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The 2019 Government Shutdown Increased Uncertainty in Major Agricultural Commodity Markets

by

Raghav Goyal and Michael K. Adjemian

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Raghav Goyal & Michael K. Adjemian*

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*Raghav Goyal is a PhD student in the Department of Agricultural and Applied Economics at the University of Georgia, and the corresponding author for this work (raghav.goyal@uga.edu); Michael K. Adjemian is an Associate Professor in the same department (michael.adjemian@uga.edu)

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Abstract

In January 2019, a government shutdown prevented the U.S. Department of Agriculture from publishing information about the situation and outlook for major U.S. agricultural commodities. We show that, as a result, Chicago Mercantile Exchange Board of Trade markets for corn and soybeans experienced heightened market uncertainty, elevating the cost of hedging. We use historical options data to estimate that the shutdown and publication delay increased the price of hedging, according to two different approaches. If the January 2019 report had been released on time and it had the impact of a normal report at that time of year, ATM corn options would have been 7% (6.1% - 8.2%) cheaper, while the price of soybean options would have fallen by 31% (24% - 35%). If the report had instead generated the same IV reduction as the makeup February 2019 publication did, it would have reduced ATM corn and soybean hedging costs by about 22% and 43%, respectively.

Keywords: WASDE, Implied Volatility, Moneyness, USDA reports, Corn, Soybeans, Counterfactual, ATM, Options, GARCH.

1 Introduction

For decades, USDA has published the market situation for a wide range of domestic commodities, and has estimated the elements of supply and demand for major agricultural commodities both in the United States and around the world. USDA publishes these reports free of charge in order to align market expectations, resolve uncertainty, and improve efficiency and economic activity in these markets. World Agriculture Supply and Demand Estimates (WASDE), Grain Stocks, Crop Progress, Feed Outlook, Oil Crops Outlook, Crop Production, Acreage and Prospective Plantings (APP) are some examples of reports published by USDA.

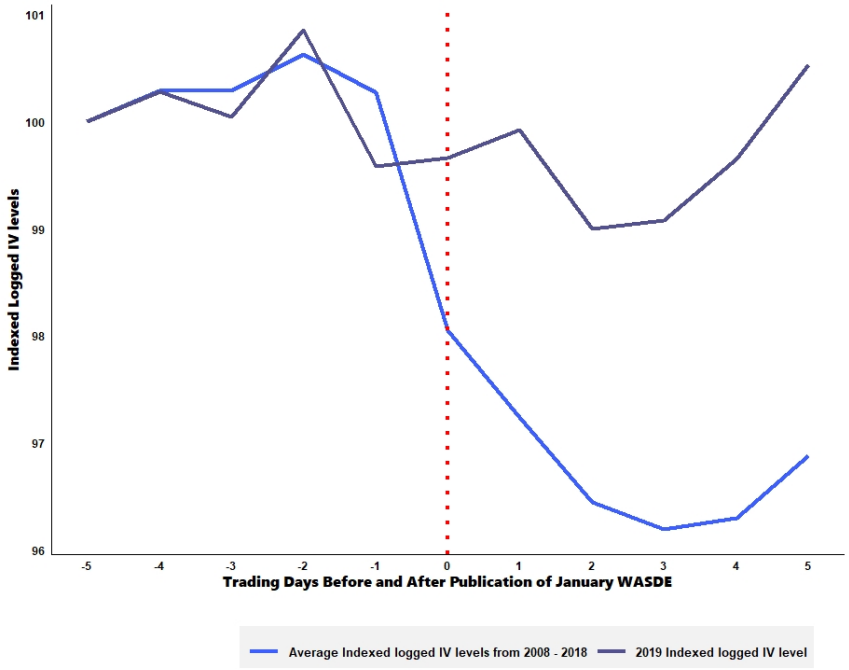
Several agents - e.g. farmers, intermediaries like elevators and commercial grain firms - use agricultural commodity futures and options markets to manage their business risks. Specifically, certain options strategies can limit their potential losses, or provide them with additional income, depending on the side they take. Information provided by USDA reports is closely followed by market participants and observers to make informed supply management and speculative decisions: realigning expectations about commodity market conditions, re-allocating resources, and maximizing their profitability. A growing empirical literature shows that these reports provide the market with important information, impacting prices and implied volatilities (IV) at announcement time (see, e.g., Sumner & Mueller, 1989; McNew & Espinosa, 1994; Isengildina-Massa et al., 2008;

Adjemian, 2012 & 2018; Ying, Chen & Dorfman, 2019).

Indeed, recent work has shown that missing USDA reports may elevate uncertainty levels in agricultural markets. During an appropriations lapse in 2013, USDA suspended its October World Agriculture Supply and Demand Estimates (WASDE) report. Adjemian et al. (2017) concluded that the corn and soybean markets did not experience normally expected changes in prices and reductions in implied volatility (IV) around the release of the USDA information. As a result, market participants had less information with which to plan or conduct their operations, and likely faced increased hedging costs. A natural extension of that work is to study the government shutdown in January 2019, which likewise forced USDA to suspend its publication of a variety of reports, including its normally-scheduled WASDE, Crop Production, and Grain Storage releases. Once the 2019 shutdown ended, USDA published that information on February 8^{th}–a month later than normal (USDA, 2019).

Figure 1 compares the average implied volatility changes for CBOT corn in logarithmic scale in a 5-day window around the normal release of a January report, against those observed around the originally-scheduled release date in 2019. The dotted line marks the event of USDA WASDE and Grain Stock report release (In case of January 2019: the scheduled announcement day for the missing reports).

Figure 1: **CBOT CORN: Indexed Logged IV Levels**



The lines are the time series of indexed logged CBOT corn IV levels. The red dotted line marks the day when the historic January USDA reports were released, and the day when missing January 2019 USDA reports were *scheduled* for release.

The impact of missing January 2019 reports is evident in figure 1 In general, USDA January announcements produce a sharp decline in CBOT corn implied volatility. However, in January 2019, no such decline is observed; indicating a level of higher uncertainty in the market than would have otherwise been observed. Similar patterns are also exhibited by CBOT soybeans (see figure 8.1 in Appendix). In this paper, we estimate the degree to which missing government information elevated uncertainty in major domestic commodity markets, and the impact it had on market participants.

The shutdown of 2019 occurred in January, while the 2013 shutdown occurred in October. Unlike October—especially during a relatively tranquil crop year like 2013—USDA publications in the month of January are viewed by some participants as among the most important. They provide the "final" production estimates for the forecasting cycle in the form of an annual summary and include one of the Department's quarterly reports of inventories, highly anticipated by traders since it signals crop disappearance. It seems inevitable that public budgetary pressures will only increase in the future, so understanding how markets are affected by missing government information is fruitful.

Adjemian et al. (2018) suggest that the price of hedging is higher in the absence of the WASDE

report. We take that step and quantify the additional hedging cost due to missing public news. In addition, to provide a full portrait of the likely derivatives-level impacts we estimate the impact of missing government information across the implied volatility surface, at different levels of option moneyness. To construct the counterfactual for the estimated changes in IV if the January 2019 reports were indeed published on time, we construct two measures: (1) the average change in IV around the release of pre-2019 January reports, and (2) the actual observed change in IV following the release of the next published report (i.e., February 2019). We use the option *vega*, a measure of how much the price of an option changes conditional on a 1% change in implied volatility, to estimate the likely changes in options prices that might have had occurred if the missing reports were published as originally scheduled. Given that the report wasn't released that month, we estimate the additional cost of hedging each futures contract over the interim, to measure the per-contract impact to potential hedgers in the market due to publication curtailment. We control for the general market uncertainty caused by the government shutdown (and other phenomena in the world, including the ongoing trade war) using the Chicago Board Options Exchange Volatility Index (VIX), as well as standard trend, seasonality, and day-of-the-week effects. Based on our first counterfactual measure, we estimate these hedging costs at 7% (6.1% - 8.2%) higher for March-delivery at-the-money (ATM) corn contracts and 31% (24% - 35%) higher for March-delivery ATM soybeans contracts on January 11, 2019. Using a different counterfactual approach–assuming that the IV reduction following the February 2019 publication would have been experienced in January, we find that the increase in hedging costs due to missing information was actually about 22% (16% - 28%) higher for March-delivery ATM corn contracts and 43% (24% - 62%) higher for March-delivery ATM soybean contracts. We find significant, but lower increases for deep out-of-the-money or in-the-money options for these commodities.

2 BACKGROUND

Every month USDA publishes a series of comprehensive reports defining the current situation and projections for supply and demand fundamentals in agricultural commodity markets. The World Agricultural Supply and Demand Estimates (WASDE) report provides a detailed balance sheet of variables for the agricultural commodity markets. WASDE is prepared by combining insights from several USDA agencies represented in the Interagency Commodity Estimates Committees (ICECs), chaired by the USDA World Agricultural Outlook Board (WAOB). ICECs relies on Foreign Agricultural Service (FAS) reports for foreign commodity developments, the National Agricultural Statistics Service (NASS) for agricultural commodity and livestock projections, the Economic Research Service (ERS) for regional assessments, the Agricultural Marketing Service (AMS) and the Farm Service Agency (FSA) for market information and impacts of domestic policies. ICEC committees generate consensus forecasts based on all these data sources. Since it contains highly market sensitive information, WASDE is prepared under secure lock-up conditions, and is released to all the users simultaneously each month (Vogel & Bange - 1999).

Uncertainty about these fundamentals naturally decreases as the harvest comes in, and USDA updates its projections. While the May WASDE report contains the first projections for the new marketing year, the first survey-based corn and soybean production forecasts are included in the

August report (Vogel & Bange - 1999). January reports contain the final annual projections each year. Between February and April, USDA makes only minor changes to its reports. NASS also issues Grain Stock reports, providing an extensive analysis of the on- and off-farm stock positions for major agricultural crops. Grain Stocks reports are released four times a year (January, March, June, September). Moreover, the January Grain Stocks report and WASDE report are released concurrently. (Adjemian et al. - 2018)

Many researchers have found USDA reports affect market expectations of prices and uncertainty. Sumner and Mueller (1989) show that market prices change following the release of USDA harvest forecasts. McNew & Espinosa (1994) report reductions in market uncertainty following report release. Isengildina-Massa et al. (2008a, 2008b) show that corn and soybean markets react to announcement days; reflected in increased futures return variance, and reduced options IV. Adjemian (2012) show that agricultural commodity futures markets rapidly incorporate new information, confirming the persistence of impact across contract positions. Following report release, futures markets respond with heightened trading volumes and realized volatility; the response is short-lived (Adjemian et al., 2018). Fortenbery and Sumner (1993), on the contrary, find a declining market effect of USDA reports in the late 1980's. More recently, Ying, Chen, Dorfman (2019) show that several USDA reports have an increasing impact, over time, on corn and soybean futures markets.

Over the last decade, private market advisory alternatives have grown and so has the accuracy of their projections. Xiao et al. (2014) finds that the accuracy of private forecasts is highest for wheat and lowest for soybeans. Recent literature suggests that, even in the presence of private forecasts, USDA reports are informative (Ying, Chen, Dorfman, 2019; Karali et al., 2019). Karali et al. (2019) observed futures commodity price movements in response to market surprises, even for the reports most likely affected by the availability of private sources of information. Moreover, since USDA reports are published by the government, they are public goods. They also have a strong track record of forecast reliability. Private forecasts, on the contrary, are not freely accessible. Even in the presence of private sources of information, USDA reports are highly valued and trusted by end users.

3 DATA

We use Bloomberg historical ATM options implied volatility data for each individual CBOT corn and soybean contract from 1995 to 2019. Corn contracts deliver in March, May, July, September and December, while soybean futures do so in January, March, May, July, August, September and November. To form a continuous series of close-to-close change in implied volatility for each commodity, we roll over from the nearby to the next deferred contract 15 days prior to the contract expiration month. We match this change in implied volatility with historical *WASDE* and *Grain Stocks* report announcements, the data on which is maintained by the Cornell University Library. For both commodities, figures 8.2 and 8.3 in the appendix compare kernel density plots based on the IVs observed on USDA announcement days relative to other days. The table below provides a summary statistic for each of the series used in our analysis. We also extract Bloomberg data on 30-day implied volatility by *moneyness*, or the ratio of the strike price of the option in question

to the ATM strike, for corn and soybeans from 2005 to 2019 (those data are not available from 1995-2004).

Table 1: Corn and Soybeans: Descriptive Statistics for Change in Daily IV

	Time	Moneyness	Statistic	Mean	Median	Std. Dev.	Skewness
Corn	1995-2019	At the Money	ΔIV	-0.0006	-0.0004	0.028	0.62
			$\lvert\Delta IV\rvert$	0.0173	0.0113	0.022	6.11
	2005-2019	100% Moneyness	ΔIV	$-2.35e^{-5}$	0.0004	0.031	-1.06
			$\lvert\Delta IV\rvert$	0.019	0.0137	0.024	7.27
		90% Moneyness	ΔIV	$-2.8e^{-5}$	-0.0023	0.036	-2.6
			$\lvert\Delta IV\rvert$	0.021	0.013	0.029	5.47
		95% Moneyness	ΔIV	$-3.4e^{-5}$	0.0007	0.032	-1.5
			$\lvert\Delta IV\rvert$	0.02	0.014	0.025	5.8
		105% Moneyness	ΔIV	$-8.1e^{-5}$	0.001	0.033	-1.58
			$\lvert\Delta IV\rvert$	0.019	0.013	0.026	7.4
		110% Moneyness	ΔIV	$-1.5e^{-5}$	0.002	0.034	-2.25
			$\lvert\Delta IV\rvert$	0.02	0.013	0.027	6.18
Soybean	1995-2019	At the Money	ΔIV	-0.00036	-0.0004	0.026	-0.066
			$\lvert\Delta IV\rvert$	0.018	0.0125	0.02	4.22
	2005-2019	100% Moneyness	ΔIV	-0.0001	-0.0002	0.025	0.13
			$\lvert\Delta IV\rvert$	0.018	0.014	0.017	2.88
		90% Moneyness	ΔIV	$-7.8e^{-5}$	0.002	0.031	-1.9
			$\lvert\Delta IV\rvert$	0.02	0.013	0.024	4.6
		95% Moneyness	ΔIV	-0.0001	0.0003	0.027	-0.19
			$\lvert\Delta IV\rvert$	0.018	0.0135	0.02	3.65
		105% Moneyness	ΔIV	-0.0001	0.0007	0.03	1.04
			$\lvert\Delta IV\rvert$	0.018	0.013	0.024	11.46
		110% Moneyness	ΔIV	$-7.9e^{-5}$	0.0013	0.031	-0.17
			$\lvert\Delta IV\rvert$	0.018	0.013	0.025	8.57

Note: Δ IV is computed as the daily difference between the logged IVs. There are a total of 6133 and 6115 observations for Corn and Soybeans respectively from 1995 to 2019. From 2005 to 2019, there are 3494 observations for corn and 3441 observations for Soybeans.

USDA published a total of 389 report announcement days (289 WASDE reports, and 100 Grain Stocks reports) from 1995 - 2019. In order to control for general market uncertainty and investor sentiment, we collect CBOE Volatility Index (VIX) data. We draw options vegas from Datastream, a database maintained by Thomson Reuters.

4 METHODOLOGY

In this paper we estimate how implied volatility changes following USDA report announcements, and calculate the daily change in implied volatility as:

$$\Delta IV_{i,t} = log(IV_{i,t}) - log(IV_{i,t-1}) \tag{1}$$

where the commodity (corn or soybeans) is indexed by 'i' and the trading day is indexed by 't'. The logarithmic transformation helps to normalize the data, and differencing ensures stationarity. Our basic regression model is specified as:

$$\begin{aligned}\Delta IV_{i,t} = \beta_0 &+ \beta_1 \Delta IV_{i,t-1} + \beta_1 D_{WASDE} + \beta_2 D_{Grain\ Stocks} \\ &+ \beta_3 D_{Pre-2019\ Jan\ WASDE} \\ &+ \beta_4 D_{Pre-2019\ Feb\ WASDE} \\ &+ \beta_5 D_{Jan19\ WASDE} + \beta_6 D_{Feb19\ WASDE} \\ &+ \beta_7 \Delta VIX_t + \beta_8 Vol_{i,t} + \beta_M \times M + \epsilon_{i,t}\end{aligned} \tag{2}$$

where VIX refers to CBOE's Volatility Index, Vol is the futures trading volume for commodity i on day t. M is a vector of other regressors including month and day-of-week dummies and time trends. We specifically include dummies for WASDE and Grain-stock report release days (D_{WASDE} & $D_{Grain\ Stocks}$), for all trading days that include WASDE and Grain stock reports released in the month of January and February ($D_{Pre-2019\ Jan\ WASDE}$ & $D_{Pre-2019\ Feb\ WASDE}$), for the missing January 2019 reports ($D_{Jan19\ WASDE}$) and for the reports released in the following month ($D_{Feb19\ WASDE}$).

Because the residuals from (2) are characterized by auto-correlation and heteroskedasticity (as discussed in detail in the next section), we also estimate GARCH Models. Our GARCH (1,1) model with ARMA (1,1) specification is as follows:

$$\begin{aligned}\Delta IV_{i,t} = \beta_0 &+ \beta_1 \Delta IV_{i,t-1} + \beta_1 D_{WASDE} + \beta_2 D_{Grain\ Stocks} \\ &+ \beta_3 D_{Pre-2019\ Jan\ WASDE} \\ &+ \beta_4 D_{Pre-2019\ Feb\ WASDE} \\ &+ \beta_5 D_{Jan19\ WASDE} + \beta_6 D_{Feb19\ WASDE} \\ &+ \beta_7 \Delta VIX_d + \epsilon_{i,t} + \epsilon_{i,t-1} \\ \epsilon_{i,t} &= \sigma_{i,t} Z_{i,t} \\ \sigma^2_{i,t} &= \omega + \alpha \epsilon^2_{i,t-1} + \beta \sigma^2_{i,t-1} + \gamma_R R \\ Z_{i,t} &\sim N(0,1)\end{aligned} \tag{3}$$

ω, α and β are GARCH parameters. R is the vector of same regressors that are added to the mean equation.

In order to estimate the counterfactual change in IV that would have occurred had the January 2019 reports been published on time, we construct two proxy measures:

- the normal change exhibited by the IV series in response to pre-2019 January reports
  $= \beta_1 + \beta_2 + \beta_3$
- The actual observed change in IV following the release of the next published report (i.e., February 2019)
  $= \beta_6 - \beta_4$

To investigate the impact of the missing reports along the IV surface, for each commodity we construct a 5x1 vector of daily changes in the 30-day IV, for 90%, 95%, 100%, 105% and 110% moneyness, as our dependent variable and estimate a dynamic conditional correlation GARCH model to generate the marginal effects of the missing report on the price of hedging.

5 RESULTS

5.1 Using 1995-2019 Data

Table 2 summarizes the results of the CBOT corn market IV models we estimate to measure the impact of missing government data. Model (1) presents the OLS regression results with no month and day-of-week effects. After controlling for other factors, it associates historic (1995-2018) January WASDE and Grain-stock reports (reported in the table as counterfactual 1) with a highly statistically significant decline in daily IV of about 4%. Under counterfactual 2, the impact of missing information is even larger: about 14%, since historic February WASDE reports have no significant effect on IV, while the release of the February 2019 WASDE report carried a substantial 13% IV decline, after controlling for other factors. Model (2) controls for additional month and day-of-week effects, but produces no significant change in any of the coefficients; indicating that the results are robust to these effects. However, both models (1) and (2) suffer from auto-correlation (as observed from LM and LBP test statistic in the table). We therefore estimate a standard GARCH(1,1) and exponential GARCH (1,1) model with ARMA (1,1) process, respectively referred to as models (3) and (4). Both make only minor changes to the counterfactual estimates, which remain highly statistically significant. Model (4) exhibits the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values, so is preferred according to our specification tests. Still, the similarity of our findings across model specifications signifies the robustness of our results.

Table 3 provides the same results for CBOT soybeans. To correct for serial correlation in OLS regression models (models 1 and 2), we estimate sGARCH (2,1) and eGARCH(2,1) models with ARMA(3,1) processes. Across model specifications, we estimate the counterfactual 1 impact on IV in the range of negative 2.6%-3%, and counterfactual 2 as a daily decline in IV of between 5.1% - 5.4%. As in the case of corn, our eGARCH model is preferred according to both AIC and BIC.

Table 2: Modeling the Daily Change in Log Implied Volatility for CBOT Corn, 1995-2019

		Regression Models			
		OLS		sGARCH [1]	eGARCH [1]
		(1)	(2)	(3)	(4)
(A)	Daily change in Log IV	-0.089^{**} (0.037)	-0.087^{**} (0.0372)	-0.963^{***} (0.0055)	-0.953^{***} (0.0084)
(B)	Generic Grain Stock Announcement	-0.025^{***} (0.004)	-0.024^{***} (0.004)	-0.023^{***} (0.0042)	-0.02^{***} (0.0012)
(C)	Generic WASDE Announcement	-0.036^{***} (0.003)	-0.034^{***} (0.0029)	-0.0297^{***} (0.0025)	-0.0252^{***} (0.0016)
(D)	Pre-2019 January WASDE/Grain Stock	0.022^{**} (0.01)	0.024^{**} (0.0099)	0.0155* (0.0088)	0.0095*** (0.00098)
(E)	Pre-2019 February WASDE	0.006 (0.0081)	0.008 (0.008)	0.0004 (0.0087)	-0.002 (0.0077)
(F)	January 2019 WASDE	0.005 (0.0027)	0.003 (0.0018)	0.0065^{***} (0.0022)	0.0048^{***} (0.0011)
(G)	February 2019 WASDE/Grain Stock Announcement	-0.134^{***} (0.0086)	-0.131^{***} (0.0085)	-0.12^{***} (0.013)	-0.12^{***} (0.0093)
(H)	Daily change in VIX	0.044^{***} (0.013)	0.034^{***} (0.013)	0.046^{***} (0.0175)	0.049^{***} (0.0005)
	Week Dummies? [2]	No	Yes	No	No
	Month Dummies? [2]	No	Yes	No	No
		Impact Of Missing WASDE			
	Counterfactual 1 (Based on Historic January reports)	-0.03918^{***} (0.0087)	-0.0349^{***} (0.0084)	-0.0373^{***} (0.0077)	-0.0365^{***} (0.0025)
	Counterfactual 2(Based on February 2019 report)	-0.1394^{***} (0.016)	-0.1394^{***} (0.0157)	-0.12^{***} (0.0197)	-0.12^{***} (0.0158)
		Test Statistics			
	AIC	-27065.81	-27097.15	-4.6935	-4.7151
	BIC	-26978.43	-26915.67	-4.6716	-4.6921
	LM Test [3]	72.705^{***}	99.236^{***}	0.576	0.565
	LBP Test (Lag 9)	44.521^{***}	54.611^{***}	7.6^{*}	6.6

Note: Robust standard errors are reported in parenthesis. Counterfactual 1 = (B) + (C) + (D), and Counterfactual 2 = (G) - (E). The standard errors for the two are calculated using Delta Method.

[1]Variables A to H were included in both mean and variance equations in the GARCH specification.
[2] Week and month dummies were initially added to the GARCH Models. However, their coefficients were insignificant and hence were subsequently dropped from the final models.
[3] For OLS models, Breush Pagan Test statistic is reported. For GARCH Models, weighted ARCH LM results (at lag 7) are presented.

$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 3: Modeling the Daily Change in Log Implied Volatility for CBOT Soybeans, 1995-2019

		Regression Models			
		OLS		sGARCH [1]	eGARCH [1]
		(1)	(2)	(3)	(4)
(A)	Daily change in Log IV	−0.064**	−0.059	0.736***	0.707***
		(0.039)	(0.0385)	(0.0935)	(0.0207)
(B)	Generic Grain Stock Announcement	−0.03***	−0.031***	−0.031***	−0.03***
		(0.0043)	(0.0043)	(0.0046)	(0.0015)
(C)	Generic WASDE Announcement	−0.032***	−0.0315***	−0.0298***	−0.0258***
		(0.0025)	(0.0025)	(0.00249)	(0.0012)
(D)	Pre-2019 January WASDE/Grain Stock	0.032***	0.037***	0.03***	0.026***
		(0.008)	(0.008)	(0.0077)	(0.0012)
(E)	Pre-2019 February WASDE	0.015**	0.0165**	0.012**	0.011*
		(0.007)	(0.007)	(0.0059)	(0.0058)
(F)	January 2019 WASDE	0.0092	0.0108	0.01	0.0103
		(0.0097)	(0.0105)	(0.04)	(0.0095)
(G)	February 2019 WASDE/Grain Stock Announcement	−0.036***	−0.037***	−0.043***	−0.12***
		(0.0078)	(0.0078)	(0.0083)	(0.006)
(H)	Daily change in VIX	0.026**	0.0189	0.039***	0.033***
		(0.012)	(0.012)	(0.011)	(0.0079)
	Week Dummies? [2]	No	Yes	No	No
	Month Dummies? [2]	No	Yes	No	No
		Impact Of Missing WASDE			
	Counterfactual 1 (Based on Historic January reports)	−0.0306***	−0.0257***	−0.0305***	−0.0295***
		(0.0063)	(0.0062)	(0.0058)	(0.0029)
	Counterfactual 2(Based on February 2019 report)	−0.0514***	−0.054***	−0.051***	−0.054***
		(0.014)	(0.014)	(0.013)	(0.012)
		Test Statistics			
	AIC	-27496.01	-27497.44	-4.7201	-4.7501
	BIC	-27408.67	-27316.04	-4.6948	-4.7226
	LM Test [3]	73.475***	97.081***	5.806	5.369
	LBP Test (Lag 11)	33.603***	44.927***	6.023	6.329

Note: Robust standard errors are reported in parenthesis. Counterfactual 1 = (B) + (C) + (D), and Counterfactual 2 = (G) - (E). The standard errors for the two are calculated using Delta Method.

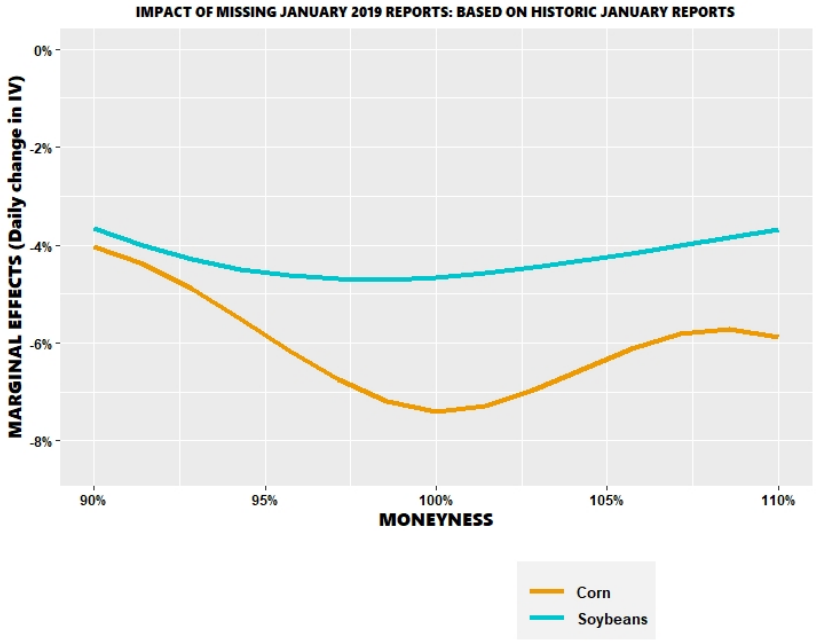
[1]Variables A to H were included in both mean and variance equations in the GARCH specification.
[2] Week and month dummies were initially added to the GARCH Models. However, their coefficients were insignificant and hence were subsequently dropped from the final models.
[3] For OLS models, Breush Pagan Test statistic is reported. For GARCH Models, weighted ARCH LM results (at lag 8) are presented.

*p<0.1; **p<0.05; ***p<0.01

5.2 ANALYSIS BY OPTIONS MONEYNESS

Implied volatility surfaces in commodity markets are generally skewed, and the impact of news may be affected by option moneyness. That is, deep out-of- or in-the-money options may be affected differently by news than ATM options. For each commodity, we therefore estimate a multivariate dynamic conditional correlation (DCC) GARCH model (DCC(1,1) eGARCH(1,1) ARMA (1,1)). [1] To gauge the impact of the government shutdown and subsequent missing January 2019 reports, for each moneyness level we extract the average change in IV around the release of pre-2019 January reports and use a cubic spline to generate a counterfactual IV level that would have been observed, had the reports been published on time. Figure 2 provides the results for both corns and soybeans, at the mean.

Figure 2: **IMPACT OF MISSING JANUARY 2019 REPORTS: Marginal Effects across Moneyness Levels**



In figure 2, ATM corn contracts experience the largest impact of government news at the mean (-7.4%), with lower impacts estimated at lower or higher levels of option moneyness. Soybeans portray a smaller variation in marginal effects across different moneyness levels, but ATM options still display the maximum impact. Overall, for both the commodities, marginal effects closely follow a convex function. One possible reason for our observations is that ATM options are generally the most heavily traded, so they are highly sensitive to changes in market uncertainty.

[1] We conduct a formal test for the relevance of DCC GARCH against a constant conditional correlation (CCC) GARCH model. For both the commodities, we reject the null hypothesis at 1% significance level, confirming the relevance of DCC GARCH model for our analysis.

Based on the marginal effects from figure 2 and the actual IVs observed on each of these days across the moneyness surface, we calculate the counterfactual IVs that would have been observed on January 11^{th} 2019, if the missing reports were indeed published. Figure 3 and Figure 4 report our mean-level results for corns and soybeans, respectively. We estimate that, had January 2019 WASDE and Grain Stocks reports been published on time, each market would have experienced notable declines in IVs across the IV surface.

Figure 3: **Impact of Missing 2019 Reports on CBOT Corn IV:** 11^{th} **January, 2019**

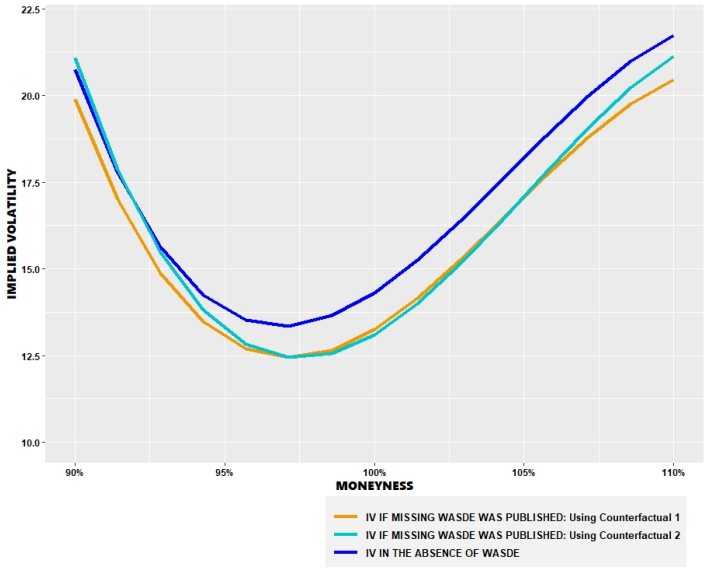
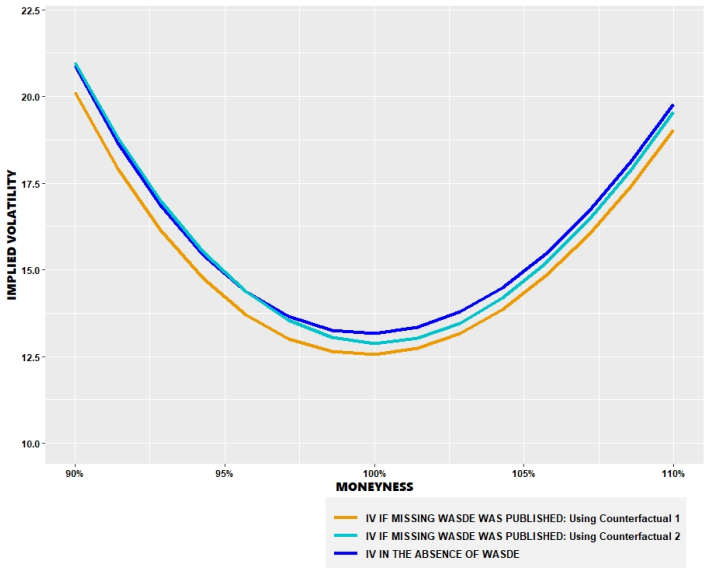


Figure 4: **Impact of Missing 2019 Reports on CBOT Soybeans IV:** 11^{th} **January, 2019**



For both the commodities, we estimate that traders of ATM corn contracts had to pay 7% more per contract per bushel (with a 95% confidence interval between 6.1% and 8.2%) on January 11, 2019. Traders of ATM soybean contracts had to pay per bushel 31% (24% - 35%) higher to hedge. Using a different counterfactual approach–assuming that the IV reduction following the February 2019 publication would have been experienced in January, we find that the increase in hedging costs due to missing information was actually about 22% (16% - 28%) more for corn and 43% (24% - 62%) more for soybeans. We find significant, but lower increases for deep out-of-the-money or in-the-money options for these commodities. Overall, ATM options display the maximum increase. Further, as the markets progress closer to the release of February WASDE reports, the increase in options premia, due to missing government reports, gradually decreases.

6 CONCLUSION

The 2019 government shutdown delayed USDA's publication of its end-of-year January crop and stocks reports, providing an opportunity to estimate this impact of missing information. We show that corn and soybean markets did not experience the normal reductions in uncertainty around important government news. Uncertainty increases hedging prices. We use options data to estimate that the shutdown and publication delay increased the price of hedging ATM corn and soybean options. According to our preferred model results, the increase amounted to an additional 7% (6.1% - 8.2%) and 31% (24% - 35%), respectively for corn and soybeans, using an approach that assumes a normal January report impact. To put this in context, those effects would raise the price of purchasing an ATM corn call and soybean option today by about $100 and $240, respectively. Using a different counterfactual approach–assuming that the IV reduction following the February 2019 publication would have been experienced in January, we find that the increase in hedging costs due to missing information was actually about 22% (16% - 28%)higher for corn and 43%

(24% - 62%) higher for soybeans, implying an increase in ATM hedging costs of $300 and $330, respectively. According to historical IV surface data, ATM options experience the largest effects of missing information. However, these options are usually the most highly traded, so our results offer important insights not only for traders and market participants, but also for decision makers who face budget constraints regarding the collection and provision of information about supply and demand fundamentals.

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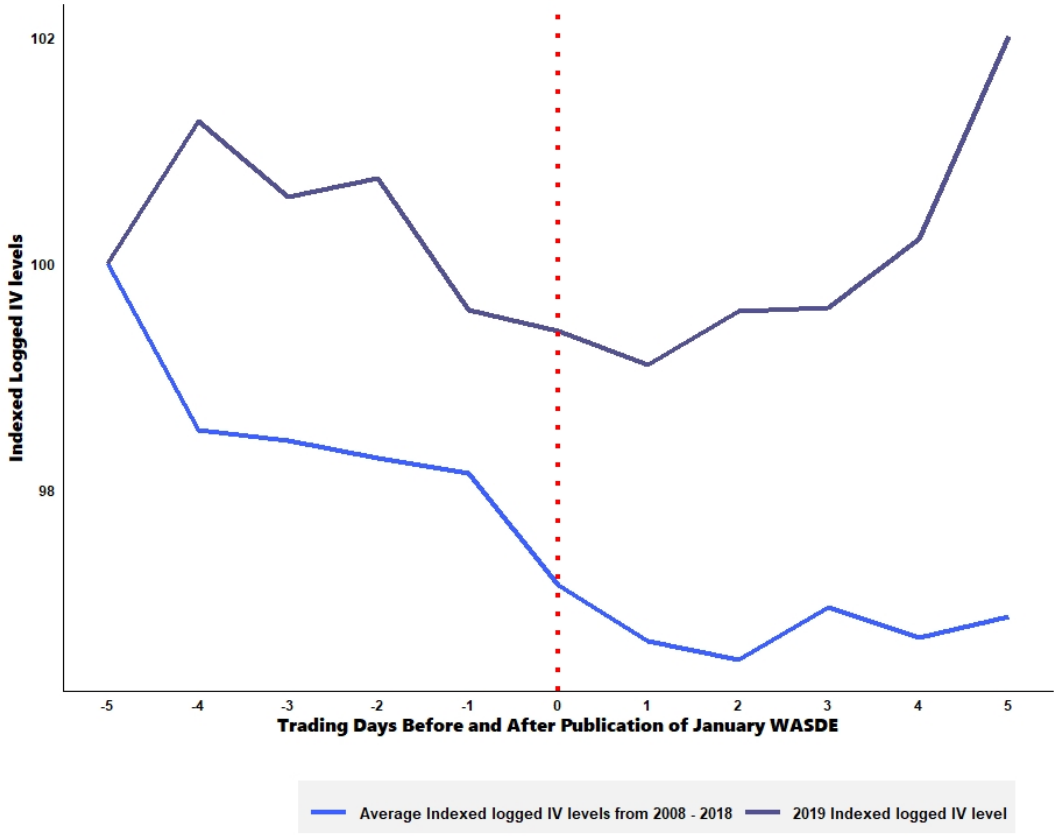
8 APPENDIX

Figure 8.1: **CBOT SOYBEANS: Indexed Logged IV Levels.**



The blue lines are the time series of the indexed logged CBOT soybean IV levels in a 5-day window around the normal release of a January report averaged from 2008 - 2018. The red dotted line marks the day when the historic January USDA reports were released, and the day when missing January 2019 USDA reports were *scheduled* for release.

Figure 8.2: **Corn: Kernel Density Plot**

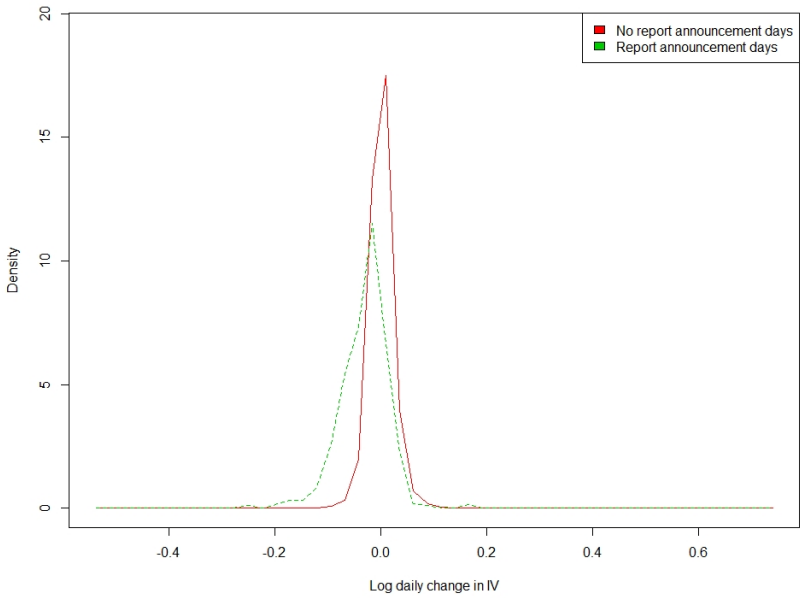


Figure 8.3: **Soybeans: Kernel Density Plot**