Journal of Commodity Markets xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of Commodity Markets

journal homepage: www.elsevier.com/locate/jcomm

ELSEVIER

When does USDA information have the most impact on crop and livestock markets?

Olga Isengildina-Massa[a,*], Xiang Cao[f], Berna Karali[b], Scott H. Irwin[c], Michael Adjemian[d], Robert C. Johansson[e]

[a] *Department of Agricultural and Applied Economics, Virginia Tech University, USA*
[b] *Department of Agricultural and Applied Economics, University of Georgia, USA*
[c] *J. Norton Chair of Agricultural Marketing in the Department of Agricultural and Consumer Economics, University of Illinois at Urbana Champaign, USA*
[d] *Economic Research Service, United States Department of Agriculture, USA*
[e] *United States Department of Agriculture, USA*
[f] *School of Economics, Sichuan University, China*

A R T I C L E I N F O

JEL classification:
Q18
Q02

Keywords:
Announcement effects
Crops
Futures
Livestock
Market impact
Price reaction
USDA reports
Value of information

A B S T R A C T

This study compares the impact of Prospective Plantings, Acreage, Crop Production, Crop Production Annual Summary, Grain Stocks, WASDE, Cattle on Feed, and Hogs and Pigs reports on corn, soybean, wheat, cotton, live cattle, and lean hogs markets over 1985–2018. Simultaneous releases of several reports are handled by evaluating the impact of report clusters. Our approach allows us to demonstrate the relative impact of various information releases and shows when the markets tend to be affected the most. The findings of this study provide evidence and guidance for future policy decision regarding the role of USDA information in modern agricultural markets.

1. Introduction

The recent government shutdown that resulted in failure to release Annual Crop Production, Grain Stocks, Winter Wheat Seedings and World Agricultural Supply and Demand Estimates reports as scheduled on Friday, January 11, 2019, brought to the forefront the issue of the value of USDA information and its impact on commodity markets. Various media sources (e.g., Associated Press, Financial Times, DTN) pondered the consequences of this lapse of USDA report releases suggesting that “some private businesses see the shutdown as an opportunity to highlight their own data and analytic services” while others worry that “that the playing field is not as level as it would be with the USDA information.” (Good, 2019) Reuters reported that “To fill the void in data, traders and farmers are relying on private crop forecasters, satellite imagery firms and brokerages offering analyses on trade and supplies. Some have been scouring Twitter for tidbits on shifting weather patterns and rumors of grain exports, *but say it is difficult to replace the USDA*.” (Huffstutter and Polansek, 2019).

* Corresponding author.
E-mail addresses: oimassa@vt.edu (O. Isengildina-Massa), caox0409@scu.edu.cn (X. Cao).

https://doi.org/10.1016/j.jcomm.2020.100137
Received 16 August 2019; Received in revised form 4 February 2020; Accepted 13 March 2020
Available online xxxx

Please cite this article as: Isengildina-Massa, O. et al., When does USDA information have the most impact on crop and livestock markets?, Journal of Commodity Markets, https://doi.org/10.1016/j.jcomm.2020.100137

There is an extensive literature devoted to the impact of USDA information with most studies focusing on crop production (Sumner and Mueller, 1989; Fortenbery and Sumner, 1993; McNew and Espinosa, 1994; Baur and Orazem, 1994; Garcia et al., 1997; McKenzie, 2008), WASDE reports in grain markets (Isengildina et al., 2008a, 2008b; Adjemian, 2012), and Cattle on Feed and Hogs and Pigs reports in livestock markets (Colling and Irwin, 1990; Mann and Dowen, 1996; Schaefer et al., 2004; Isengildina et al., 2006; Karali et al., 2019a). However, in most cases the studies focus on a single report and do not take into account the release of other information, which may lead to an overestimation of impact of these reports. For example, WASDE reports are often released simultaneously with Crop Production reports and the individual report impact cannot be separated without additional information.[1] Furthermore, separate analyses make it difficult or impossible to compare impacts across various reports due to differences in methodology and time periods across studies.

The goal of this study is to examine when various USDA information releases cause the largest market reactions in crop and livestock markets over 1985 through 2018. Our study assesses the market impact of USDA information spanning multiple commodities (corn, soybeans, wheat, cotton, live cattle, and lean hogs) and multiple reports (Prospective Plantings, Acreage, Crop Production, Crop Production Annual Summary, Grain Stocks, WASDE, Cattle on Feed, and Hogs and Pigs), while taking simultaneous release of information, or report clustering, into account. We identify the release of most important USDA information for each month and group the reports that are released together in clusters. Market impact is measured for each monthly release over the period of study. Changes in market impact over time for most influential releases are also evaluated.

Market impact is measured using a traditional event study approach. The basic notion of the event study is simple: if prices react to the announcement of information ("the event") in an efficient market, then the information is valuable to market participants (Campbell et al., 1997). In our study, the events are the releases of USDA information which may include single reports or report clusters, based on report release schedule that has remained fairly stable during the period of study.[2] Daily returns of nearby futures contracts for each commodity over 1985–2018 are used to measure market reaction. The impact of information is assessed by comparing futures return variability on information release sessions versus pre- and post-release sessions. Parametric and nonparametric tests are used to measure changes in futures return variability in response to information releases.

Results are examined focusing on the F-test as the most general and flexible measure of market impact that allows comparison across multiple reports and markets. First, we compare the impact of USDA information across monthly releases of various reports or report clusters for each commodity for the entire sample period. Second, we evaluate how the impact of the main sources of information has changed over time using a 15-year rolling analysis. The findings of this study will help identify the main sources of public information in crop and livestock markets, compare their impact across releases and commodities as well as demonstrate how this impact has changed over time. These findings will shed light on the relative value of various USDA information to commodity markets.

2. USDA reports

USDA reports typically publish estimates on a marketing year basis. The marketing year follows the production of the commodity and spans from September 1 to August 31 for corn and soybeans, June 1 to May 31 for wheat, August 1 to July 31 for cotton, January 1 to December 31 for cattle, and December 1 to November 30 for hogs. Table 1 provides a summary of main USDA report releases and lists reports that are released together with a "+" and as well as separately released reports.

For spring planted crops, such as corn, soybeans, cotton, and spring wheat, the annual forecasting cycle starts at the end of March with Prospective Plantings reports. These reports contain information about producer planting intentions based on producer responses to the March Agricultural Survey. Similar information for winter wheat is reported in the Winter Wheat Seedings reports that are typically released in January. Good and Irwin (2011) provide a thorough review of the survey procedures used by the USDA. Planted acreage estimates from Prospective Plantings reports serve as a foundation for early production estimates by USDA.

The WASDE forecasting cycle typically starts in May for most crops with reports released between the 9th and the 12th of each month at 3pm EST until April 1994, at 8:30am EST from May 1994–December 2012, and at 12pm EST from January 2013 to present. These reports combine supply and use information from all available sources and combine it in a balance sheet format that shows resulting changes in ending stocks and price. Separate balance sheets are maintained for over 90 countries to produce estimates for both US and World supply and use for major crops and livestock. When WASDE reports are released simultaneously with other reports (such as Crop Production) they include the latest information from these reports.

Additional information on expected supply becomes available at the end of June from the annual Acreage reports that provide updated survey information on planted acreage and estimates of harvested acreage. Both Acreage and Prospective Plantings reports were released at 3pm EST through 1994, at 8:30am EST from 1995 to 2012, and at 12pm EST from 2013 to present. Crop Production reports include information from Acreage reports and survey-based estimates of yield and production estimates for major crops consistent with their growth cycles: August through November for corn and soybeans, May through August for winter wheat, July and August for spring wheat,[3] and August through December for cotton.[4] The Crop Production Annual Summary reports published in January contain final production information for corn, soybeans, wheat, and cotton. Additionally, starting in 1994, the final estimates

[1] Private expectations are required to isolate new information in Crop Production forecasts, e.g. Karali et al., 2019a, 2019b.

[2] Prior to 1985 clustering was less prevalent due to differences in release schedules.

[3] Historically, spring wheat crop production estimates were also published in September. However, September estimates for spring wheat were discontinued in 2002.

[4] Cotton production estimates are typically revised in May when ginning information becomes available.

Table 1
Monthly releases of main USDA reports for corn, soybeans, wheat, cotton, cattle and hogs.

	Corn	Soybeans	Wheat	Cotton	Cattle	Hogs
January	CPAS + GS + WASDE	CPAS + GS + WASDE	CPAS + GS + WASDE + WWS	CPAS + WASDE	COF	COF
February	WASDE	WASDE	WASDE	WASDE	COF	COF
March	WASDE	WASDE	WASDE	WASDE	COF	COF
	PP + GS	PP + GS	PP + GS	PP	HPR	HPR
April	WASDE	WASDE	WASDE	WASDE	COF	COF
May	WASDE	WASDE	WASDE + CP	WASDE + CP	COF	COF
June	WASDE	WASDE	WASDE + CP	WASDE	COF	COF
	ACR + GS	ACR + GS	ACR + GS	ACR	HPR	HPR
July	WASDE	WASDE	WASDE + CP	WASDE	COF	COF
August	WASDE + CP	WASDE + CP	WASDE + CP	WASDE + CP	COF	COF
September	WASDE + CP	WASDE + CP	WASDE	WASDE + CP	COF	COF
	GS	GS	SGAS, GS		HPR	HPR
October	WASDE + CP	WASDE + CP	WASDE	WASDE + CP	COF	COF
November	WASDE + CP	WASDE + CP	WASDE	WASDE + CP	COF	COF
December	WASDE	WASDE	WASDE	WASDE + CP	COF HPR	COF HPR

Notes: WASDE=World Agricultural Supply and Demand Estimates, PP=Prospective Plantings, ACR = Acreage, CP=Crop Production, CPAS=Crop Production Annual Summary, WWS=Winter Wheat Seedings, GS = Grain Stocks, SGAS=Small Grains Annual Summary, COF=Cattle on Feed reports, HPR=Hogs and Pigs reports.

for wheat are published in September Small Grains Annual Summary reports. Crop Production reports typically have been published between the 9th and the 12th of each months and released at 3pm EST until April 1994, at 8:30am EST from May 1994–December 2012, and at 12pm EST from January 2013 to present.

Grain Stocks reports track available supply throughout the marketing year, which is a function of annual production and the pace of use, and are issued by NASS quarterly, in the beginning of January, and at the end of March, June, and September and describe stocks in storage at the beginning of these months. These reports are most affected by clustering as January releases coincide with Crop Production Annual Summary and WASDE reports, March reports are released simultaneously with Prospective Plantings reports, June releases coincide with Acreage reports and September releases cluster with Small Grain Annual Summary reports. These reports describe stocks of multiple crops, including corn, soybeans, and wheat, as well as the number and capacity of on- and off-farm storage facilities. The release schedule for Grain Stocks reports changed similarly to the other reports described above with 3pm EST release time through June 1994, 8:30 a.m. EST release time from September 1994–September 2012 and 12pm EST release time from January 2013 to present.

Report clustering is not as prevalent in the livestock markets as Cattle on Feed and Hogs and Pigs reports that provide production information relevant to these markets typically do not overlap in their releases. Cattle on Feed reports are monthly USDA publications that report data on the number of cattle in the feedlots, placements, marketings, and other disappearance; thus, providing market participants with information regarding current and future cattle supplies. The reports are typically released at 3:00pm EST[5] on the third Friday of the month and contain data as of the beginning of the month. The information in these reports is based on a survey of feedlots in major cattle feeding states in the U.S., representing about 98 percent of total U.S. production (for more information see Mark and Small, 2007).

Hogs and Pigs reports are a quarterly USDA publication that reports data for the swine breeding herd, market hog inventory, and farrowings. The reports are typically released at 3:00pm EST[6] on Friday near the end of March, June, September, and December (i.e. the first month of each quarter) and present inventory data as of the first day of the month and the previous and future quarters.[7] These reports provide quarterly inventory estimates for the major hog producing states that account for about 95 percent of total U.S. production. The reports also aggregate the remaining states to produce the U.S. total. As such, these reports provide the most comprehensive publicly available estimates of current and future hog supplies (Small et al., 2007).

The list of reports described above represents main sources of information from National Agricultural Statistical Service (NASS), a branch of USDA primarily responsible for data collection and dissemination, as well as the World Agricultural Outlook Board, responsible for the release of WASDE reports. While this list is not exhaustive,[8] it does include all major NASS reports shown to have market impact in the previous studies. Furthermore, Table 1 demonstrates the importance of joint evaluation of the market impact of these reports as many of them are often released together, as illustrated in the introduction by the missing USDA reports on January 11, 2019.

[5] There were a couple of exceptions due to USDA's release schedule before the holidays. Cattle on Feed report in December 2005 was released at 1:00pm EST, and May 2015 and December 2016 reports were released at 12:00pm EST.

[6] Hogs and Pigs report was released at 1:00pm EST in December 2011, and at 12:00pm EST in March and December 2016 due to the USDA's release schedule before the holidays.

[7] The release schedule of Hogs and Pigs report changed to monthly from January 2001 through September 2003, after which quarterly schedule was resumed. Only quarterly reports are included in our study.

[8] NASS alone publishes more than 400 reports every year.

3. Methods

The impact of information on commodity markets is traditionally measured using an event study approach (Colling and Irwin, 1990; Fortenbery and Sumner, 1993; Grunewald et al., 1993; Garcia et al., 1997; Isengildina-Massa et al., 2008a, 2008b; Karali, 2012). The basic notion of the event study is simple: if prices react to the announcement of information ("the event") in an efficient market, then the information is valuable to market participants (Campbell et al., 1997). Specifically, variability of futures prices around important scheduled news announcements should be characterized by a "spike" in variability on the announcement date and "normal" variability on non-announcement dates (Sumner and Mueller, 1989). Since, under market efficiency, futures prices represent the conditional expectation of spot prices at contract maturity, the spike in futures return variance reflects the change in market participants' expectation of spot prices due to the new announcement. Note that the change in futures return can be either positive or negative depending on the implications of the news for the level of prices, therefore the analysis focuses on changes in volatility as a measure of market reaction. The purpose of statistical tests implemented in this study is to determine whether futures return variability on event sessions is significantly different from normal variability on non-event days.

In our study, the events are the releases of main USDA reports. Table 1 describes the release schedule of USDA reports included in this study. Identification of events requires comparison of the time of report release to the futures market trading times. If a report is released in the morning, it is expected to affect the trading session on the same day, but if the report is released in the afternoon, after the markets close, it is expected to affect the trading session the following day. Close-to-close returns are used to measure market reaction.[9]

Report release information is combined in this study with futures market price data to measure the impact of USDA reports on the markets. Daily futures prices for the Chicago Board of Trade (CBOT) corn, soybeans, and soft red winter wheat futures contracts were collected. Cotton futures prices were obtained from the Intercontinental Exchange (ICE). Lean Hog and Live Cattle futures prices were gathered from the Chicago Mercantile exchange (CME).

Nearby futures price series are constructed by rolling over to the second closest to expiration contract once that next contract has a trade volume exceeding the nearest to delivery contract, which usually happened at the end of the month prior to delivery month.[10] Table 2 shows specific futures contract maturities used in market reaction tests for each commodity. Futures returns are calculated as the percentage change in futures contract's settlement price from day $d-1$ to day d for each report release i: $r_{d,i} = 100 \times (\ln P_{d,i} - \ln P_{d-1,i})$. The trading day index is $d = -5, \ldots, -1, 0, +1, \ldots, +5$, with zero indicating the release of USDA report $i$and the event window consisting of five trading days before and after the event (a negative number indicates sessions before the report release and a positive number indicates sessions after the report release).[11] The event window is used to compute normal variability during pre- and post-report sessions.

Daily price limits constrain the reaction of commodity markets to new information, therefore we examined the prevalence of price limits for each commodity included in this study. Our analysis revealed that in crops, prices reached a limit move only in about 2% of total observations, a frequency low enough not to warrant any adjustments. The presence of limit moves was also low in cattle (4.4% of total observations), but not in hogs, where prices reached the limit in 8% of total observations. More importantly, 28.5% of the days with

Table 2
Maturities of futures contracts used in price reaction tests.

Calendar Month	Corn (CBOT)	Soybeans (CBOT)	Wheat (CBOT)	Cotton (ICE)	Live Cattle (CME)	Lean Hogs (CME)
$January_t$	Mar_t	Mar_t	Mar_t	Mar_t	Feb_t	Feb_t
$February_t$	Mar_t	Mar_t	Mar_t	Mar_t	Apr_t	Apr_t
$March_t$	May_t	May_t	May_t	May_t	Apr_t	Apr_t
$April_t$	May_t	May_t	May_t	May_t	$June_t$	$June_t$
May_t	$July_t$	$July_t$	$July_t$	$July_t$	$June_t$	$June_t$
$June_t$	$July_t$	$July_t$	$July_t$	$July_t$	Aug_t	$July_t$
$July_t$	Dec_t	Nov_t	Sep_t	Dec_t	Aug_t	Aug_t
$August_t$	Dec_t	Nov_t	Sep_t	Dec_t	Oct_t	Oct_t
$September_t$	Dec_t	Nov_t	Dec_t	Dec_t	Oct_t	Oct_t
$October_t$	Dec_t	Nov_t	Dec_t	Dec_t	Dec_t	Dec_t
$November_t$	Dec_t	Jan_{t+1}	Dec_t	Dec_t	Dec_t	Dec_t
$December_t$	Mar_{t+1}	Jan_{t+1}	Mar_{t+1}	Mar_{t+1}	Feb_{t+1}	Feb_{t+1}

Note: The subscript, t or t + 1, refers to the year of the futures contract expiration date relative to the year t of the daily price being computed. Low volume contracts (September corn, August and September soybeans, May KCBT hard red winter wheat, October cotton, and May lean hogs) are eliminated.

[9] The use of close-to-close returns may result in a conservative measure of market reaction to USDA reports, as discussed in Isengildina-Massa et al. (2008a), p. 100. However, if there is any downward bias, it would be consistent across the study period and would not affect the overall conclusions.

[10] Due to relatively low trading volume, September contracts for corn, August and September contracts for soybeans, October contracts for cotton, and May contracts for lean hogs were eliminated.

[11] If another report was released within an event window, which was fairly common for Cattle on Feed and Hogs and Pigs reports, that release session was excluded from the event window and an extra day was added accordingly.

Hogs and Pigs report releases were subject to price limit moves. Therefore, the following adjustment was made to the futures returns calculation above to take into account the impact of limit moves, if trading day −1 was non-limit and trading day 0 (report release) was limit, the return for day 0 was calculated using the closing price on day −1 and the closing price on the first non-limit day available thereafter (an approach similar to that used in previous studies, e.g., Garcia et al., 1997). The reaction window was also adjusted to include five post-report days.

The null hypothesis for all statistical tests is that the standard deviation of close-to-close returns on report days is equal to that of on non-report days (no reaction). The null hypothesis is tested with parametric tests including the F-test, Levene and Brown-Forsythe test, as well as a non-parametric Siegel-Tukey test to insure robustness across different measures and minimize the impact of non-normality of futures price distributions (Yang and Brorsen, 1994; Venkateswaran et al., 1993). Our discussion of the results focuses on the F-test because it provides a direct, intuitive and flexible measure that allows us to demonstrate and compare the market impacts across various reports and commodities as well evaluate changes in market impact over time. The F-test is a simple ratio of return variance on the report days relative to non-report day variance:

$$F = s^2_{r_{0,i}} \Big/ s^2_{r_{k,i}} \tag{1}$$

where k is a trading day index for non-release days, $k = -5, \ldots, -1, +1, \ldots, +5$, and zero indicating the release session for each report i. Levene's test uses absolute rather than squared differences from the mean, which makes it less sensitive to fat-tailed distributions. Brown-Forsythe's test is a modification of the Levene's test where the absolute *mean* differences are replaced with the absolute *median* differences (see Snedecor and Cochran, 1989 for test details). Siegel-Tukey is a non-parametric test that first orders all observations from lowest to highest for each group. Next, it assigns the rank of 1 to the lowest value, rank 2 to the *highest* value, rank 3 to the second highest value, rank 4 to the second lowest value, rank 5 to the third lowest value, and so on. The test statistic compares the sum of the ranks assigned to each group (see Conover, 1999 for test details).

4. Results

Our results shown in Table 3 and Fig. 1 demonstrate that 9 out of 15 monthly information releases included in this study had a statistically significant impact in the corn market. The largest market impacts were due to clusters of reports that included Grain Stocks reports. For example, January report clusters that included Grain Stocks, Crop Production Annual Summary and WASDE reports increased the variance of nearby corn prices by about 7.7 times. This information release that caused the largest corn market reaction on average over 1985–2018 was followed by the March release of Prospective Plantings and Grain Stocks reports that increased the corn market variance by about 5.3 times, and the June release of Acreage and Grain Stocks reports that increased variance by about 4.5 times. Crop Production reports released in August, September, October and November also caused significant market reaction ranging from 3.8 times normal variance for August reports to 2.2 times for November reports. On the other hand, WASDE reports released separately in February, March, April, June, July and December did not change corn market volatility significantly. The only separate WASDE report that caused statistically significant corn market reaction was the one released in May and contained the first estimates for the new marketing year.

Our results for soybeans reported in Table 4 and Fig. 1 are very similar to our findings for corn with just a few distinctions reflected in lower impact of Acreage and Grain Stocks reports released in June and larger impact of October crop production reports that increased the volatility of soybean nearby futures prices by about 5 times on average over 1985–2018. Our findings for wheat shown in Table 5

Table 3
Corn market reaction to USDA reports, 1985–2018.

Month	Reports	N	Non-report day std. dev.	Report day std. dev.	Diff of std. devs.	F-test	Brown Forsythe test	Siegel-Tukey test
January	CPAS + GS + WASDE	33	1.25	3.47	2.22	7.66***	78.44***	5.47***
February	WASDE	34	1.03	1.16	0.12	1.25	0.83	1.01
March	WASDE	35	1.27	1.25	−0.02	0.97	0.13	0.9
	PP + GS	32	1.36	3.11	1.76	5.27***	64.00***	5.46***
April	WASDE	34	1.25	1.02	−0.24	0.66	0.98	0.75
May	WASDE	34	1.45	1.98	0.53	1.87**	4.18**	1.05
June	WASDE	34	1.70	1.69	−0.01	0.99	0.04	1.34
	ACR + GS	30	2.00	4.23	2.23	4.48***	35.75***	3.73***
July	WASDE	34	2.08	1.82	−0.26	0.77	1.21	0.82
August	WASDE + CP	34	1.48	2.90	1.42	3 82***	38.30***	3.95***
September	WASDE + CP	34	1.45	2.26	0.81	2.42***	12.65***	2.96***
	GS	34	1.49	2.28	0.79	2.35***	10.73***	3.40***
October	WASDE + CP	33	1.57	2.56	0.99	2.66***	13.80***	4.13***
November	WASDE + CP	34	1.25	1.87	0.61	2.21***	15.59***	4.10***
December	WASDE	34	1.27	0.98	−0.28	0.60	0.65	0.64

Notes: WASDE= World Agricultural Supply and Demand Estimates, PP=Prospective Plantings, ACR = Acreage, CP=Crop Production, GS = Grain Stocks; CPAS=Crop Production Annual Summary. Asterisks show statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

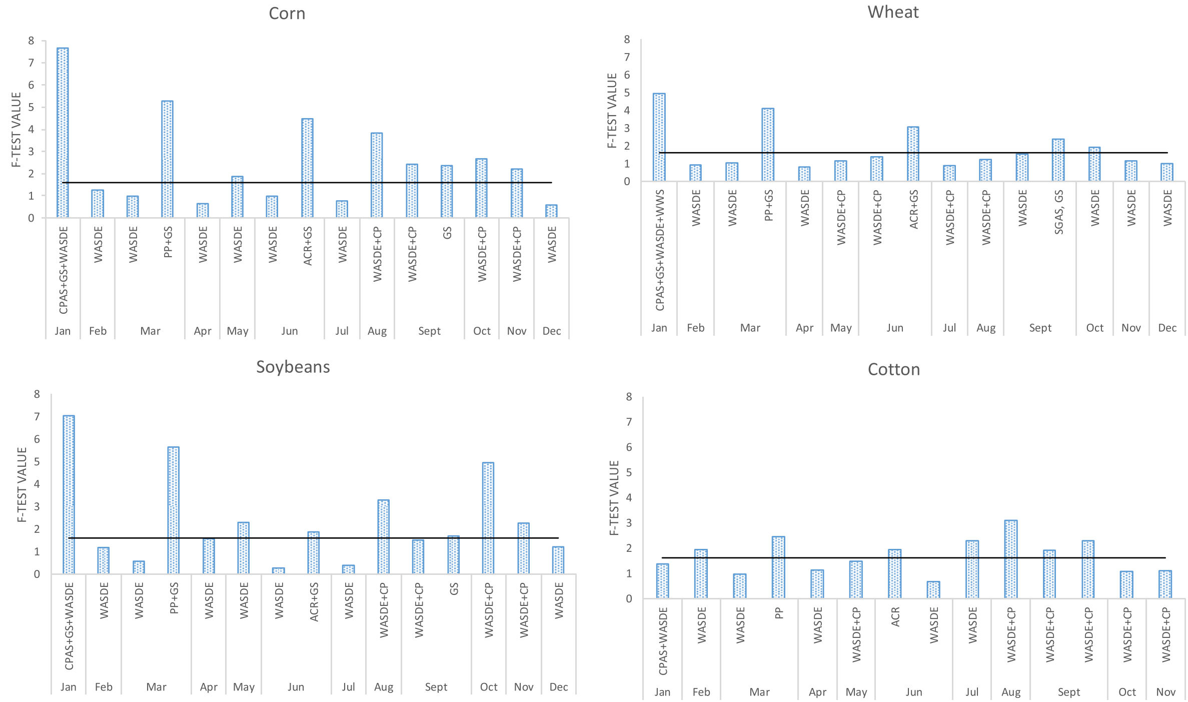

Fig. 1. Crop Market Reaction to USDA Reports, 1985–2018. Notes: The bars represent the ratios of report day variance to non-report day variance. WASDE=World Agricutural Supply and Demand Estimates, PP=Prospective Plantings, ACR = Acreage, CP=Crop Production, CPAS=Crop Production Annual Summary, GS = Grain Stocks, WWS=Winter Wheat Seedings. Solid black line shows the critical value for the F-test at 90 percent level.

Table 4
Soybeam market reaction to USDA reports, 1985–2018.

Month	Reports	N	Non-report day std. dev.	Report day std. dev.	Diff of std. devs.	F-test	Brown Forsythe test	Siegel-Tukey test
January	CPAS + GS + WASDE	33	1.07	2.83	1.76	7 05***	75 92***	4 94***
February	WASDE	34	1.05	1.14	0.10	1.19	0.81	1.04
March	WASDE	35	1.23	0.92	−0.31	0.56	1.84	0.41
	PP + GS	32	1.12	2.65	1.54	5.64***	82.67***	5.64***
April	WASDE	34	1.12	1.40	0.28	1.57	0.42	0.17
May	WASDE	34	1.23	1.87	0.64	2.30***	5.47**	1.75*
June	WASDE	34	1.48	0.77	−0.71	0.27	9.25***	2.81***
	ACR + GS	30	1.84	2.52	0.68	1.87**	9.25***	3 15***
July	WASDE	34	2.04	1.29	−0.75	0.40	5.15**	1.36
August	WASDE + CP	34	1.56	2.82	1.26	3 28***	22.80***	3.31***
September	WASDE + CP	34	1.33	1.64	0.31	1.52	5.04**	2.51**
	GS	34	1.28	1.65	0.38	1.68*	4.87**	3.35***
October	WASDE + CP	33	1.31	2.93	1.61	4.96***	39.37***	3 79***
November	WASDE + CP	34	1.31	1.97	0.66	2.27***	14.64***	4.00***
December	WASDE	34	1.04	1.14	0.11	1.22	0.27	0.15

Notes: WASDE= World Agricutural Supply and Demand Estimates, PP=Prospective Plantings, ACR = Acreage, CP=Crop Production, GS = Grain Stocks; CPAS=Crop Production Annual Summary. Asterisks show statistical significance: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

and Fig. 1 differ from our results for corn and soybeans by showing a much more muted reaction,[12] which suggests a smaller informational value of these reports in wheat markets consistent with the findings of previous studies (Karali et al., 2019b, 2019a). Our results show that only 4 out of 15 monthly information releases included in this study caused statistically significant reaction in wheat futures markets. Each of these four releases contained Grain Stocks information. The largest wheat market reaction to USDA information was attributed to January releases containing Grain Stocks, Winter Wheat Seedings, Crop Production Annual Summary and WASDE reports, which increased wheat futures variance by about 5 times. The smallest statistically significant reaction was attributed to the

[12] Wheat price reaction tests were also conducted using KCBOT and MGEX futures contracts and yielded very similar results.

Table 5
Wheat market reaction to USDA reports, 1985–2018.

Month	Report	N	Non-report day std. dev.	Report day std. dev.	Diff of std. devs.	F-test	Brown Forsythe test	Siegel-Tukey test
January	CPAS + GS + WASDE + WWS	33	1.39	3.09	1.70	4.95***	35.77***	3.57***
February	WASDE	34	1.46	1.41	−0.05	0.93	0.04	0.10
March	WASDE	35	1.71	1.76	0.05	1.06	0.03	0.29
	PP + GS	32	1.63	3.31	1.68	4 11 ***	39.27***	4.24***
April	WASDE	34	1.69	1.54	−0.15	0.83	0.14	0.04
May	WASDE + CP	34	1.74	1.85	0.12	1.14	0.55	0.82
June	WASDE + CP	34	1.75	2.06	0.31	1.39	2.23	1.74*
	ACR + GS	30	1.93	3.39	1.46	3.08***	12.99***	1.47
July	WASDE + CP	34	1.91	1.79	−0.11	0.89	0.48	1.01
August	WASDE + CP	34	1.81	2.01	0.19	1.22	2.29	1.73*
September	WASDE	34	1.54	1.90	0.37	1.53	6.49**	3 24***
	SGAS, GS	34	1.60	2.47	0.87	2.39***	14.60***	3.76***
October	WASDE	34	1.84	2.54	0.70	1.91**	1.27	0.55
November	WASDE	35	1.57	1.68	0.11	1.14	1.55	1.53
December	WASDE	34	1.37	1.37	−0.0032	1.00	0.45	1.31

Notes: WASDE=World Agricultural Supply and Demand Estimates, WWS=Winter Wheat Seedings, PP=Prospective Plantings, ACR = Acreage, CP=Crop Production, CPAS=Crop Production Annual Summary, SGAS=Small Grain Annual Summary. Asterisks show statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

group of Grain Stocks and Small Grains Annual Summary reports released in September which increased variance by about 2.4 times.

Our results for cotton presented in Table 6 and Fig. 1 are consistent with the findings for other commodities as they show statistically significant market reactions to Prospective Plantings, Acreage and Crop Production reports. These reactions are smaller in magnitude with Prospective Plantings release increasing the variance of nearby cotton futures by about 2.5 times, Acreage by about 2 times and the largest reaction to Crop Production of about 3.1 times recorded for August reports. Similar to previous findings, most WASDE reports released separately did not cause statistically significant market reaction with exception of July reports that increased volatility of cotton futures by about 2.3 times.

Our results for livestock shown in Tables 7 and 8 and Fig. 2 focus on Cattle on Feed (COF) and Hogs and Pigs reports (HPR) impact on live cattle and lean hog markets, respectively. Our findings demonstrate that very few reports had a statistically significant impact on the cattle markets, namely May through July and September COF reports and June HPR reports. The magnitude of these market reactions was moderate with cattle futures volatility increasing by less than two times in all cases. Market reaction to USDA information was even less common in lean hog markets with significant reaction observed only for June HPR reports, when hog market variance increased by 2.8 times in reaction to these reports.

Overall, our findings demonstrate that the impact of USDA information varies across commodities, across reports, and across releases of the same report within a marketing year. For example, Fig. 1 demonstrates that corn and soybean markets are more responsive to USDA information than wheat and cotton market. Across releases, the clusters containing Grain Stocks, Prospective Plantings, Acreage reports and Crop Production Annual Summary reports appear to cause largest market reactions, while WASDE reports do not seem to move the markets as much. Markets also react to crop production reports, but not equally. For example, October crop production report

Table 6
Cotton market reaction to USDA reports, 1985–2018.

Month	Reports	N	Non-report day Report day std. std. dev. dev.	Diff of std. devs.	F-test	Brown Forsythe test	Siegel-Tukey test	
January	CPAS + WASDE	32	1.33	1.55	0.23	1.37	0.00	0.60
February	WASDE	34	1.51	2.10	0.59	1.94**	1.33	0.03
March	WASDE	34	1.48	1.47	−0.02	0.98	0.00	0.15
	PP	34	1.36	2.12	0.76	2.45***	14.09***	2.73***
April	WASDE	34	1.42	1.51	0.10	1.14	0.36	0.72
May	WASDE + CP	34	1.49	1.81	0.32	1.48	1.59	1.24
June	WASDE	34	1.79	1.46	−0.33	0.67	1.18	1.09
	ACR	34	1.79	2.48	0.70	1.94**	5.63**	2.25**
July	WASDE	34	1.53	2.31	0.78	2.28***	10.98***	2.51**
August	WASDE + CP	34	1.51	2.66	1.15	3.10***	36.45***	5.54***
September	WASDE + CP	33	1.62	2.24	0.61	1.90**	6.99***	3.02***
October	WASDE + CP	33	1.51	2.29	0.78	2.29***	11.64***	2.72***
November	WASDE + CP	34	1.55	1.60	0.06	1.07	0.24	1.09
December	WASDE + CP	33	1.42	1.49	0.07	1.10	0.25	0.87

Notes: WASDE= World Agricultural Supply and Demand Estimates, PP=Prospective Plantings, ACR = Acreage, CP=Crop Production, CPAS=Crop Production Annual Summary. Asterisks show statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

Table 7
Live cattle market reaction to USDA reports, 1985–2018.

Month	Report	N	Non-report day std. dev.	Report day std. dev.	Diff of std. devs.	F-test	Brown Forsythe test	Siegel-Tukey test
January	COF	32	0.80	0.93	0.14	1.37	1.11	0.23
February	COF	36	0.81	0.95	0.15	1.39	3.50*	2.18**
March	COF	33	0.84	0.84	0.00	1.00	0.08	0.40
	HPR	33	0.90	1.05	0.15	1.37	0.78	0.70
April	COF	34	0.91	1.05	0.14	1.33	1.92	1.64
May	COF	34	0.82	1.12	0.30	1.88**	5.24**	1.45
June	COF	32	0.88	1.13	0.25	1.66*	5.10**	2.18**
	HPR	32	0.87	1.13	0.26	1.71*	0.87	0.06
July	COF	34	0.91	1.19	0.28	1.70*	2.99*	1.26
August	COF	34	0.85	0.76	−0.09	0.80	1.68	1.40
September	COF	33	0.73	1.03	0.30	2.01**	9.28***	2.62***
	HPR	33	0.80	0.96	0.15	1.42	0.74	0.39
October	COF	33	0.86	1.00	0.13	1.34	1.12	1.05
November	COF	35	0.79	0.84	0.06	1.15	0.24	0.38
December	COF	30	1.02	0.76	−0.26	0.56	1.25	0.94
	HPR	30	1.02	0.93	−0.10	0.82	0.03	0.09

Notes: COF=Cattle on Feed reports, HPR=Hogs and Pigs reports. Asterisks show statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

Table 8
Lean hog market reaction to USDA reports, 198S2018.

Month	Report	N	Non-report day std. dev.	Report day std. dev.	Diff of std. devs.	F-test	Brown Forsythe test	Siegel-Tukey test
January	COF	32	1.34	1.21	−0.14	0.81	0.11	0.12
February	COF	36	1.29	1.09	−0.19	0.72	0.98	0.56
March	COF	33	1.27	1.36	0.09	1.14	0.26	0.43
	HPR	33	1.25	1.40	0.14	1.24	0.00	0.65
April	COF	34	1.23	1.22	−0.01	0.99	0.00	0.47
May	COF	34	1.09	1.21	0.12	1.23	0.15	0.15
June	COF	32	1.21	1.27	0.05	1.09	0.26	0.71
	HPR	32	1.22	2.04	0.82	2.81***	30.87***	4 99***
July	COF	34	1.31	0.86	−0.46	0.42	5.21**	2.05**
August	COF	34	1.59	1.81	0.23	1.30	0.08	0.07
September	COF	33	1.33	1.24	−0.09	0.87	0.40	0.41
	HPR	33	1.37	1.61	0.24	1.39	1.14	1.17
October	COF	33	1.51	1.64	0.13	1.18	0.34	0.40
November	COF	35	1.40	1.65	0.26	1.40	1.15	1.14
December	COF	30	1.31	1.21	−0.11	0.84	0.25	0.39
	HPR	30	1.40	1.59	0.19	1.29	1.70	1.87*

Notes: COF=Cattle on Feed reports, HPR=Hogs and Pigs reports. Asterisks show statistical significance: *p < 0.10, **p < 0.05, ***p < 0.01.

increases soybean market volatility by about 5 times, while September crop production report does not appear to cause a significant market reaction. The next section will investigate how the impact of the releases shown to affect the markets in this study, which includes Grain Stocks clusters, Crop Production, COF and HPR reports, has changed over time.

5. Changes in market impact over time

Changes in market impact over time are evaluated by calculating the F-test (a ratio of report to non-report day variance) for 15-year rolling samples[13] for each monthly report or report cluster. Thus, the first point on each graph represents the F-test for 1985–1999, the second is for 1986–2000, and so on, with the last point reflecting information for 2004–2018. The critical value for the F-test with 14 degrees of freedom and 90 percent confidence level (2.169) is plotted in the graphs to assess the significance of our results. Fig. 3 shows changes in market reaction to information clusters containing Grain Stocks reports. Our findings show that the impact of the group of reports released in January that includes Grain Stocks, Crop Production Annual Summary, WASDE and Winter Wheat Seedings has increased over time. Thus, the variance of corn futures on these report release sessions was about 6 times above normal in the beginning of the sample during 1985–2001, this reaction reached around 10 times above normal between 1990 and 2014 and settled around 9 times above normal in the most recent 2001–2018 period. A very similar pattern was observed for this group of reports in the soybean markets, starting with a reaction of about 6 times above normal volatility during 1985–2002, reaching almost 10 times above normal over 1997–2011 and evening out to about 8 times increase in volatility in response to these releases since 1998. Wheat markets

[13] Sensitivity of these results to sample selection was assessed using a 10-year rolling window. While shorter sample results were more “choppy” due to greater sensitivity to individual observations, the general patterns discussed here were very similar. These results are not presented here but available from the authors upon request.

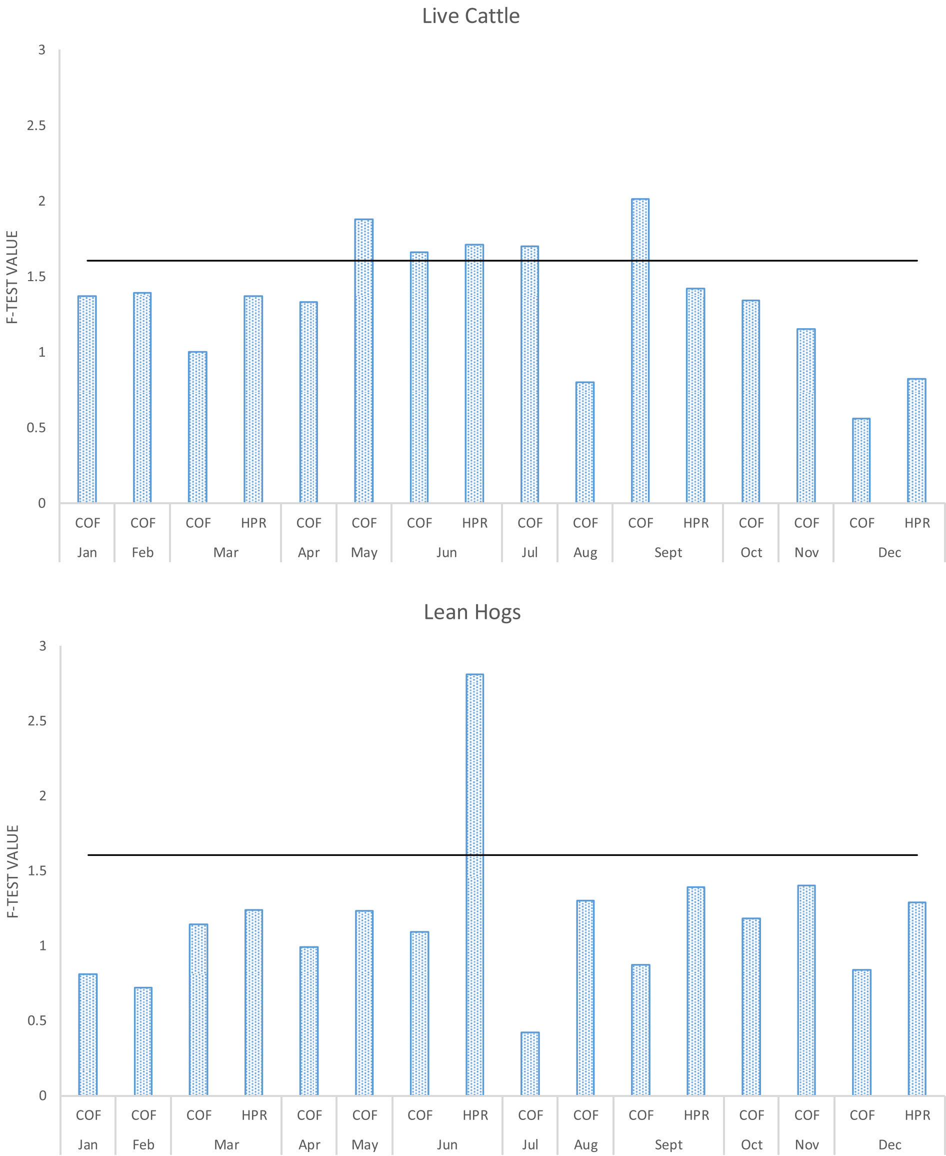

Fig. 2. Livestock Market Reaction to USDA Reports, 1985–2018. Notes: The bars represent the ratios of report day variance to non-report day variance. CF=Cattle on Feed, HP=Hogs and Pigs reports. Solid black line shows the critical value for the F-test at 90 percent level.

demonstrated a very different pattern with two distinct reaction levels: around 2 times above normal volatility in the early part of the sample (1985–2008) and about 6.5 times increase in volatility in the later part (1995–2018) with changes starting in the mid-to late-2000s. Since Grain Stocks information is not particularly relevant for cotton markets, it was not surprising to observe lack of significant reaction to January release cluster in these markets.

The impact of the second group of reports released in March, which includes Prospective Plantings and Grain Stocks reports, has increased over time in corn and wheat markets and remained stable in soybean and cotton markets. Thus, market reaction to this group of reports ranged around 3–4 times above normal volatility through 2011 but started increasing since and reached over 6 times above normal volatility in recent years (2002–2018). A similar pattern observed in wheat with market reaction to these reports ranging around 3 times above normal volatility through 2010 and increasing to around 5 times above normal volatility during 1998–2018. The impact of these reports on soybean markets started and ended at around 5–6 times above normal volatility over 1985–2003 and 1998–2018. However, it was lower in the middle of the sample dipping to less than 3 times above normal volatility during 1992–2008. The

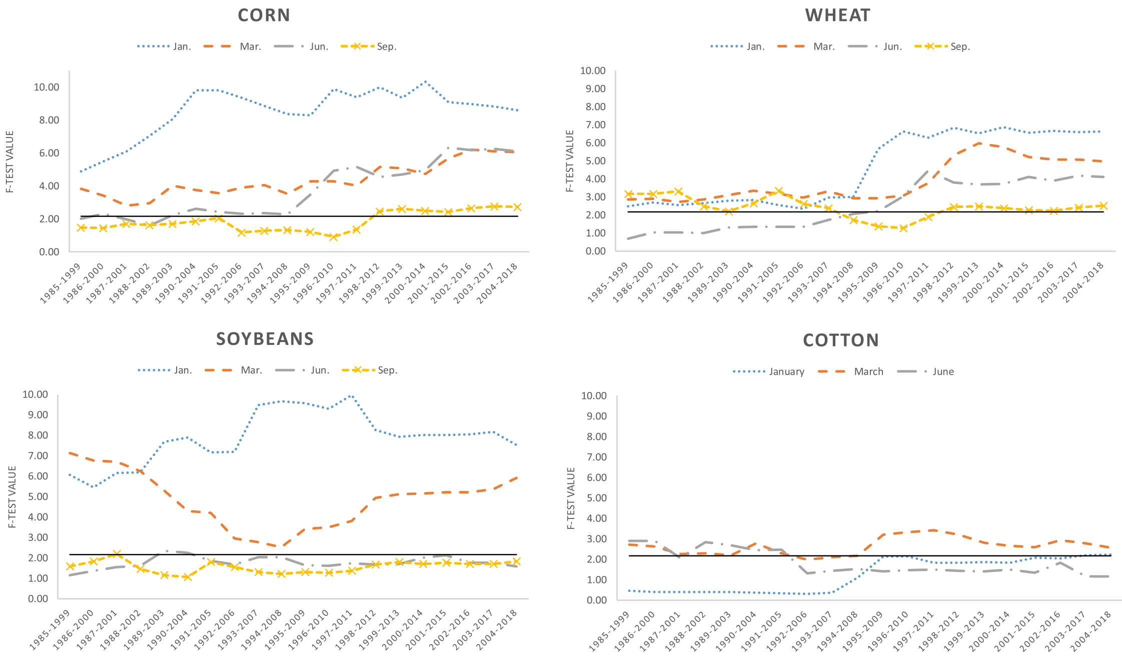

Fig. 3. 15-year rolling analysis of changes in crop market reaction to report clusters: January includes Crop Production Annual Summary, Grain Stocks, Wasde and Winter Wheat Seedings; March includes Prospective Plantings and Grain Stocks; June includes Acreage and Grain Stocks; September includes Grain Stocks and Small Grain Annual Summary. Solid black line shows the critical value for the F-test at 90 percent confidence level.

information about Grain Stocks is probably not very relevant for the cotton markets, but Prospective plantings reports released in March have increased the volatility of cotton prices by 3 times in the later part of the sample (1995–2018) and by 2 times in the earlier part (1985–2008).

The impact of the next group of reports released in June, which included Grain Stocks and Acreage reports, grew in corn and wheat markets, but not in soybean and cotton markets. This group of reports increased the volatility of corn prices by 5–6 times above normal during the recent 1996–2018 sub-period, but this reaction was much lower at around 2 times above normal during 1985–2008. Wheat market reaction to this information is revealed by a 4-fold increase in price variance during 1997–2018, while in the early part of the sample (1985–2009) this reaction was not statistically significant. Soybean market did not appear to significantly react to these reports during the period of our study. Cotton market reaction to these reports was modest, but statistically significant at about 2.5–3 times above normal volatility over 1985–2005, but has decreased and become insignificant since.

Market reaction to Grain Stocks reports released in September was modest but statistically significant at about 2 times above normal volatility for wheat during most of our study period, and for corn over more recent 1998–2018 period, but not for soybeans, where it was slightly lower and not statistically significant.

Our next set of results shown in Fig. 4 describe changes in market reaction to Crop Production reports. Our findings for the corn market suggest that while August crop production reports have historically caused the largest reaction in the corn market, their impact has declined slightly over time from 4 to 5 times above normal volatility over 1985–2005 to about 3 times above normal volatility during 1999–2018. The impact of September and October reports remained stable at about 2.5–3 times normal volatility during the period of study. On the other hand, the impact of November reports dropped from about 4 to 5 times above normal volatility over 1985–2005 to insignificant during 1995–2018. This finding suggests that while the earlier (August–October) crop production reports are still very informative to corn markets, by November the market participants appear to become well informed about the size of the corn crop.

A slight decline in market reaction to crop production reports is also observed in the soybean markets. Soybean market reaction declined from 3 to 4 times above normal volatility over 1985–2003 to about 2.5 times above normal volatility during 1994–2018 for August reports. The reaction to October reports changed from about 6 to 7 times above normal volatility over 1985–2003 to about 5 times normal volatility during 1997–2018. On the other hand, the reaction of soybean markets to November reports dropped from about 5 times above normal volatility over 1985–2002 to no longer significant during 1994–2018. September Crop Production reports did not cause a significant reaction in soybean markets during our study period. Differently from corn markets, where the August reports seem to cause the largest reaction, October Crop Production reports are the most influential in the soybean markets likely due to the physical characteristics of a soybean crop that tends to mature later than corn.

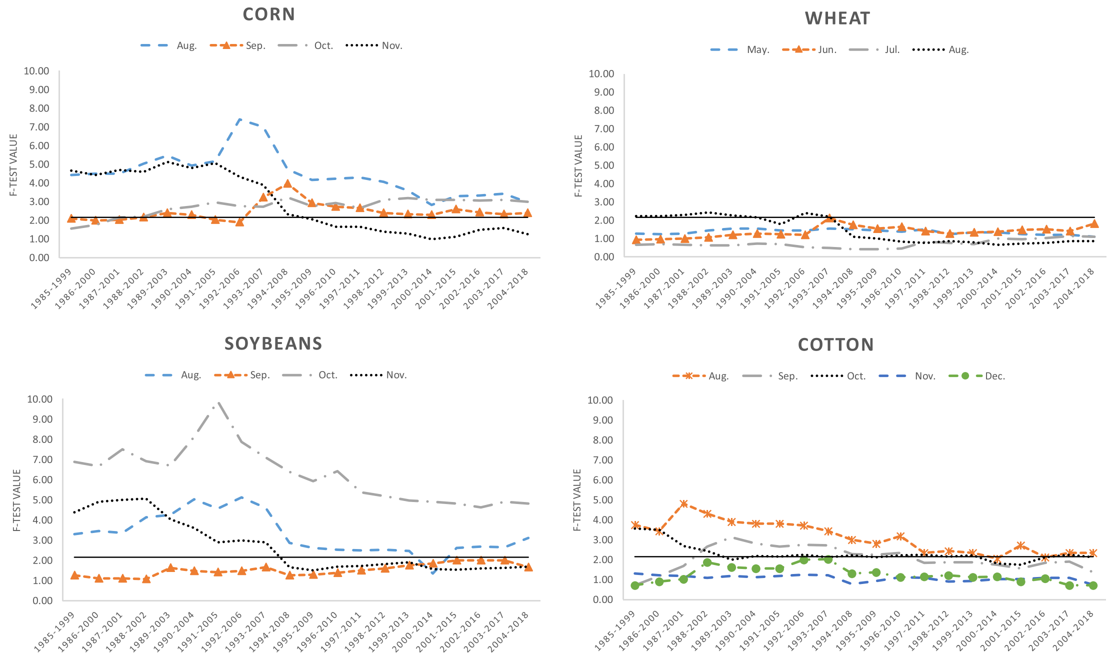

Fig. 4. 15-year rolling analysis of changes in crop market reaction to Crop Production reports released in different months. Solid black line shows the critical values for the F-test at 90 percent confidence level.

August Crop Production report is also the most impactful on the cotton markets, even though its impact declined from about 4 times above normal variance over 1985–2006 to slightly over 2 times above normal during 1997–2018. While both September and October reports had significant impacts on the cotton markets in the past (1988–2007 and 1985–2001, respectively), their impact has become largely insignificant since 1994. November and December reports did not appear to cause statistically significant reaction in cotton markets during our study period.

On the other hand, wheat markets did not appear to significantly react to crop production information. Several arguments may help explain this finding. One is that the wheat market is more efficient and already incorporates information contained in Crop Production reports. Second is that wheat prices are significantly affected by quality characteristics, such as protein content and therefore production information plays a less important role in price formation and induces less of a price reaction. Third is that wheat markets have become more globally oriented over time with the U.S. share of global production falling over the last 20 years, thus making domestic production information less important. Identifying an exact cause of the lack of the wheat market reaction to USDA Crop Production reports is an interesting area for future research.

Our findings for the livestock markets shown in Fig. 5 suggest that lean hog market reaction to Hogs and Pigs reports has been gradually declining over time. In fact, most of the limit moves in the lean hog markets caused by the Hogs and Pigs reports took place during 1985–1999, when the June reports increased the normal variance by over 6 times. However, the impact of June reports became insignificant during 1998–2018. The impact of most other Hogs and Pigs report releases remained insignificant during our period of study. Other findings show that live cattle markets stopped significantly reacting to Cattle on Feed reports during 1990–2018, even though the reaction was modest but significant previously at about 1.5 times the normal volatility over 1985–2003. These changes may have been associated with increased vertical integration in these markets as discussed in Karali et al. (2019a), with hog and cattle markets becoming more informed about their market dynamics within vertically integrated structures. On the other hand, vertical integration did not appear to affect access to information about a related market, as live cattle market reaction to June Hogs and Pigs reports appears to have increased over time peaking at about 3 times normal variance during 1997–2011, but decreasing subsequently and becoming insignificant during 2003–2018. This finding suggests that information about competing markets was relevant for cattle industry in the recent past.

6. Summary and conclusions

This study sought to compare the impact of various USDA information releases on crop and livestock markets across monthly releases and over time. We examined the impact of Prospective Plantings, Acreage, Crop Production, Crop Production Annual Summary, Grain Stocks, WASDE, Cattle on Feed, and Hogs and Pigs reports on corn, soybean, wheat, cotton, live cattle, and lean hogs markets over 1985–2018. Simultaneous releases of several reports were handled by examining the impact of report clusters. A traditional event study

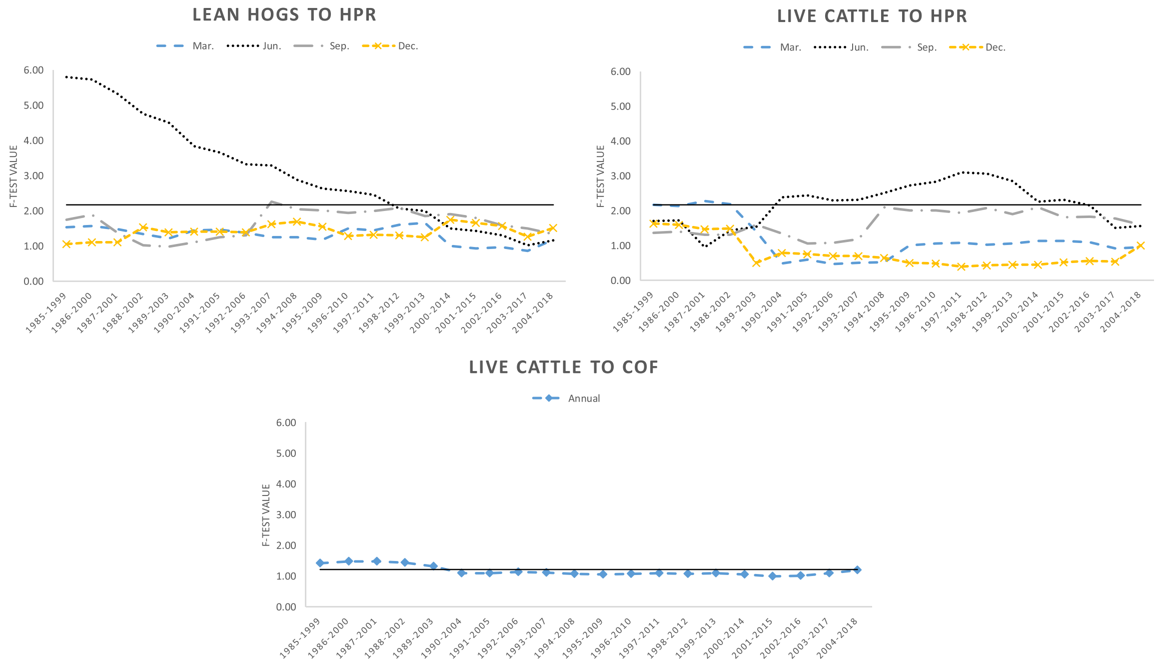

Fig. 5. 15-year rolling analysis of liveastock market reaction to Hogs and Pigs reports (top) and Cattle on Feed reports (bottom). Solid black line shows the critical value for the F-test at 90 percent confidence level.

methodology was applied where the impact of the information release was measured as an increase in nearby futures price volatility on report day relative to "normal" volatility on non-report days using an F-test, as well as several alternative parametric and non-parametric tests.

Our findings suggest that information clusters containing Grain Stocks, Crop Production Annual Summary as well as Prospective Plantings and Acreage reports had the largest impact on the crop markets and this impact has been increasing over time in most cases. For example, the impact of the January report cluster that was delayed in 2019 due to government shutdown appears to be the largest across all other releases in corn, soybeans and wheat. Furthermore, this impact has grown over time in corn, soybeans and wheat reaching around 9 times increase in variance for corn, 8 times increase for soybeans and about 6.5 times increase for wheat in response to these reports in the recent years. As we discussed in the introduction, the lack of this information sent market participants scrambling for other information sources and left a void of data that was not filled for several weeks. Our findings suggest that the value of information in this report cluster far exceeds the impact of the October WASDE report that may not have been missed by the markets according to Adjemian et al. (2018).

Crop Production reports also had a very strong and significant impact on corn, soybean and cotton markets but their impact has been decreasing slightly over time. Market impact differed across Crop Production reports released in different months with August reports having the largest impact on corn and cotton markets and October reports being most influential in soybean markets. These findings raise substantial concerns regarding USDA's decision to remove Objective Yield Estimates from August corn, soybean and cotton (except Texas) Crop Production forecasts announced in March 2019 (Field Crop Program, 2019). Our results suggest that these reports have historically demonstrated strong informational value in these markets.

On the other hand, our findings demonstrate that the impact of Hogs and Pigs reports on the lean hog market has deteriorated over time. This finding likely illustrates the implications of changes in the market structure of the livestock industry with rapid increases in consolidation and vertical integration over the last three decades. However, the impact of June Hogs and Pigs report on the live cattle markets was significant from 2003 to 2016 and the impact of Cattle on Feed report on the live cattle markets remained fairly stable over time. These results raise questions about the role of USDA information in these highly integrated markets.

The findings of this study should provide evidence and guidance for future policy decision regarding the role of USDA information in modern agricultural markets. USDA may have to make some very tough decisions in the environment of ever-decreasing budgets and increasing competition from the private information sources resulting from the big data revolution. While market impact is by far not the only role these reports play, the insight about their relative impact provided in our study should help inform these decisions.

CRediT authorship contribution statement

Olga Isengildina-Massa: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing, Project administration, Funding acquisition. **Xiang Cao:** Data curation, Formal analysis. **Berna Karali:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Scott H. Irwin:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Michael Adjemian:** Supervision. **Robert C. Johansson:** Supervision.

Acknowledgement

Funding support from the Office of the Chief Economist of the U.S. Department of Agriculture under Cooperative Agreement No. 58-0111-15-014 is gratefully acknowledged. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and not necessarily reflect the view of the U.S. Department of Agriculture.

References

Adjemian, M.K., 2012. Quantifying the WASDE announcement effect. Am. J. Agric. Econ. 94, 238–256.
Adjemian, M.K., Johansson, R., McKenzie, A., Thomsen, M., 2018. Was the missing 2013 WASDE missed? Appl. Econ. Perspect. Pol. 40, 653–671.
Baur, R.F., Orazem, P.F., 1994. The rationality and price effects of USDA forecasts of oranges. J. Finan. 49, 681–696.
Campbell, J.Y., Lo, A.W., MacKinlay, A.C., 1997. The Econometrics of Financial Markets. Princeton University Press, Princeton, N.J.
Colling, P.L., Irwin, S.H., 1990. The reaction of live hog futures prices to USDA hogs and Pigs reports. Am. J. Agric. Econ. 72, 84–94.
Conover, W.J., 1999. "Some Tests Based on the Binomial Distribution." *Practical Nonparametric Statistics*, third ed. John Wiley and Sons, Inc., New York, NY, pp. 123–178.
Field Crop Program. 2019. (available at: https://www.nass.usda.gov/Surveys/Program_Review/2019/Field-Crop-Program.pdf).
Fortenbery, T.R., Sumner, D.A., 1993. The effects of USDA reports in futures and options markets. J. Futures Mark. 13, 157–173.
Garcia, P., Irwin, S.H., Leuthold, R.M., Yang, L., 1997. The value of public information in commodity futures markets. J. Econ. Behav. Organ. 32, 559–570.
Good, D.L., Irwin, S.H., 2011. USDA corn and soybean acreage estimates and yield forecasts: dispelling myths and misunderstandings. Market. Outlook Brief 2, 11-02.
Good, K.. "Shutdown impacting USDA data and programs – market signals missing." farm policy news. https://farmpolicynews.illinois.edu/2019/01/shutdown-impacting-usda-data-and-programs-market-signals-missing/. (Accessed 13 January 2019).
Grunewald, O., McNulty, M.S., Biere, A.W., 1993. Live cattle futures response to cattle on feed reports. Am. J. Agric. Econ. 75, 131–137.
Huffstutter, P.J., Polansek, T., 2019. "U.S. shutdown sends grain traders, farmers hunting for data." Reuters Business News. Jan 11. https://www.reuters.com/article/us-usa-shutdown-agriculture/u-s-shutdown-sends-grain-traders-farmers-hunting-for-data-idUSKCN1P51G3.
Isengildina, O., Irwin, S.H., Good, D.L., 2006. The value of USDA situation and Outlook information in hog and cattle markets. J. Agric. Resour. Econ. 31, 262–282.
Isengildina-Massa, O., Irwin, S.H., Good, D.L., Gomez, J.K., 2008a. The impact of situation and Outlook information in corn and soybean futures markets: evidence from WASDE reports. J. Agric. Appl. Econ. 40 (1), 89–103.
Isengildina-Massa, O., Irwin, S.H., Good, D.L., Gomez, J.K., 2008b. Impact of WASDE reports on implied volatility in corn and soybean markets. Agribusiness 24, 473–490.
Karali, B., Isengildina-Massa, O., Irwin, S.H., 2019a. The changing role of USDA inventory reports in livestock markets. J. Agric. Resour. Econ. 44, 591–604.
Karali, B., Isengildina-Massa, O., Irwin, S.H., Adjemian, M.K., Johansson, R., 2019b. Are USDA reports still news to changing crop markets? Food Pol. 84, 66–76.
Mann, T.L., Dowen, R.J., 1996. Are hog and pig rreports informative? J. Futures Mark. 16, 273–287.
Mark, D.R., Small, R.M., 2007. *Interpretation of the USDA Cattle on Feed Report.* No. 850. Extension Report.
McKenzie, A., 2008. Pre-harvest price expectations for corn: the information content of USDA reports and new crop futures. Am. J. Agric. Econ. 90, 351–366.
McNew, K.P., Espinosa, J.A., 1994. The informational content of USDA crop reports: impacts on uncertainty and expectations in grain futures markets. J. Futures Mark. 14, 475–492.
Schaefer, M.P., Myers, R.J., Koontz, S.R., 2004. Rational expectations and market efficiency in the U.S. Live cattle futures market: the role of proprietary information. J. Futures Mark. 24, 429–451.
Small, R.M., Waterbury, J.A., Mark, D.R., 2007. *Interpretation of the USDA Quarterly Hogs and Pigs Report.* No. 851. Extension Report.
Snedecor, G.W., Cochran, W.G., 1989. Statistical Methods, eighth ed. Iowa State University Press, Ames, IA.
Sumner, D.A., Mueller, R.A.E., 1989. Are harvest forecast news? USDA announcements and futures market reactions. Am. J. Agric. Econ. 71, 1–8.
Venkateswaran, M., Brorsen, B.W., Hall, J.A., 1993. The distribution of standardized futures price changes. J. Futures Mark. 13, 279–298.
Yang, S.R., Brorsen, B.W., 1994. Daily futures price changes and nonlinear dynamics. Struct. Change Econ. Dynam. 5, 111–132.