The Role of USDA Reports on Extreme Volatility Coexceedances:

An Application to the Soybean Complex

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Abstract

Supply and demand data provided in USDA reports are publicly available and constitute important fundamental information on major crops. These crops are not only used for direct consumption, but also serve as intermediate goods in the production of other products. This study examines whether extreme price volatility or extreme trading volume occurs contemporaneously in markets linked in a supply chain on report release days. We focus on the commodities in the soybean complex and use an ordinal logistic model to investigate whether the releases of USDA reports increase the probability of joint occurrence of extreme events. After controlling for other sources, such as releases of selected macroeconomic reports, we find that the USDA reports released in March have the largest impact for both volatility and trading volume.

Key words: coexceedance, extreme volatility, ordinal logistic regression, soybean complex

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Introduction

The relationship between prices and information has been a key focus in commodity markets. The completeness and accuracy of information that goes into price determination influences the decisions of buyers and sellers, and further contributes to the efficient functioning of commodity markets (Hieronymus 1977). Without reliable information, market participants are not in a position to accurately evaluate market conditions and take advantage of their forecasts. Especially in agriculture, an assured production is important for food security. The need for better information for farmers and market participants has long been recognized in the U.S.

U.S. Department of Agriculture (USDA) provides the public a stream of reports on crop sizes, livestock inventories, and other statistics that constitute important fundamental information on agricultural commodities (Allen 1994). However, roaring private information services, negative evidence of report releases, and budgetary pressures have been challenging the economic value of public information in agricultural markets (Garcia et al. 1997). To better understand the informational value of USDA reports, some studies investigate the accuracy of USDA forecasts (e.g., Egelkraut et al. 2003; Isengildina-Massa, Karali, and Irwin 2013, 2020; Bora, Katchova, and Kuethe 2021) and willingness-to-pay of traders for having earlier access to those forecasts (e.g., Carter and Galopin 1993; von Bailey and Brorsen 1998; Huang, Serra, and Garcia 2021). In addition, to directly evaluate the impact of USDA reports, others investigate their informational value by exploring market reactions (either price or volatility) to the release of USDA reports (e.g., Summer and Mueller 1989; Adjemian and Irwin 2018; Fernandez-Perez et al. 2019; Karali, Irwin, and Isengildina-Massa 2020).

Most of these previous research focus on agricultural commodities contained in USDA reports, such as corn, soybean, and wheat. However, these agricultural commodities are not only used for direct consumption, but they can also serve as intermediate goods in the production of other goods, such as food products, to satisfy consumer preferences. For example, soybeans are crushed into soybean meal and oil, which are the major component of animal feed and cooking oil, respectively; corn is processed into various food and industrial products, such as starch and ethanol. As a result, new fundamental information on such a commodity not only affects its own price, but might also lead to price movements and volatility in the markets of its end products.

A common method to capture the dynamic relationships among these related commodities has been modelling the conditional variances and covariances, such as in multivariate GARCH models. However, these models are not suitable to detect joint tail events, in which two or more related markets simultaneously suffer from extreme events. The risk of extreme events, such as extremely large price volatility, can bring out broader social risks in terms of food security, human development, and political stability (Kalkuhl, von Braun, and Torero 2016). Studying the relationship between extreme price events and their underlying factors aids to reduce price risks in commodity markets. Therefore, the goal of our study is to examine whether USDA reports lead to contemporaneous occurrence of extreme price volatility or extreme trading volume in related markets linked in a supply chain as USDA information is found to be one of the important sources for volatility spikes (e.g., Adjemian and Irwin 2018; Couleau, Serra, and Garcia 2020).

The contemporaneous occurrence of *extreme price changes* across related commodities is termed as "coexceedance" and is first introduced by Bae, Karolyi, and Stulz (2003). They focus on counts of coexceedances rather than the correlations of joint extreme returns, and use a multinomial logistic regression to investigate the determinants of financial contagion from emerging markets to the U.S. and Europe. This approach has been applied in other studies. For example, Christiansen and Ranaldo (2009) investigate the financial integration between new and old European Union members and Koch (2014) studies the propagation of extreme price changes in energy futures markets. In the context of agricultural markets, Algieri, Kalkuhl, and Koch (2017) use a multinomial logistic regression to investigate the factors explaining the occurrence of extreme price changes across different agricultural commodities. To capture the temporal dependence and persistence in the coexceedances, Algieri and Leccadito (2021) use an integer-valued generalized autoregressive conditional heteroskedasticity (INGARCH) model in their investigation of the factors underlying the joint occurrence of extreme price changes in futures markets.

Our study builds and expands on this previous work to investigate contemporaneous occurrence of *extreme volatility* instead of price levels. We focus on the commodities in the soybean complex (soybean, soybean meal, and soybean oil) for two reasons. First, the soybean market is one of the most volatile agricultural markets according to the Chicago Mercantile Exchange (CME) Group. In fact, previous studies document a drastic volatility reaction in the soybean futures markets to USDA reports. For example, Karali (2012) shows the conditional variance of daily soybean futures returns increases by 143.52% from its average value on the release days of Grain Stocks reports; Adjemian and Irwin (2018) demonstrate noticeable volatility spikes in the intraday soybean futures returns after USDA report releases. We argue that as the primary input for producing soybean oil and meal, extreme volatility in the price of soybean should result in corresponding volatility spikes in soybean meal and oil prices. Second, price movements in these three markets are closely related. The price relationships between markets linked through a food chain are often complex because of processing technologies, product differentiation, and market conditions for other inputs (von Cramon-Taubadel and Goodwin 2021). For example, fluid milk is processed into dozens of dairy products, such as cheese, yogurt, and butter; livestock is slaughtered into a variety of cuts of meat according to quality grade. Compared to other raw agricultural products, processing soybean into soybean end products is a relatively simple case. Moreover, 94% of global soybean production is used for soybean meal and oil production (Oliveira and Schneider 2016). This indicates the soybean demand is derived by soybean meal and oil instead of by its own direct consumption. To fully investigate the effects of USDA reports in the soybean complex, we also expand this exceedance analysis to the crush spread and trading volumes.

We first measure the exceedance counts; that is, the number of these three markets that exhibit extreme volatility simultaneously. Then, we explore whether USDA reports have an explanatory power for the occurrence of (co)exceedances. Since the exceedance count has a natural ordering, we use an ordinal multinomial logistic model to investigate whether these reports increase the probability of joint occurrence of extreme volatility in the soybean complex. To reduce the informational effect of other sources, we control for the releases of macroeconomic reports on consumer price index (CPI), producer price index (PPI), and employment situation. Our study finds empirical evidence that the release of USDA reports affects the joint occurrence of volatility exceedances in two or more markets in the soybean complex as well as the extreme volatility occurrence in the soybean crush. More specifically, our findings show the release of World Agricultural Supply and Demand Estimates (WASDE) and Oil Crops Outlook (OCO) reports in March has the largest impact on the volatility coexceedances, while the release of Grain Stocks (GS) and Prospective Plantings (PP) reports in March has the largest impact on the coexceedances in the trading volume of three commodities.

Data Construction and Preliminary Analysis

We use high-frequency prices and trading volumes of the nearby futures contracts in the soybean complex traded at the CME Globex, the electronic trading platform of the CME Group. One-minute bar intraday data are obtained from Barchart (formerly Commodity Research Bureau) and cover the period from January 1, 2013 to December 31, 2019. After excluding missing trading records, our sample contains 1672 trading days. Since futures markets are more active during day-trading sessions, we focus on the trading hours from 8:30 am Central Time (CT) to 13:15 pm CT.[1]

Because conditional volatility is unobservable, Andersen and Bollerslev (2003) suggest measuring price volatility over a fixed interval as the square root of the sum of squared returns at high sampling frequency, termed as realized volatility (RV). In our analysis, we calculate RV for each commodity over five-minute intervals using one-minute bar intraday prices. To this end, we first compute the one-minute return, $r_{i,j,d}$, for commodity *i* as,

(1) $$r_{i,j,d} = ln(p_{i,j,d}) - ln(p_{i,j-1,d}),$$

where $i = S$ (soybean), O (soybean oil), and M (soybean meal), and $p_{i,j,d}$ is the j^{th}-minute price for commodity *i* on day *d*. Then, the five-minute realized volatility on day *d* ($RV_{i,t,d}$) is the

[1] CME Group adjusts the CBOT grain trading hours according to customer feedback. In our sample period, there are two adjustments made. Beginning on April 8, 2013, there is a break added to the electronic trading from 7:45 am CT to 8:30 am CT, and both floor and CME Globex trading hours end earlier at 1:15 pm CT on weekdays. Since July 6, 2015, the end of trading hours has been extended to 1:20 pm CT. We select the trading hours which are not affected by these adjustments.

square root of the sum of squared one-minute returns within the interval [j−5, j],

(2) $$RV_{i,t,d} = \sqrt{\sum_{\ell=0}^{4} r_{i,j-\ell}^{2}},$$

where subscript t denotes the five-minute interval. In addition, the gross soybean crush margin is the key for processors in deciding when and if to commit to processing soybeans on a future date (Plato 2001). The crush spread is measured as the difference between the value of soybeans and its end products and can be regarded as a gauge of the potential profit margin for soybean processors. Therefore, we also investigate the price volatility of the crush spread. Based on the CME Group's guidelines,[2] we calculate the j^{th}-minute soybean crush spread on day d, $p_{j,d}^{S}$, as,

(3) $$p_{j,d}^{S} = p_{M,j,d} \times 0.022 + p_{O,j,d} \times 11 - p_{S,j,d}.$$

Following equations (1) and (2), we calculate the five-minute RV for the soybean crush on day d and denote it as $RV_{t,d}^{S}$. To capture the pattern of trading volumes, we follow Adjemian and Irwin (2018) and take the simple average of the one-minute bar trading volumes on day d ($v_{i,j,d}$) within the five-minute interval,

(4) $$\bar{V}_{i,t,d} = \frac{1}{5}\sum_{j=0}^{4} v_{i,j,d}.$$

USDA reports and report clusters

We select seven USDA reports that provide fundamental information, such as planting areas and stocks, for the soybean complex. Table 1 provides the release frequency, time, and day of these

[2] Pricing units of the futures contracts are dollars per short ton for soybean meal, dollars per pound for soybean oil, and dollars per bushel for soybean. CME Group's guideline, *Soybean Crush Reference Guide*, is available at https://www.cmegroup.com/education/files/soybean-crush-reference-guide.pdf.

selected reports during our sample period. Except for WASDE and OCO reports, the remaining five reports only provide information for the soybean market. These important reports are prepared by USDA agencies, including National Agricultural Statistical Service (NASS), World Agricultural Outlook Board (WOB), and Economic Research Service (ERS). The release of USDA reports is, in fact, affected by the government operation and the federal funding. For instance, when USDA ceased its routine operations from October 1 to October 16, 2013, the WASDE report was not released. As a result, there were no elevated realized volatility in corn and soybean futures markets around the time of the missed WASDE report (Adjemian et al. 2018). Moreover, the federal government shutdown in 2019 postponed the release of USDA reports from January 11 to February 8, 2019.

To identify extreme volatility events, we construct a benchmark for a normal market in which price movements are not affected by the release of USDA reports. To this end, we define a three-day event window surrounding the report releases (three days before and three days after), and represent the normal market behavior by the price volatility, or trading volume, on these non-release days. The impact of USDA reports is assessed by comparing the realized volatility or average trading volume on release days versus non-release days. However, there are two issues needed to be addressed when setting up the event windows. First, many of these reports are often released together. For example, the releases of CP reports from August to November contains information on area harvested. Yield per acre, and production which are also included in the simultaneously-released WASDE reports. Second, some of the selected reports are released only few days apart, which leads to the issue of overlapping within an event window. For example, the release of WASDE reports is usually two days prior to OCO reports. This would cause including the WASDE release in the pre-release period of OCO reports, and the OCO release in the post-release period of WASDE reports.

To address these two issues, we analyze each calendar month separately and focus on the report clusters that are released together. In addition, we also cluster the overlapping reports but redefine their event window as the three days before first report release and three days after the second report release. In Table 2, we provide a summary of USDA report clusters by month. Except for March, June, and September, the other nine months only have one report cluster. When there are two report clusters in the same month, the release of one cluster is in the middle of that month while the other cluster is released at the end of the month.

Exceedance counts in the soybean complex

We sort each commodity's five-minute RVs on non-release days within the event window for a given month from the smallest to the largest, and define the extreme price volatility, or exceedance, as one that lies above the 95% quantile of their distributions. We do the same for average trading volume. As a result, the thresholds for extreme price volatility, or trading volume, varies for each calendar month and report cluster. We then count the number of markets that simultaneously experience extreme volatility, or coexceedances, in the soybean complex as

(5) $$U_{t,d,m}^{RV} = \sum_{i=1}^{3} I(\, RV_{i,t,d,m} \geq Q_{i,m}^{RV}),$$

and the counts for joint occurrence of extremely large trading volume as,

(6) $$U_{t,d,m}^{V} = \sum_{i=1}^{3} I(\, \bar{V}_{i,t,d,m} \geq Q_{i,m}^{V}),$$

where the subscript *m* stands for month, $I(\cdot)$ is an indicator function that equals one if the condition in parenthesis is satisfied, and $Q_{i,m}^{RV}$ and $Q_{i,m}^{V}$ are the 95% thresholds for volatility and trading volume. These coexceedance counts ($U^J_{t,d,m}$, where *J* = *RV*, *V*) indicate four outcomes for the occurrence of the extreme events in a given five-minute interval: 1) no extreme event takes place in any of the markets, $U^J_{t,d,m} = 0$; 2) an extreme event occurs only in one market, $U^J_{t,d,m} = 1$; 3) the coexceedance happens in two markets, $U^J_{t,d,m} = 2$; 4) all three markets simultaneously experience an extreme event, $U^J_{t,d,m} = 3$.

Since crush spread is measured as a combination of price series from three markets, there is only the possibility of an exceedance, rather than coexceedance. The exceedance count for the soybean crush spread is

(7) $$U^S_{t,d,m} = I(RV^S_{t,d,m} \geq Q^S_m),$$

where Q^S_m is the 95% threshold for the five-minute RV of the soybean crush spread on non-release days. In this case, there are only two possible outcomes: 1) no extreme volatility of the crush spread, $U^S_{t,d,m} = 0$; 2) extremely large volatility of the spread, $U^S_{t,d,m} = 1$.

Figure 1 shows the percentage of exceedance counts, calculated by dividing the frequency of $U^J_{t,d,m} = h$, *J* = *RV*, *V*, *S*, and where *h* = 1, 2, 3 for the volatility and trading volume of soybean complex and *h* = 1 for the volatility of crush spread, by the total number of five-minute observations within the event window in month *m*. In figure 1(a), we present the percentage of one, two, and three exceedances in the soybean complex by month. For example, 5.71% of total observations within the event window of January have the exceedance in one market, 4.25% in two markets, and 0.88% in three markets. Comparing the exceedance counts across months, extreme volatility in one market occurs more often in November (8.35%) and less often in July (4.53%). The percentage of coexceedance in two markets is the highest in April (6.32%), while it is the lowest in May (2.49%). On the other hand, the percentage of three exceedances is very close to each other across months, ranging from 0.87% to 1.97%. Figure 1(b) displays the exceedance counts for the soybean crush spread. The exceedance occurs more frequently in November with 7.04% of observations exceeding the 95% threshold, while it happens less frequently in May with 3.99% of observations higher than the threshold. Similar to the soybean complex volatility, there is also variation in the exceedance counts of trading volume across months as shown in figure 1(c). September (May) witnesses the highest (lowest) percentage of exceedance in one market, November (June) in two markets, and January (November) in three markets.

We further compare the percentage of exceedance counts on release days to non-release days within the event window of each month in figures 2-4. In general, with few exceptions, the percentage of exceedances on release days is higher than that on non-release days. For the volatility in the soybean complex given in figure 2, the percentages of two and three exceedances on release days in March are 10.44%, and 7.28%, respectively, which are 3.61 and 9.20 times larger than the corresponding percentages on non-release days. For the crush spread in figure 3, the largest difference in the exceedance percentages between the release and non-release days is observed in November, with 13.86% of observations exceeding the 95% threshold on release days whereas only 5% on non-release days. In figure 4, the percentages of exceedances in trading volume on release days, in general, are larger compared to those on non-release days, with the largest difference observed for three exceedances in March (3.74 times).

Methodology

As it is evident in figures 2-4 those extreme events (extremely large volatility or trading volume) happen on USDA report release days, we further explore whether these reports increase the probability of the occurrence of (co)exceedances. To this end, we follow Bae, Karolyi, and Stulz (2003) and Koch (2014) and use a logistic regression model. All of our exceedance counts have a natural ordering since they indicate the degree of market volatility. The higher value of the exceedance count is, more commodities experience extreme volatility or trading volume; thus, the market condition for the soybean complex is more turbulent. Accordingly, we employ an ordinal logit model to estimate the probability of (co)exceedance occurrences in volatility and trading volume in all three separate markets and in the volatility of soybean crush spread. The probability of observing outcome h in the ordinal model is

$$(8) \qquad \Pr\left[U_{t,d,m}^{J} = h\right] = \Pr[\alpha_{h-1} < X'\beta + u \leq \alpha_h]$$

$$= \frac{1}{1 + \exp\left(-\alpha_h + X'\beta\right)} - \frac{1}{1 + \exp\left(-\alpha_{h-1} + X'\beta\right)}$$

where $U_{t,d,m}^{J}$, $J = RV, V, S$, are the exceedance counts defined in equations (5)-(7), $h = 0, 1, 2, 3$ for soybean complex volatility and trading volume, and $h = 0, 1$ for crush spread. The matrix X contains explanatory variables, β is the parameter vector, and α_h is the cutpoint with $\alpha_0 < \alpha_1 < \alpha_2 < \alpha_3$.

In matrix X, we include dummy variables for report releases. For USDA reports, dummy variables are created for each report cluster in a given month. As macroeconomic news can also lead to price spikes (Barnhart 1989), we also include dummy variables representing the releases of CPI, PPI, and employment situation reports, which are released monthly by the U.S. Bureau of Labor Statistics.

Empirical Results

For an easier interpretation, we report in table 3 the average marginal effects of report clusters, which indicate the average change in the probability of (co)exceedance occurrences between release days and non-release days of USDA reports. For the soybean complex, the releases of 10 out of 15 report clusters significantly decrease the probability of no volatility exceedance in any of the three markets, indicating increased probability of exceedances at three different levels. For the volatility in the soybean complex (U^{RV} portion of the table), the largest impact of USDA report releases on the probability of one exceedance is observed for the GS and ACR cluster in June, with a 12.8 percentage-point increase, and the least impact for the WASDE and OCO cluster in April (2.1 percentage points). The probability of extreme volatility exceedances in two (three) markets increases by 27.0 (47.9) percentage points on the release days of WASDE and OCO reports in March.

There are three major findings for the crush spread. First, nearly half of the report clusters do not contribute to a significant change in the probability of the exceedance occurrences. Second, the report clusters, except for May and June, significantly decrease the probability of observing a calm market ($U^S = 0$) and increase that of a turbulent one ($U^S = 1$). Third, similar to the volatility in the soybean complex, the WASDE and OCO report cluster in March has the largest impact on the exceedance probability, with an increase of 41.6 percentage points on release days.

The analysis of (co)exceedances in the trading volume on release days helps to comprehend how USDA report releases affect the market activity. Except for May, August, and December, the report clusters either significantly increase or decrease the probability of no exceedance ($U^V = 0$) in the trading volume. The direction of the impact depends on the type of information. For example, the March release of WASDE and OCO reports, which provide information on all three markets, increases the probability of no exceedance by 10.5 percentage points, while the release of GS and PP reports, which provide information only on the soybean market, in the same month decreases the occurrence by 10.7 percentage points. The marginal effects of USDA reports also vary across release months. For instance, the probability of observing two exceedances is 1.2 percentage points higher on the release days of WASDE and OCO reports in January, while it is 2.1 percentage points lower in March.

Conclusions

USDA reports provide fundamental information on major agricultural commodities and their releases lead to price and volatility spikes in the commodity markets. Since major crops are commonly used as a raw material in food processing, USDA reports not only affect these crops, but also their end products. Our study focuses on the extreme price volatility (or trading volume) in the markets of the soybean complex, as well as the crush spread, and investigates the role of USDA reports on the occurrence of such extreme events. Thus, our study provides new insights on the empirical linkages between market reactions and public information.

We find statistical evidence of an increased probability of (co)exceedances on the release days of USDA reports. The magnitude of report effects varies by the release month and the type of information contained in the reports. The joint release of GS and ACR reports in June has the largest impact on the occurrence of one exceedance in the soybean complex. For coexceedances in two or more markets, the overlapping release of WASDE and OCO reports in March has the largest impact. These findings are not surprising since GS and ACR reports provide information on the soybean market, while WASDE and OCO reports serve all three markets together. Moreover, WASDE reports provide information for both domestic and global markets. Since Brazil is the largest soybean supplier in the world, new information on the South American soybean might lead to volatility spikes in the U.S. futures markets. The harvest season for U.S. soybean is from late September to the end of November, while for Brazilian soybean it is from early March to late May.[3] The largest impact of the WASDE and OCO cluster on volatility exceedances often occurs in March, which provides evidence that fundamental information about Brazilian soybean increase the market volatility of the U.S. soybean complex. For the soybean crush spread, we surprisingly find the release of WASDE and OCO reports decreases the probability of exceedance occurrences in the U.S. planting season (May and June).[4] This indicates WASDE and OCO reports have a dual role of stimulating the price volatility during non-planting season and smoothing the volatility in the planting season. In addition, the joint release of GS and PP reports in March has the largest impact on the coexceedances in trading volume. Overall, our findings show the release of USDA reports affects the volatility exceedances and trading volume in the futures markets of the soybean complex, and the magnitude and direction of the impact is affected by the release month.

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[3] The harvest season of Brazilian soybean is obtained from the USDA's Foreign Agricultural Service, available at https://ipad.fas.usda.gov/rssiws/al/crop_calendar/br.aspx.

[4] The planting season for soybean is from early May to mid-June, while the harvest season spans from late September to the end of November. For more details, see the soybean production calendar available at https://simpson.ca.uky.edu/files/corn_and_soybean_production_calendar.pdf.

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Table 1. USDA Reports for the Soybean Complex, 2013-2019

USDA Report	Content	Release Frequency	Release Time	Release Days
CPAS	Soybean	Annual	11 am CT	10th to 12th of Jan.
PP	Soybean	Annual	11 am CT	End of Mar.
ACR	Soybean	Annual	11 am CT	End of Jun.
GS	Soybean	Quarterly	11 am CT	10th to 12th of Jan. and end of Mar., Jun, and Sep.
OCO	Soybean complex	Monthly	11 am CT	11th to 17th of each month
CP	Soybean	Monthly (Aug. to Nov.)	11 am CT	9th to 12th of each month
WASDE	Soybean complex	Monthly	11 am CT	9th to 12th of each month

Notes: CPAS=Crop Production Annual Summary, PP=Prospective Plantings, ACR=Acreage, GS=Grain Stocks, OCO=Oil Crop Outlook, CP=Crop Production, WASDE=World Agricultural Supply and Demand Estimates.

Table 2. Report Clusters in Each Month

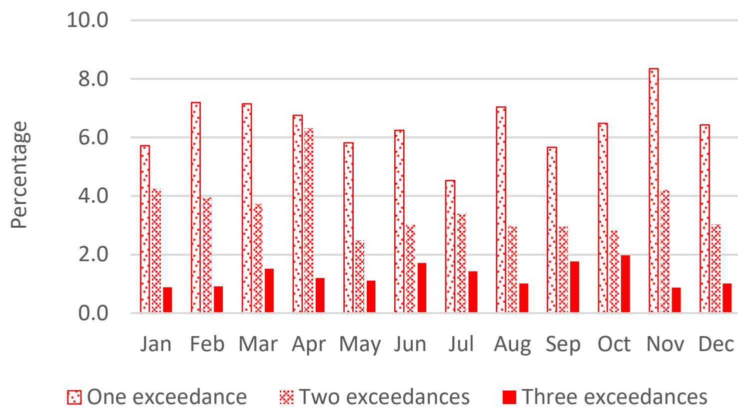
Month	Report Clusters
January	CPAS+GS+WASDE+OCO
February	WASDE+OCO
March	WASDE+OCO
	GS+PP
April	WASDE+OCO
May	WASDE+OCO
June	WASDE+OCO
	GS+ACR
July	WASDE+OCO
August	CP+WASDE+OCO
September	CP+WASDE+OCO
	GS
October	CP+WASDE+OCO
November	CP+WASDE+OCO
December	WASDE+OCO

Notes: Each row lists the reports that are included in the same cluster due to simultaneous or overlapping release.

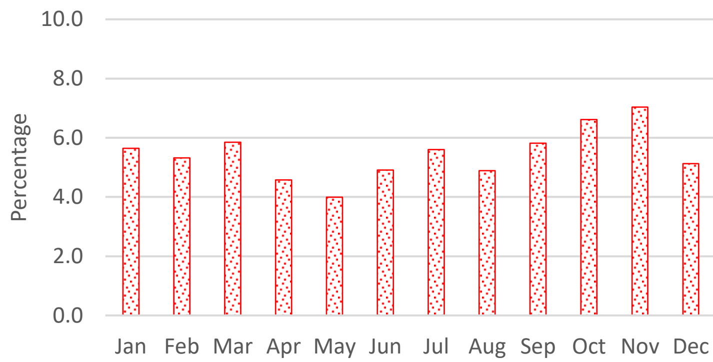
Table 3. Determinants of Extreme Events in the Soybean Complex

	Jan.	Feb.	Mar.		Apr.	May.	Jun.		Jul.	Aug.	Sep.		Oct.	Nov.	Dec.
	CPAS+ GS+ WASDE+ OCO	WASDE+ OCO	WASDE+ OCO	GS+PP	WASDE+ OCO	WASDE+ OCO	WASDE+ OCO	GS+ACR	WASDE+ OCO	CP+ WASDE OCO	CP+ WASDE+ OCO	GS	CP+ WASDE OCO	CP+ WASDE+ OCO	WASDE+ OCO
U^{RV}															
0	-0.089***	-0.058***	-0.799***	-0.156***	-0.037**	0.007	0.019	-0.279***	-0.015	-0.027	0.018	-0.233***	-0.096***	-0.110***	-0.066**
	(0.027)	(0.015)	(0.06)	(0.023)	(0.014)	(0.02)	(0.012)	(0.034)	(0.018)	(0.019)	(0.018)	(0.032)	(0.023)	(0.018)	(0.034)
1	0.042***	0.011	0.050	0.025*	0.021**	-0.004	-0.010	0.128***	0.007	-0.008	-0.009	0.106***	0.052***	0.063***	0.038**
	(0.012)	(0.011)	(0.071)	(0.015)	(0.008)	(0.012)	(0.006)	(0.014)	(0.008)	(0.014)	(0.009)	(0.014)	(0.013)	(0.010)	(0.019)
2	0.038***	0.040***	0.270***	0.077***	0.011**	-0.002	-0.006	0.090***	0.006	0.017	-0.005	0.075***	0.026***	0.038***	0.020*
	(0.012)	(0.01)	(0.068)	(0.016)	(0.005)	(0.006)	(0.003)	(0.013)	(0.007)	(0.012)	(0.005)	(0.013)	(0.007)	(0.007)	(0.011)
3	0.009**	0.008*	0.479**	0.054***	0.004**	-0.001	-0.003	0.061***	0.002	0.018*	-0.003	0.052***	0.019***	0.009***	0.008*
	(0.004)	(0.005)	(0.192)	(0.012)	(0.002)	(0.003)	(0.002)	(0.011)	(0.003)	(0.009)	(0.003)	(0.011)	(0.006)	(0.002)	(0.004)
U^{S}															
0	-0.015	-0.001	-0.416**	-0.055***	0.004	0.045***	0.024***	-0.069***	-0.022	-0.006	0.001	-0.109***	-0.069***	-0.072***	-0.031
	(0.015)	(0.009)	(0.164)	(0.015)	(0.009)	(0.006)	(0.007)	(0.022)	(0.015)	(0.014)	(0.014)	(0.025)	(0.019)	(0.013)	(0.027)
1	0.015	0.001	0.416**	0.055***	-0.004	-0.045***	-0.024***	0.069	0.022	0.006	-0.001	0.109***	0.069***	0.072***	0.031
	(0.015)	(0.009)	(0.164)	(0.015)	(0.009)	(0.006)	(0.007)	(0.022)	(0.015)	(0.014)	(0.014)	(0.025)	(0.019)	(0.013)	(0.027)
U^{V}															
0	-0.058**	-0.024*	0.105***	-0.107***	-0.043***	-0.019	-0.049***	0.093***	-0.054***	-0.021	-0.072***	-0.078***	-0.075***	-0.031**	-0.038
	(0.023)	(0.013)	(0.005)	(0.021)	(0.013)	(0.020)	(0.013)	(0.004)	(0.020)	(0.019)	(0.023)	(0.029)	(0.022)	(0.016)	(0.032)
1	0.028**	-0.011	-0.059***	0.015	0.022***	-0.016	0.024***	-0.049***	0.003	0.015	0.053***	0.058***	0.039***	0.019**	0.023
	(0.011)	(0.009)	(0.004)	(0.013)	(0.007)	(0.014)	(0.006)	(0.003)	(0.014)	(0.014)	(0.017)	(0.021)	(0.011)	(0.009)	(0.019)
2	0.012**	0.009	-0.021***	0.035***	0.008***	0.029**	0.009***	-0.017***	0.027**	0.003	0.014***	0.015**	0.016***	0.010*	0.007
	(0.005)	(0.007)	(0.002)	(0.011)	(0.003)	(0.012)	(0.003)	(0.002)	(0.011)	(0.003)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)
3	0.018**	0.025***	-0.025***	0.057***	0.012***	0.006	0.016***	-0.027***	0.023**	0.003	0.005**	0.005**	0.020***	0.002*	0.008
	(0.008)	(0.008)	(0.003)	(0.014)	(0.004)	(0.011)	(0.004)	(0.002)	(0.011)	(0.003)	(0.002)	(0.002)	(0.007)	(0.001)	(0.007)

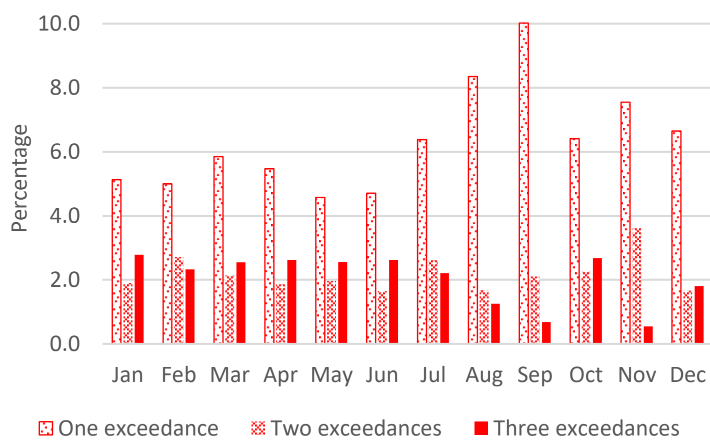
Notes: Table reports the average marginal effects, which represent the difference in the probability of (co)exceedance occurrences between the release and non-release days and calculated using the estimated ordinal logit coefficients from equation (8). U^{RV}, U^{V}, and U^{S} are the exceedance counts for the extreme volatility in the soybean complex, extreme trading volume, and extreme volatility in the soybean crush calculated as in equations (5), (6), and (7) respectively. Standard errors are given in parentheses. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.



(a) Soybean complex



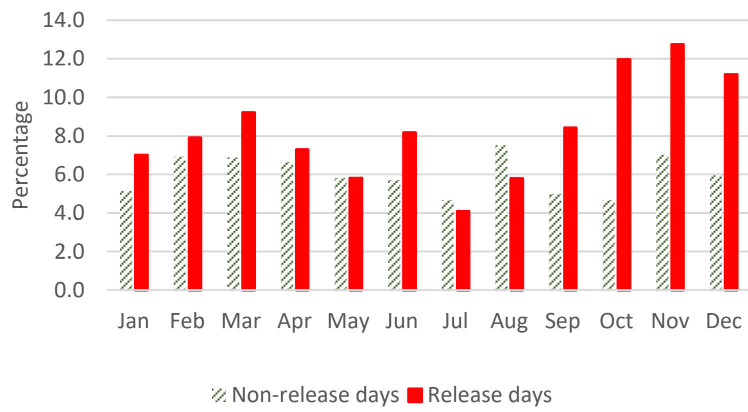
(b) Soybean crush spread



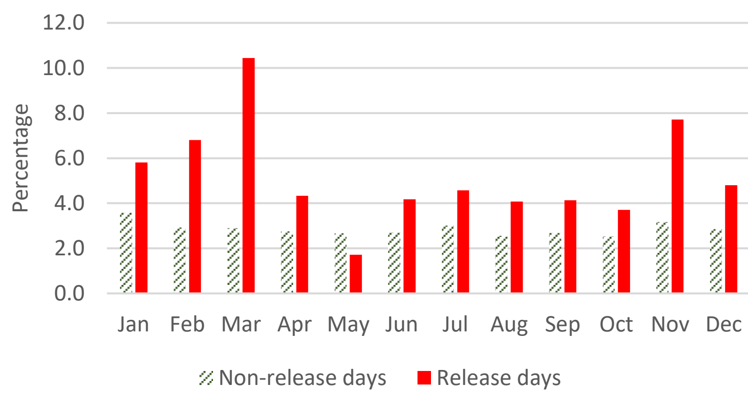
(c) Trading volume

Figure 1. Percentage of exceedance counts within event window

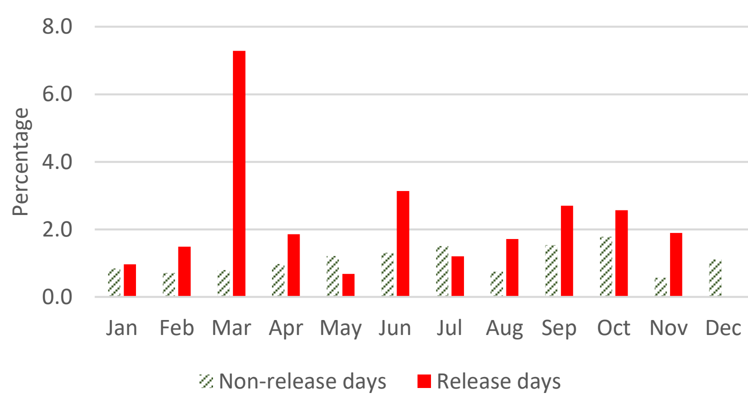
Notes: The percentage of exceedance counts is measured by dividing the frequency of exceedance counts at different levels by the total number of five-minute observations within the event window (both release and non-release days) in each month.



(a) One exceedance



(b) Two exceedances



(c) Three exceedances

Figure 2. Percentage of exceedance counts in the soybean complex on release vs. non-release days

Notes: The percentage of exceedance counts on release (non-release) days is measured by dividing the frequency of exceedance counts at different levels on release (non-release) days by the total number of five-minute observations on release (non-release) days.

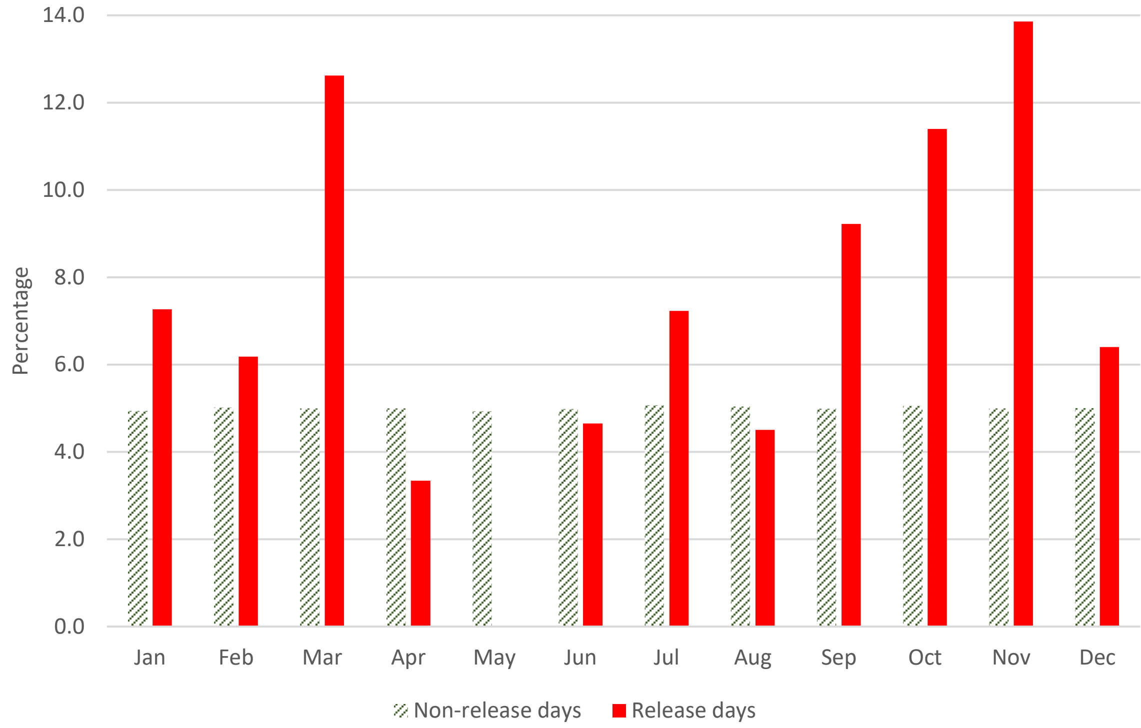
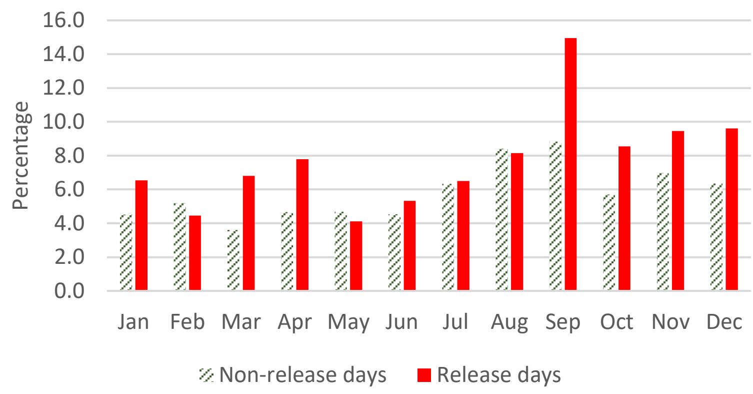
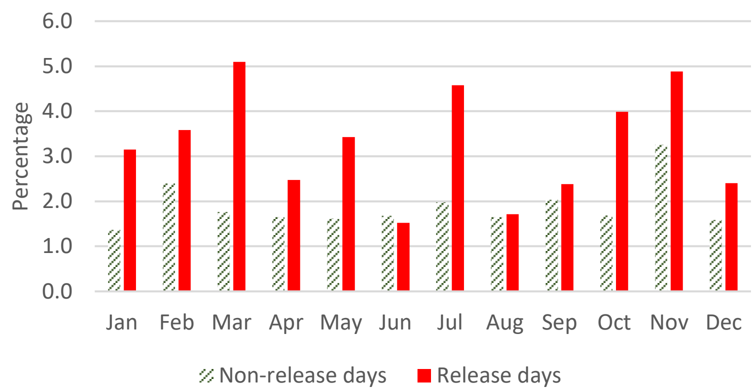


Figure 3. Percentage of exceedance counts in the soybean crush spread on release vs. non-release days

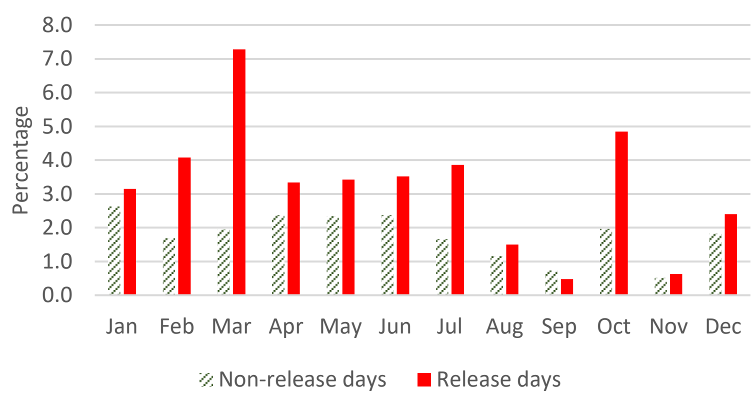
Notes: The percentage of exceedance counts on release (non-release) days is measured by dividing the frequency of exceedance counts on release (non-release) days by the total number of five-minute observations on release (non-release) days.



(a) One exceedance



(b) Two exceedances



(c) Three exceedances

Figure 4. Percentage of exceedance counts in trading volume of the soybean complex on release vs. non-release days

Notes: The percentage of exceedance counts on release (non-release) days is measured by dividing the frequency of exceedance counts at different levels on release (non-release) days by the total number of five-minute observations on release (non-release) days.