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Do USDA Reports Contribute to Extreme Price Volatility? The Case of the Soybean Complex

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USDA reports are publicly available and provide important fundamental information on agricultural commodities. An extensive literature finds evidence of price or volatility spikes following USDA report releases, especially for 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 focuses on the joint occurrence of extreme price volatility in commodity markets linked in a supply chain on report release days. We investigate 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 macroeconomic reports, we find that the USDA reports released in March have the largest impact on the joint occurrence of extreme volatility in all three markets.

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

Introduction

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 good use 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, lack of announcement effects from USDA reports, 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 and volatility movements 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 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.

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. More specifically, our findings show the release of the World Agricultural Supply and Demand Estimates (WASDE) and Oil Crops Outlook (OCO) cluster in November has the largest impact on the occurrence of one exceedance. While the Grain Stock (GS) and Prospective Plantings (PP) cluster at the end of March has the largest impact on volatility coexceedances.

Data Construction and Exceedances in the Soybean Complex

We use high-frequency prices of the nearby futures contracts[1] 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, 2021. After excluding missing trading records, our sample contains 2732 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 1:15 pm CT.[2]

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 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.

USDA report clusters

[1] We focus on the most active contracts and roll over the nearby contracts based on the combination of volume and open interest.

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

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 selected reports during our sample period. Except for the WASDE and OCO cluster, 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 on these non-release days. The impact of USDA reports is assessed by comparing the realized volatility 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.

Macroeconomics news on commodity prices

As macroeconomic news can also lead to futures price spikes (i.e. Barnhart 1989; Hess, Huang, and Niessen 2008; Roache and Rossi 2010), we control for the release of macroeconomic news within the event window of USDA reports. We select three significant macroeconomic reports: CPI, PPI, and ES. All three reports are released monthly at 7:30 am CT by the U.S. Bureau of Labor Statistics. CPI and PPI is a measure of average change over time in the prices paid by urban consumers and selling prices received by domestic producers, respectively. Specifically, the food index is an important indicator in both CPI and PPI, which indicates the purchasing power of money in food consumption and production. In addition, employment situation includes statistics from two monthly surveys implying the direction of wage and employment trends in the U.S. economy.

Within the event window in each month, the release of each macroeconomic report occurs either on the release or non-release days. The macroeconomic reports have a dual role of stimulating the occurrence of coexceedances if they occur on release days, and smoothing the coexceedance volatility if they show up on non-release days.[3] Figure 1 describes the number of five-minute observations within the event window when the macroeconomic news releases on the same day. In general, the release of macroeconomic news is often higher on the non-release days of USDA report clusters. Especially for ES reports, they are all released on the non-release days except January, March, and November.

Exceedance thresholds and 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. As a result, the thresholds for extreme price volatility are based the normal market behavior (non-release days within event window) varying for each calendar month. Table 3 shows a monthly summary of price volatility in the normal market behavior of each commodity. For volatility on non-release days, the average volatility in July is the highest, while the largest standard deviation is in June for all three commodities. The threshold for extreme volatility in July is often the highest for soybean and soybean meal, but soybean oil has the highest threshold in March. We then count the number of markets that simultaneously experience extreme volatility, or coexceedances, in the soybean complex as

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

where the subscript m stands for month, $I(\cdot)$ is an indicator function that equals one if the condition in parenthesis is satisfied, and $Q_{i,m}^{RV}$ is the 95% thresholds for volatility. These coexceedance counts ($U_{t,d,m}^{RV}$) 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, $U_{t,d,m}^{RV} = 0$; 2) an extreme event occurs only in one market, $U_{t,d,m}^{RV} = 1$; 3) the coexceedance happens in two markets, $U_{t,d,m}^{RV} = 2$; 4) all three markets simultaneously experience an extreme event, $U_{t,d,m}^{RV} = 3$.

The percentage of exceedance counts is calculated by dividing the frequency of $U_{t,d,m}^{RV} = h$, where h = 1, 2, 3 for the volatility of soybean complex, by the total number of five-minute observations within the event window in month m. As shown in figure 2, we present the percentage of one, two, and three exceedances in the soybean complex by month. For example, 6.33% of total observations within the event window of January have the exceedance in one market, 3.95% in two markets, and 1.85% in three markets. Comparing the exceedance counts across months, extreme volatility in one market occurs more often in November (7.45%) and less often in April (3.03%). The percentage of coexceedance in two markets is the highest in January (3.95%), while it is the lowest in May (2.49%). On the other hand, the percentage of three

[3] The release of macroeconomic reports brings new information into the futures markets and leads to an increase in price volatility on non-release days. Since we use the data on non-release days as a baseline of normal market behavior, increasing price volatility can lead to higher thresholds for extreme volatility. The higher the thresholds for extreme volatility are, the lower probability of the extreme events jointly occurs among three markets of the soybean complex.

exceedances is very close to each other across months, ranging from 1.01% to 1.85%.

We further compare the percentage of exceedance counts on release days to non-release days within the event window of each month given in figure 3. In general, with few exceptions, the percentage of exceedances on release days is higher than that on non-release days. The percentage of one exceedance on release days in June and December is 5.27% and 5.38%, respectively. These two months are the only two exceptions that the percentage of exceedances on release days is less. The difference in the percentage of three exceedances between on release days and non-release days is, in general, larger than that of one or two exceedances. For example, the percentage of three exceedances on release days in January is 3.68%, which are 3.09 times larger than the corresponding percentages on non-release days. While, in the same month, the percentages of one and two exceedances on release days are only 2.54 and 1.37 times larger than non-release days, respectively.

Methodology

As extremely large volatilities happen on USDA report release days (see figure 3), 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; 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 price volatility in all three separate markets. The probability of observing outcome h in the ordinal model is

$$(4) \qquad \Pr\left[U_{t,d,m}^{RV} = h\right] = \Pr[\alpha_{h-1} < X'\beta + u \leq \alpha_h] = \frac{1}{1 + \exp\left(-\alpha_h + X'\beta\right)} - \frac{1}{1 + \exp\left(-\alpha_{h-1} + X'\beta\right)}$$

where $U_{t,d,m}^{RV}$ are the exceedance counts defined in equations (4), h = 0, 1, 2, 3 for soybean complex volatility. 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. We also include dummy variables representing the releases of CPI, PPI, and ES reports.

Empirical Results

We report in table 4 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 volatility in the soybean complex, the releases of 12 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. We compare report clusters varying across months at each (co)exceedance occurrence. The largest impact of USDA report releases on the probability of one exceedance is observed for the CP, WASDE and OCO cluster in November, with a 3.9 percentage-point increase, and the least impact for the WASDE and OCO cluster in April (2.0 percentage points).[4] The report cluster in January has the largest impact on the probability of extreme volatility exceedances in two markets by increasing 6.2 percentage points, which is very closed to the second largest one from the GS and PP cluster in March. While the lease impact on the occurrence of two coexceedances occurs in April. The probability of extreme volatility exceedances in three markets increases by 4.9 percentage points on the release days of WASDE and OCO reports in March. As a result, we find the marginal effect with statistical significance on release days in April is always the smallest regardless of the levels of U^{RV}. More importantly, the joint occurrence of exceedances in two more or markets is more like to happen when the release of GS and PP cluster 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 in the markets of the soybean complex, 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. The joint release of CP, WASDE and OCO cluster in November has the largest impact on the occurrence of one exceedance in the soybean complex. This is not surprising because the new-crop contracts enter the soybean futures market in November. The traders might be sensitive to the new supply information for soybeans since new crops are planted but their harvests are uncertain. For coexceedances in two markets, the joint release of CPAS, GS, WASDE and OCO reports in January has the largest impact. More specifically, coexceedance in two markets in January is 6.2 percentage points higher on the release days, which is very close to the second largest impact from the GS and PP cluster in March (6.1 percentage points). However, we surprisingly find the release of GS and PP reports at the end of March having the highest impact on the probability of coexceedance in three markets, although these reports only provide information for soybeans.

In addition, the magnitude of report effects is affected by the type of information contained in the reports. All these report clusters can be divided into two broad categories: 1) reports or report clusters only providing information for soybean markets (the GS and PP cluster, the GS and ACR cluster, and the GS report); 2) report clusters serve all three markets together (the WASDE and OCO cluster, and the CP, WASDE, and OCO cluster).[5] For the reports or report clusters only having information for the soybean market, all these reports significantly decrease the probability of no volatility exceedance. The release of these reports does not have impacts on the occurrence of one exceedance with statistical significance at 10% level or lower.

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[4] We focus on the marginal effects with the statistical significance at 10% level or below. For one exceedance, the report clusters have not significant impacts in March, June, September, and December.

[5] We get rid of the CPAS, GS, WASDE, and OCO report cluster in January because the CPAS, GS, and WASDE reports are released simultaneously. We cannot distinguish the impacts from the reports targeting only on soybeans (CPAS and GS reports) with the reports providing information for all three commodities (WASDE reports).

However, they significantly increase the join occurrence of extreme volatility in either two or three markets. It indicates that the supply and storage information for soybean market does not only affect the occurrence of extreme volatility in a single market, instead it jointly influences two or three markets in the soybean complex. Moreover, WASDE reports provides 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.[6] When comparing the report clusters in the harvest season between U.S. and Brazil, we find the impacts of the WASDE and OCO cluster in the U.S. harvest season (September to November) are larger than those in Brazilian harvest season. For instance, the largest impact of the WASDE and OCO cluster on three coexceedances in the Brazil harvest season is in May by increasing 1.4 percentage points on release days, while the largest impact increases 2.3 percentage points in the U.S. harvest season. This indicates the dominant role of U.S. information on the U.S. futures markets. The global soybean trade is concentrated in three countries: the U.S., Brazil, and China. Although U.S. had been the world's largest soybean suppliers, its first place was taken over by Brazil since 2011/2012 marketing year. Our results show the futures markets are more likely to react the U.S. information rather than Brazil. Overall, our findings show the release of USDA reports affects the volatility exceedances in the futures markets of the soybean complex, and the magnitude and direction of the impact is affected by both the release month and information type.

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[6] 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.

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Table 1. USDA Reports for the Soybean Complex, 2013-2021

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. Summary Statistics of Realized Volatility in Normal Market Behavior of Each Commodity

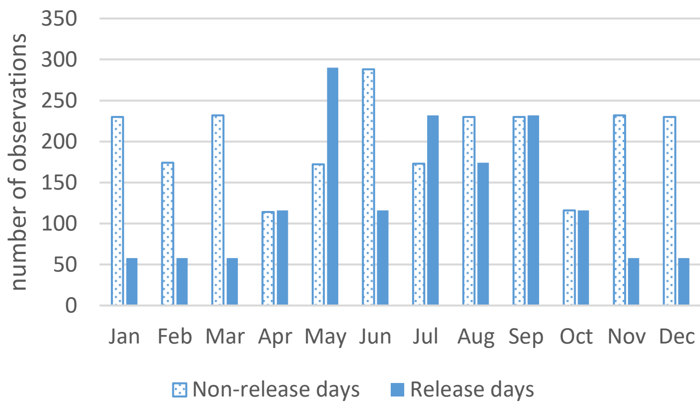
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
RV_S												
Mean	0.094	0.089	0.093	0.086	0.105	0.113	0.126	0.104	0.100	0.101	0.096	0.099
Std. Dev.	0.055	0.052	0.053	0.052	0.066	0.084	0.076	0.058	0.060	0.058	0.060	0.063
Min.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max.	0.646	0.456	0.542	0.473	0.814	2.440	0.801	0.588	0.984	0.650	0.754	0.821
95% Threshold	0.198	0.186	0.191	0.180	0.225	0.246	0.268	0.209	0.206	0.214	0.208	0.215
RV_M												
Mean	0.120	0.115	0.116	0.107	0.123	0.135	0.149	0.123	0.117	0.124	0.124	0.122
Std. Dev.	0.071	0.072	0.068	0.071	0.080	0.103	0.095	0.072	0.073	0.077	0.091	0.082
Min.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max.	0.625	0.865	0.729	0.647	1.031	3.326	1.027	0.768	0.917	0.737	1.131	1.049
95% Threshold	0.261	0.247	0.241	0.234	0.271	0.298	0.323	0.257	0.248	0.274	0.284	0.265
RV_O												
Mean	0.110	0.108	0.120	0.109	0.122	0.128	0.132	0.116	0.123	0.119	0.114	0.128
Std. Dev.	0.066	0.065	0.082	0.070	0.076	0.107	0.085	0.068	0.078	0.075	0.072	0.093
Min.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max.	0.569	0.610	1.478	0.744	0.740	2.677	0.856	0.968	1.287	0.663	0.891	1.408
95% Threshold	0.228	0.227	0.412	0.229	0.269	0.284	0.280	0.235	0.257	0.256	0.247	0.287
Observations	2597	2832	6009	3057	3114	5751	3120	3120	6240	2778	3120	3120

Notes: The variables, RV_S, RV_M, and RV_O, represent the five-minute realized volatility of each commodity *i*, where *i*=*S* (Soybean), *M* (soybean meal), and *O* (soybean oil). We summarize the statistics of realized volatility on both pre- and post-release days within event window in each month. To show the difference in their distribution varying for each calendar month, the statistics reported in this table is multiplied by 100. The 95% threshold is the 95% quantile of the distribution and define the extreme price volatility in each market.

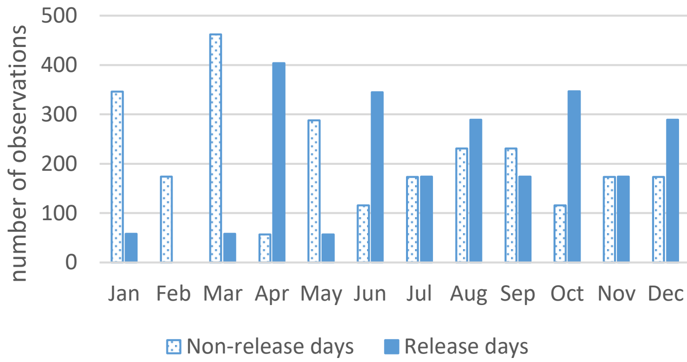
Table 4. Determinants of Extreme Events in the Soybean Complex

	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
0	-0.123***	-0.060***	-0.019	-0.114***	-0.034***	-0.064***	-0.001	-0.110***	-0.060***	-0.088***	-0.056***	-0.113***	-0.073***	-0.068***	-0.018
	(0.017)	(0.013)	(0.012)	(0.021)	(0.012)	(0.013)	(0.012)	(0.022)	(0.013)	(0.014)	(0.013)	(0.022)	(0.014)	(0.013)	(0.012)
1	0.028**	0.034***	-0.006	0.004	0.020***	0.034***	0.001	0.007	0.029***	0.030***	0.008	0.021	0.032***	0.039***	-0.009
	(0.011)	(0.007)	(0.009)	(0.015)	(0.007)	(0.007)	(0.006)	(0.013)	(0.006)	(0.010)	(0.009)	(0.015)	(0.011)	(0.008)	(0.009)
2	0.062***	0.020***	0.010	0.061***	0.010***	0.022***	0.000	0.059***	0.020***	0.025***	0.025***	0.056***	0.020**	0.022***	0.018**
	(0.011)	(0.005)	(0.007)	(0.016)	(0.004)	(0.005)	(0.004)	(0.015)	(0.005)	(0.008)	(0.008)	(0.016)	(0.008)	(0.005)	(0.008)
3	0.033***	0.007***	0.014**	0.049***	0.005***	0.008***	0.000	0.044***	0.010***	0.034***	0.023***	0.036***	0.021***	0.007***	0.008*
	(0.008)	(0.002)	(0.006)	(0.014)	(0.002)	(0.002)	(0.002)	(0.012)	(0.003)	(0.006)	(0.006)	(0.013)	(0.006)	(0.002)	(0.004)

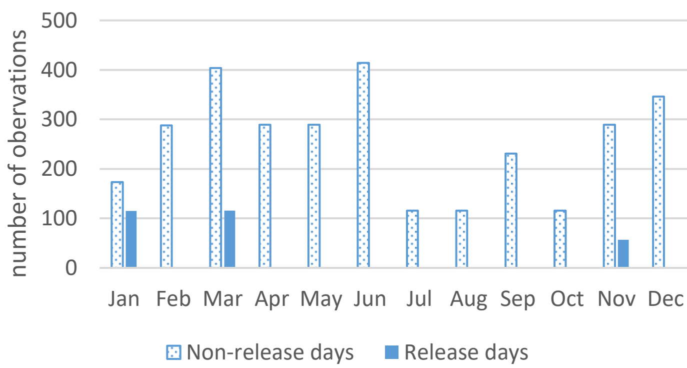
Notes: Table reports the average marginal effects of price volatility, which represent the difference in the probability of (co)exceedance occurrences between the release and non-release days and calculated using the estimated ordinal logit coefficients from equation (4). The exceedance counts for the extreme volatility in the soybean complex are calculated in equations (3). Standard errors are given in parentheses. The asterisks *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.



(a) Consumer price index



(b) Producer price index



(c) Employment situation

Figure 1. Release of macroeconomic news on release vs. non-release days

Notes: The numbers of five-minute observations are counted either on release days or non-release days when a macroeconomic report releases simultaneously.

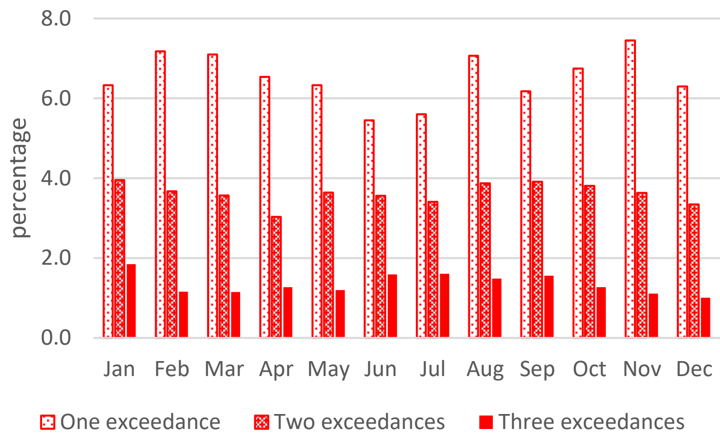
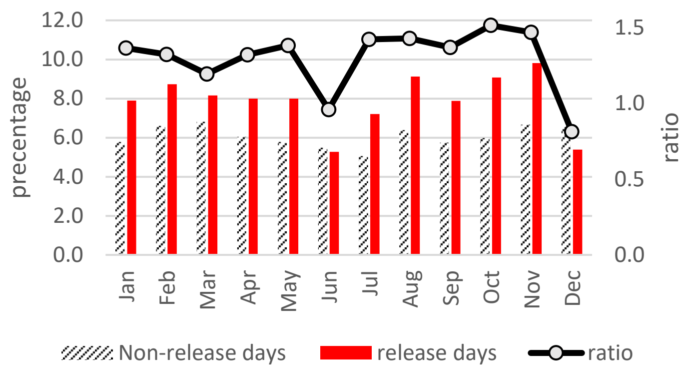
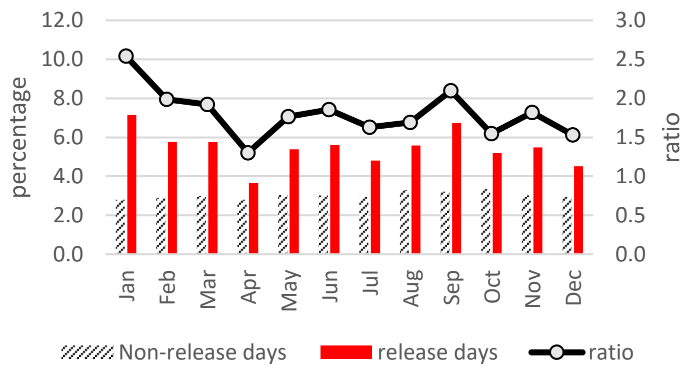


Figure 2. Percentage of exceedance counts in the soybean complex within event window

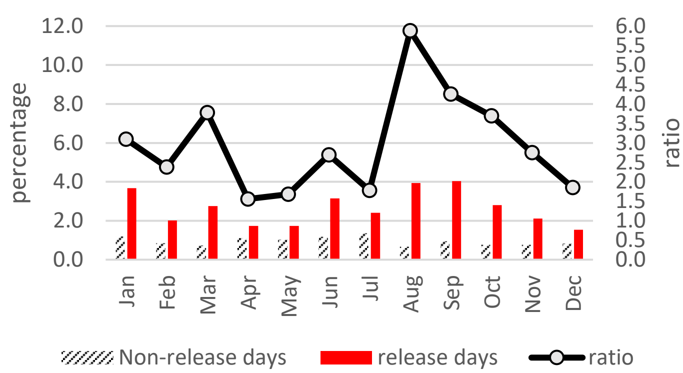
Notes: The percentage of exceedance counts is measured by dividing the frequency of exceedance counts at different levels by the total number of five-minute observations within the event window (both release and non-release days) in each month.



(a) One exceedance



(b) Two exceedances



(c) Three exceedances

Figure 3. 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. The ratio of exceedance counts on release days to non-release days measures the difference in the percentage of exceedances counts on release and non-release days.