	149
Big Surprises COF	0.56	0.33	0.00	-0.96	0.65	9

Note: IVOL denotes implied volatility. N indicates the number of observations. One star indicates significance at the 10% level. Two stars indicate significance at the 5% level. Three stars indicate significance at the 1% level. The All COF group includes COF reports released from January 2012 until August 2024. Big Surprises COF group includes COF releases with absolute value of standardized ending stocks surprises exceeding 1.96.

Table 8. Robustness checks.

	Change in IVOL (COF vs Non-COF Mondays) (1)		Abs Price Change (COF-affected vs Previous Trading Sessions) (2)		Abs Price Change (COF vs Non-COF Mondays) (3)	
Commodity	t-test	Wilcoxon p-value	t-test	Wilcoxon p-value	t-test	Wilcoxon p-value
Corn	-2.00*	0.08*	-0.87	0.65	-1.36	0.81
Soybean	0.23	0.13	-2.20**	0.02**	-2.46***	0.01***
Live Cattle	-0.75	0.82	1.96*	0.08	0.66	0.88
Feeder Cattle	-0.88	0.31	1.63	0.06	-0.74	0.11
Lean Hogs	1.75	0.16	0.94	0.38	-0.44	0.19

Figure 8. Average Implied Volatility relative to COF-affected release across days for Corn, January 2017 - August 2024.



Panel 2 of Table 7 presents the statistical test results for soybean options. The findings show a statistically significant increase in implied volatility on COF-affected days compared to the previous trading sessions, with significance at the 1% level. Implied volatility increases in 64% of the sample, however, the change in implied volatility is extremely close to 0. Figure 9 illustrates the average implied volatility over a 10-day window surrounding COF announcements, which indicates an increased market uncertainty on days -5, 0, and 5, possibly indicating increased implied volatility on Monday. The first robustness check Table 8 (1) shows the change in implied volatility observed in Panel 2 Table 7 is attributable to the effect of Mondays rather than COF reports. Interestingly, we see significant results of COF reports on price movements in soybeans. While the uncertainty remains non-statistically different, price movements are smaller compared to previous trading sessions and non-COF Mondays, possibly indicating that the market anticipates the COF report's content, leading to muted price reactions.

Figure 9. Average Implied Volatility relative to COF-affected release across days for Soybean, January 2017 - August 2024.

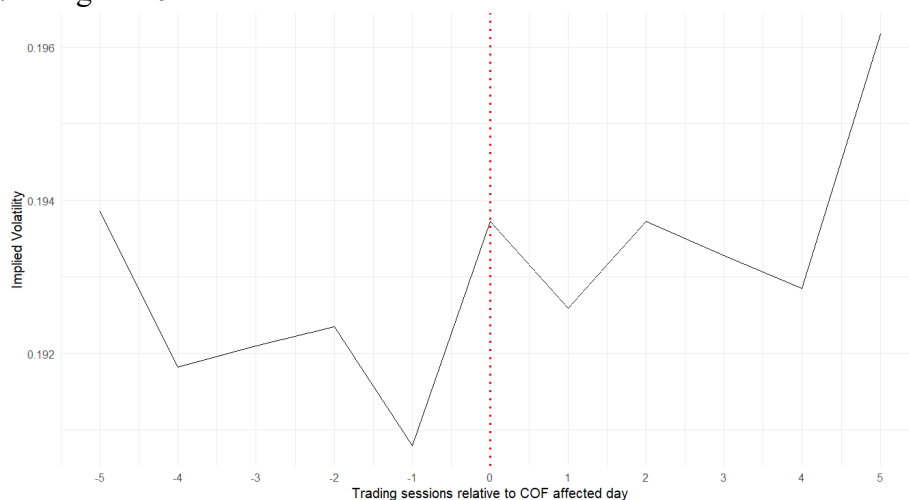


Figure 10 illustrates the average implied volatility over a 10-day window surrounding COF announcements for lean hogs, showing a gradual decrease in volatility over two weeks. However, this trend is likely unrelated to the COF report. Since COF reports do not provide fundamental information on hog markets or their key inputs, a lack of a market reaction is expected. This finding is further supported by robustness checks in Table 8, which confirm that COF announcements have no significant impact on implied volatility in the lean hog market.

Figure 11 shows evidence of the lack of market uncertainty reaction to COF report for live cattle as clear 5-day seasonality is observed. Table 8 (1) shows that the observed increase in implied volatility is attributable to Mondays rather than the effect of the USDA report.

Figure 10. Average Implied Volatility relative to COF-affected release across days for Lean Hogs, January 2017 - August 2024.

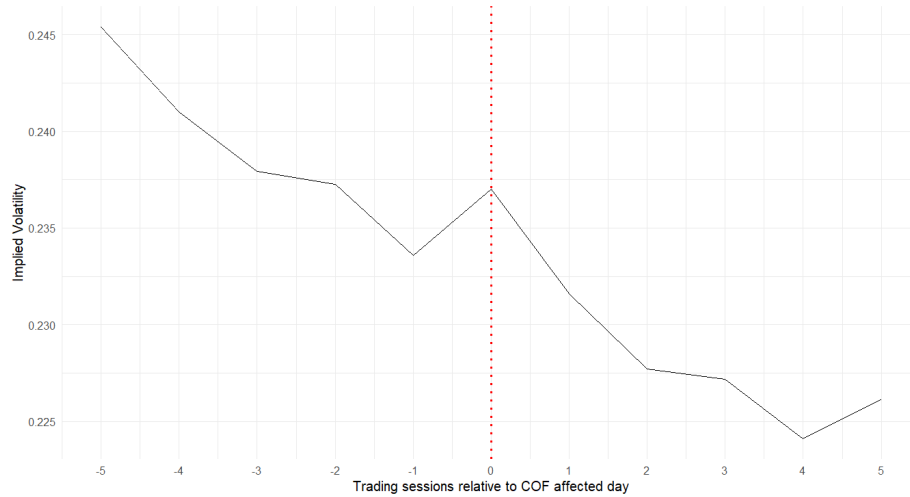
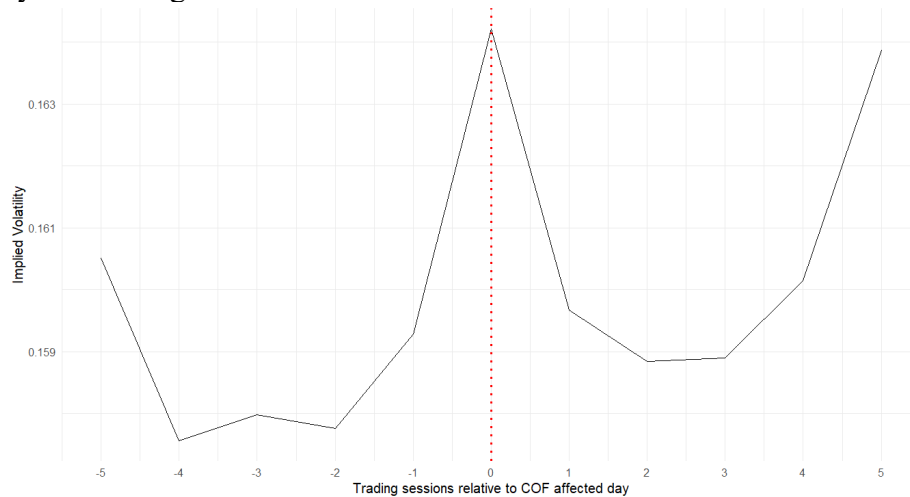


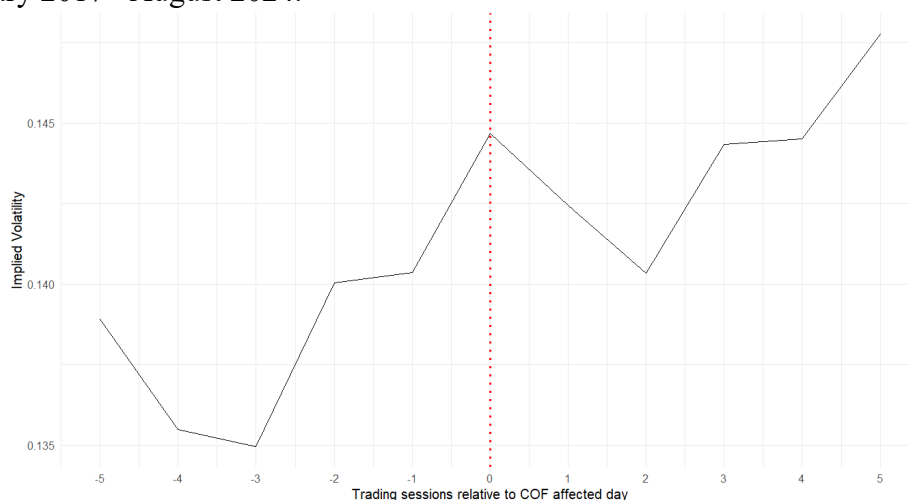
Figure 11. Average Implied Volatility relative to COF-affected release across days for Live Cattle, January 2017 - August 2024.



Panel 4 of Table 7 presents the statistical test results for feeder cattle options. The findings show a statistically significant increase in implied volatility on COF-affected days compared to the previous trading sessions, with significance at the 1% level. Figure 12 illustrates the average implied volatility over a 10-day window surrounding COF announcements. The line shows a pattern of uncertainty peaking on Mondays, decreasing on Tuesday and stagnating

between Wednesday and Thursday. The first robustness check Table 8 (1) shows the change in implied volatility observed in Panel 4 Table 7 is attributable to the effect of Mondays rather than COF reports.

Figure 12. Average Implied Volatility relative to COF-affected release across days for Feeder Cattle, January 2017 - August 2024.



Overall, Table 8 shows that the mean change in implied volatility is close to zero across all commodities, suggesting either a very weak market reaction or a complete lack of response to COF releases in terms of uncertainty. This finding may be explained by the timing of the report's release—on Fridays at 3:00 pm ET—allowing market participants to process the information over the weekend before trading resumes. Additionally, the livestock market may be inherently more predictable compared to grains and oilseeds.

Determinants of Change in Implied Volatility

The estimation results of Equation 8 for WASDE releases are presented in Table 9 for Corn, Soybean, and Lean Hogs. The negative intercepts for Corn and Soybean suggest that implied volatility tends to decline on WASDE announcement days relative to the previous trading session,

which is consistent with the results from Z-test, t-test, and Wilcoxon test. Consistent with Cao and Robe (2022), we find a statistically significant negative relationship between bullish corn surprises and changes in implied volatility. Given the definition of bullish surprises—where more negative values indicate stronger bullish sentiment, the regression results imply that as bullish surprises become stronger (more negative), the percentage change in implied volatility increases. This suggests that bullish WASDE Corn surprises contribute to increased market uncertainty. A similar pattern is observed for soybeans, with smaller absolute effect of bullish surprises on implied volatility. From columns (1)-(4), we see stronger reaction of implied volatility for bullish surprises compared to bearish surprises – market uncertainty is more responsive to reports when analysts overestimate the underlying ending stocks.

The negative coefficient associated with the range of private analysts' estimates for corn (columns (1)-(2)) implies that a wider range of pre-WASDE forecasts corresponds to a decrease in implied volatility following the announcement. This finding highlights the role of the WASDE report in resolving uncertainty, particularly when pre-announcement expectations exhibit greater divergence. We also observe the absence of market uncertainty reaction on estimates range for soybeans. Interestingly, when WASDE announcements are released during the planting season, implied volatility in the corn and soybean markets tends to increase. This seasonal effect may reflect the stronger response of the market to the official information on supply expectations during this critical period when the uncertainty surrounding acreage decisions, weather conditions, and early yield projections is at its peak.

Columns (5)-(6) report the results of Equation 9 for Lean Hogs. Considering the results shown in Table 5 Panel 3 that indicate no significant relationship between WASDE announcements

and change in market uncertainty for lean hogs, any statistically significant coefficients in Table 9 for Lean Hogs are unlikely to be meaningful.

Table 9. Equation 9 Results on the Effect of WASDE surprises for Corn (1-2), Soybean (3-4), and Lean Hogs (5-6). January 2017 - September 2024

	Corn		Soybean		Lean Hogs	
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.07*** (0.03)	-0.07*** (0.03)	-0.06*** (0.02)	-0.06*** (0.02)	0.01 (0.04)	0.01 (0.03)
Bearish Corn Surprise	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.01)	-0.01 (0.01)	-0.02 (0.02)	-0.02 (0.02)
Bearish Soybean Surprise	-0.01 (0.01)	-0.01 (0.01)	-0.003 (0.01)	-0.003 (0.01)	0.02 (0.02)	0.02 (0.03)
Bullish Corn Surprise	-0.04** (0.02)	-0.04** (0.01)	-0.01 (0.01)	-0.01* (0.01)	0.04* (0.02)	0.04* (0.02)
Bullish Soybean Surprise	0.02 (0.02)	0.02 (0.01)	0.0004 (0.01)	0.0004 (0.01)	-0.01 (0.02)	-0.01 (0.02)
Corn Estimates Range	-0.0001** (0.0001)	-0.0001** (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)	-0.0001 (0.0001)	-0.0001 (0.0001)
Soybean Estimates Range	0.0001 (0.0001)	0.0001 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	0.0001 (0.0002)	0.0001 (0.0002)
Corn Sentiment	0.0003 (0.02)	0.0003 (0.02)	-0.01 (0.01)	-0.01 (0.01)	0.002 (0.02)	0.002 (0.02)
Soybean Sentiment	0.01 (0.02)	0.01 (0.02)	0.01 (0.01)	0.01 (0.01)	0.01 (0.03)	0.01 (0.03)
VIX returns	-0.01 (0.09)	-0.01 (0.08)	-0.03 (0.07)	-0.03 (0.06)	0.17 (0.13)	0.17* (0.10)
Planting	0.07*** (0.02)	0.07*** (0.02)	0.04** (0.02)	0.04** (0.02)	-0.01 (0.03)	-0.01 (0.02)
R-squared	0.34	0.34	0.18	0.18	0.15	0.15
Adj R-squared	0.18	0.18	-0.02	-0.02	-0.06	-0.06
F Statistic	2.08**	2.08**	0.88	0.88	0.73	0.73

Note: Table 9 reports OLS estimation results for WASDE surprises. Columns (2), (4), and (6) report heteroskedasticity-robust standard errors. Sample period: January 2017 - September 2024. Number of observations

is 92. *Statistically significant at 10% level; ** at 5% level; *** at 1% level. We do not include the rest of control variables as the estimates are not statistically significant and are close to 0.

The estimation results of Equation 8 for WASDE releases are presented in Table 10 for Live Cattle and Feeder Cattle. Columns (2) and (4) indicate that stronger bearish corn surprises increase implied volatility in both live cattle and feeder cattle markets. When analysts underestimate the corn ending stocks, market uncertainty for cattle increasing. This highlights reaction asymmetry between commodities: corn and soybean markets are reactive to bullish surprises while cattle markets face increased uncertainty with bearish surprises. In addition to that, we observe small but statistically significant effect of corn estimates range on market uncertainty for live cattle. Similar to corn's reaction, a wider range of pre-WASDE forecasts leads to a greater reduction in implied volatility following the announcement.

Overall, Table 9 and Table 10 estimate regression equation 9 for WASDE surprises. We observe that bullish corn surprises increase implied volatility for corn and soybeans while bearish corn surprises lead to increased market uncertainty in live cattle and feeder cattle market. One big observation is the higher role of corn surprises and related estimates on market volatility across markets compared to soybean-related metrics. This might be related to the shifting production of soybeans. Overall, our results are consistent with Cao and Robe (2022), Issengildina-Massa (2008b) and Isengildina, Irwin, and Good (2006) and highlight the importance of unanticipated information from WASDE reports on market uncertainty.

Table 10. Equation 9 Results on the Effect of WASDE surprises for Live Cattle (1-2) and Feeder Cattle, January 2017 - September 2024

	Live Cattle		Feeder Cattle	
	(1)	(2)	(3)	(4)
Intercept	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.02)	-0.01 (0.02)
Bearish Corn Surprise	0.02 (0.01)	0.02* (0.01)	0.02 (0.01)	0.02** (0.01)
Bearish Soybean Surprise	0.001 (0.01)	0.001 (0.01)	-0.002 (0.01)	-0.002 (0.01)
Bullish Corn Surprise	0.002 (0.01)	0.002 (0.01)	-0.002 (0.01)	-0.002 (0.01)
Bullish Soybean Surprise	-0.01 (0.01)	-0.01 (0.01)	0.0004 (0.01)	0.0004 (0.01)
Corn Estimates Range	-0.0000 (0.0000)	-0.0000* (0.0000)	-0.0000 (0.0000)	-0.0000 (0.0000)
Soybean Estimates Range	-0.0000 (0.0001)	-0.0000 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
Corn Sentiment	0.01 (0.01)	0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Soybean Sentiment	0.001 (0.01)	0.001 (0.01)	0.01 (0.01)	0.01 (0.01)
VIX returns	0.05 (0.06)	0.05 (0.05)	0.06 (0.06)	0.06 (0.04)
Planting	0.01 (0.01)	0.01 (0.01)	-0.0002 (0.01)	-0.0002 (0.01)
R-squared	0.26	0.26	0.27	0.27
Adj R-squared	0.07	0.07	0.09	0.09
F Statistic	1.39	1.39	1.49	1.49

Note: Table 10 reports OLS estimation results for WASDE surprises. Columns (2) and (4) report heteroskedasticity-robust standard errors. Sample period: January 2017 - September 2024. Number of observations is 92. *Statistically significant at 10% level; ** at 5% level; *** at 1% level. We do not include the rest of control variables as the estimates are not statistically significant and are close to 0.

We examined the relationship between Cattle on Feed surprises and change in implied volatility. The event study results suggest that although implied volatility appears to increase

following COF announcements, this effect is not statistically significant once accounting for the fact that most post-announcement days fall on Mondays (Table 7 and Table 8, with an exception for Corn). Moreover, the mean change in implied volatility is close to 0 across all five commodities. We report the results of the regression in Table 11. We observe a statistically significant relationship between COF bullish surprises and corn's implied volatility with stronger bullish surprises potentially leading to increased market uncertainty.

We observe the lack of statistical significance between COF reports and live cattle, feeder cattle, and lean hogs implied volatility reported in Table 8. Consequently, any statistically significant relationship between COF surprises and changes in implied volatility may lack economic significance. For completeness, we report the regression results for livestock commodities in Table 12.

Table 11. Equation 9 Results on the Effect of COF surprises for Corn (1-2) and Soybean (3-4), January 2012 - August 2024

	Corn		Soybean	
	(1)	(2)	(3)	(4)
Intercept	0.003 (0.01)	0.003 (0.01)	-0.001 (0.02)	-0.001 (0.01)
Bearish COF Surprise	-0.001 (0.003)	-0.001 (0.002)	-0.01* (0.003)	-0.01* (0.003)
Bullish COF Surprise	-0.004 (0.003)	-0.004*** (0.002)	-0.005 (0.003)	-0.005** (0.002)
Placement Est. Range	-0.0003 (0.001)	-0.0003 (0.001)	-0.0003 (0.001)	-0.0003 (0.001)
On Feed Est. Range	0.002 (0.01)	0.002 (0.004)	0.01 (0.01)	0.01 (0.004)
Marketing Est. Range	-0.001 (0.002)	-0.001 (0.002)	-0.0001 (0.002)	-0.0001 (0.002)

Table 11 continued

On Feed Sentiment	-0.004 (0.01)	-0.004 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Marketing Sentiment	0.004 (0.01)	0.004 (0.01)	0.001 (0.01)	0.001 (0.01)
Winter	0.03*** (0.01)	0.03*** (0.01)	0.01 (0.01)	0.01 (0.01)
Spring	0.03*** (0.01)	0.03*** (0.01)	0.02* (0.01)	0.02** (0.01)
Summer	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
R-squared	0.10	0.10	0.07	0.07
Adj R-squared	0.02	0.02	-0.01	-0.01
F Statistic	1.21	1.21	0.85	0.85

Note: Table 11 reports OLS estimation results for COF surprises. Columns (2) and (4) report heteroskedasticity-robust standard errors. Sample period: January 2012 – August 2024. Number of observations is 149. *Statistically significant at 10% level; ** at 5% level; *** at 1% level. We do not include the rest of control variables as the estimates are not statistically significant and are close to 0.

Table 12. Equation 9 Results on the Effect of COF surprises for Live Cattle (1-2), Feeder Cattle (3-4) and Lean Hogs (5-6), January 2012 - August 2024

	Live Cattle		Feeder Cattle		Lean Hogs	
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.05** (0.02)	0.05** (0.02)	0.05*** (0.02)	0.05*** (0.02)	0.03* (0.02)	0.03* (0.02)
Bearish COF Surprise	0.004 (0.004)	0.004 (0.004)	0.004 (0.004)	0.004 (0.004)	-0.005 (0.004)	-0.005 (0.004)
Bullish COF Surprise	0.003 (0.004)	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)	0.002 (0.003)	0.002 (0.004)
Placement Est. Range	-0.002 (0.002)	-0.002 (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.002 (0.002)	-0.002 (0.002)
On Feed Est. Range	-0.01 (0.01)	-0.01 (0.01)	-0.003 (0.01)	-0.003 (0.01)	0.004 (0.01)	0.004 (0.005)

Table 12 continued

Placement Sentiment	-0.02 (0.01)	-0.02 (0.01)	-0.02** (0.01)	-0.02* (0.01)	0.01 (0.01)	0.01 (0.01)
On Feed Sentiment	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	-0.02** (0.01)	-0.02** (0.01)
Marketing Sentiment	0.01 (0.01)	0.01 (0.01)	0.004 (0.01)	0.004 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Winter	0.02 (0.02)	0.02 (0.02)	0.01 (0.01)	0.01 (0.02)	-0.01 (0.01)	-0.01 (0.01)
Spring	0.03* (0.02)	0.03* (0.02)	0.01 (0.01)	0.01 (0.02)	0.02 (0.01)	0.02 (0.01)
Summer	0.01 (0.02)	0.01 (0.02)	-0.002 (0.01)	-0.002 (0.01)	0.02 (0.01)	0.02 (0.01)
R-squared	0.11	0.11	0.11	0.11	0.15	0.15
Adj R-squared	0.03	0.03	0.03	0.03	0.08	0.08
F Statistic	1.41	1.41	1.43	1.43	2.01**	2.01**

Note: Table XX reports OLS estimation results for COF surprises. Number of observations is 149 for all regressions. Columns (2), (4), and (6) report heteroskedasticity-robust standard errors. Sample period: January 2012 - August 2024. *Statistically significant at 10% level; ** at 5% level; *** at 1% level.

CONCLUSION

USDA reports are closely watched by agricultural market participants as they contain information about fundamentals of the markets and can have a market-moving effect. This research paper aimed to explore how WASDE and COF USDA reports affected intercommodity market uncertainty between 2012 and 2024 for COF report and 2017 and 2024 for WASDE report. We use papers by Issengildina-Massa et al. (2008b) and Cao and Robe (2022) as the foundation for this paper.

To test whether there is a statistically significant relationship between USDA report we have used Z-test, t-test and non-parametric Wilcoxon test to compare implied volatility on the days of reports and the previous trading day sessions. We find that WASDE reports lead to decreased uncertainty in corn, soybean, live cattle and feeder cattle options, potentially indicating the ability of WASDE report to resolve uncertainty. However, no strong market reaction is observed in the days affected by COF reports with the mean implied volatility change approximating 0, indicating less market-moving behavior of COF report compared to WASDE.

We further account for unanticipated information brought by USDA reports by defining market surprises as standardized difference between actual USDA reported figures and Bloomberg analysts' estimates. We run OLS regression of changes in implied volatility on USDA announcements days against market surprises. We find a statistically significant relationship between bullish corn surprises and corn and soybean market uncertainty and between bearish corn surprises and implied volatility changes in live cattle and feeder cattle markets. The results show intercommodity effects of WASDE surprises on cattle markets. Notably, we do not see a significant effect of soybean surprises. One potential reason for the observed patterns could be the shifting

production of soybeans to Latin America. Since this paper primarily focuses on U.S. domestic ending stocks, it overlooks the market-moving surprises related to estimates from other major soybean-producing regions, particularly Latin America, which are included in WASDE reports. Future research could expand on this by exploring how surprises in Latin American production estimates influence uncertainty in futures markets, potentially providing a more comprehensive understanding of global supply dynamics and their impact on market volatility.

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