NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

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by

Olga Isengildina-Massa, Berna Karali, Scott H. Irwin, Michael K. Adjemian, and Xiang Cao

Suggested citation format:

Isengildina-Massa, O., B. Karali, S. H. Irwin, M. K. Adjemian, and X. Cao. "The Value of USDA Information in a Big Data Era." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.illinois.edu/nccc134].

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Olga Isengildina-Massa,

Berna Karali,

Scott H. Irwin,

Michael K. Adjemian,

and

Xiang Cao[1]

Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management
St. Louis, Missouri, April 18 -19, 2016

[1] Olga Isengildina is an Associate Professor in the Department of Agricultural and Applied Economics at Virginia Tech University, Berna Karali is an Associate Professor in the Department of Agricultural and Applied Economics at the University of Georgia, Scott H. Irwin is a Laurence J. Norton Chair of Agricultural Marketing in the Department of Agricultural and Consumer Economics at the University of Illinois at Urbana-Champaign, Michael K. Adjemian is an Economist at the Market and Trade Economic Division of USDA Economic Research Service, and Xiang Cao is a graduate student in the Department of Agricultural and Applied Economics at Virginia Tech University. The funding support from the Office of Chief Economist of the US Department of Agriculture under the 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 do not necessarily reflect the view of the U.S. Department of Agriculture.

The Value of Public Situation Information in a Big Data Era

Abstract

The goal of this study is to determine how big data and access to information affects the role and impact of USDA's situation and outlook programs. Changes in market reaction to various USDA reports including WASDE, Crop Production, Grain Stocks, Prospective Plantings, Acreage, Hogs and Pigs and Cattle on Feed reports over 1970-2016 study period were analyzed. Market reaction was measured as a change in volatility of corn, soybean, wheat, lean hogs, live cattle, cotton and frozen concentrated orange juice returns on report release days. Our findings demonstrate that the impact of USDA reports has not diminished and often increased in crops during the recent decade. On the other hand, the value of USDA reports in livestock markets appears to be decreasing.

Keywords: *big data, corn, soybeans, wheat, cotton, orange juice, lean hogs, live cattle, market reaction.*

Introduction

Access to information has evolved dramatically over the last half a century. The emergence of "big data," or very large data sets that can potentially be mined for information, provide agricultural producers with access to multiple sources of private information to aid their decision making. In this environment some (e.g. Just, 1983) argue that public information programs can be downsized or eliminated because private firms now perform their functions. At the same time, substantial evidence of the market impact of USDA reports (e.g., Dorfman and Karali, 2015; Lehecka, Wang, and Garcia, 2014; Karali, 2012; Adjemian, 2012; Isengildina-Massa et al. 2008; Isengildina, Irwin, and Good, 2006), suggests that they continue to provide valuable new information that has not been replaced by other sources.

The goal of this study was to examine how the role and impact of USDA information programs evolved in the era of big data and better access to information. Specifically, our study examined whether USDA information still functions as an effective public good or if its impacts have eroded over time as the information available from private sources has improved in quantity and quality. To ensure generalizability of our findings, analysis was conducted across a wide range of agricultural commodities (corn, soybeans, wheat, lean hogs, live cattle, cotton, and frozen concentrated orange juice) for a sample period of 1970-2016. Our investigation focused on a wide selection of USDA reports relevant to these markets, including World Agricultural Supply and Demand Estimates (WASDE), Crop Production, Grain Stocks, Prospective Plantings, Acreage, Hogs and Pigs, and Cattle on Feed reports. Following previous studies, the impact of USDA reports was examined within event study framework, which is based on the notion that the information has value if prices react to the announcement of information (the event) in an efficient market (Campbell, Lo, and MacKinlay, 1997).

Our findings demonstrate that the impact of USDA reports has not diminished and often increased in crops during the recent decade. On the other hand, the value of USDA reports in

livestock markets appears to be decreasing. Several explanations based on the structure of crop versus livestock markets are proposed.

Data

Table 1 shows the number of USDA reports released for each commodity during the study period from January 1970 through February 2016. WASDE reports were released monthly since 1985, but sometimes more frequently in the earlier years. Also note that WASDE reports for cotton were often released separately in the earlier years, hence the difference in report counts between cotton and corn and soybeans. Another change in release schedule in 1985 resulted in many WASDE and Crop Production reports being released simultaneously, as shown in table 1. Monthly Crop Production report releases have been broken down by commodity based on their informational content, as shown in table 2. For example, NASS production forecasts for corn and soybeans were released from August through November, for wheat from May through August, and for cotton from August through December. The annual summary published in January contained final production information for corn, soybeans, wheat and cotton. Orange juice production forecasts were published in January through July and updated in October and December.

Changes in market reaction over time are examined by splitting the data into subsamples. The subsamples were chosen to be consistent with the evolution of the big data, changes in the USDA release schedules and market conditions: 1970-1984, 1985-1994, 1995-2006, 2007-2015. The big data developments that affected the choice of subsamples included the emergence of architecture for data warehousing in 1985, the explosion of the world wide web in 1995, and the emergence of open source data storage in 2007. Changes in the release schedule that took place in 1985 are discussed above. These sub-periods are also consistent with changes in market conditions due to policy changes in the U.S. Farm bills of 1985, 1996 and 2008. Specific report counts by sub-period are given in table 3.

Market reaction to USDA reports is tested using the nearby futures contract prices. Nearby futures contract 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. Due to relatively low trading volume, we eliminated August contract for soybeans and September contract for both corn and soybeans. Table 4 shows specific futures contract maturities used in market reaction tests for each commodity.

Identification of events requires the comparison of the time of report release to the futures market trading times. For example, if WASDE is released after trading hours, the market reaction to its information will take place during the following trading day, which is considered as the event day. With the evolution of electronic trading, changes in trading hours have been taking place in all commodities during recent years, which lead to many reports being released during regular trading hours. Thus the reaction to these reports may only be captured using close-to-close or open-to-close returns. To ensure continuity of our analysis, close-to-close returns are used to measure market reaction. Specifically, 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: $r_{d,i} = 100 \times (\ln P_{d,i} - \ln P_{d-1,i})$. Table 5 shows descriptive statistics of close-to-close

returns for each commodity during the study period of January 1970-February 2016. While mean returns are not significantly different from zero, the mean of absolute returns, which reflects variability in price movements, is significantly different from zero. All series exhibit significant skewness and kurtosis, hence, it is not surprising that normality is rejected in all cases at the 1% significance level. Therefore, several parametric and non-parametric tests are included in market reaction tests.

Methodology

Two alternative approaches for measuring market reaction to USDA reports were used to ensure robustness of results. Based on the theory of efficient markets, variability of futures prices around important scheduled news announcements should be characterized by a "spike" on the announcement dates compared to "normal" variability on non-announcement dates (Sumner and Mueller, 1989). This approach requires specification of "the event," *i*, which is associated with report release. The trading day index is d = -6, …, -1, 0, +1, …, +5, where zero indicates a release of USDA report (*i*) and the event widow consists of five trading days before and after the event (a negative number indicates sessions before report release and a positive number indicates sessions after report release). The null hypothesis for all statistical tests is that return variability for report sessions and pre- and post-report sessions is equal (no reaction). In the first set of results, the null hypothesis was tested with parametric tests including the F-test, Levene and Brown-Forsythe test, as well as a non-parametric Siegel Turkey test.

Furthermore, GARCH (1,1) models with Student t-distributed error terms were estimated to examine changes in conditional volatility of nearby futures prices in response to report releases while controlling for other factors that may affect market reaction, such as clustering (release of several reports on the same day), seasonality and day of the week effects (Adjemian, 2012; Karali, 2012; Isengildina, Irwin, and Good, 2008). The combination of these approaches allowed us to examine both economic and statistical significance of structural changes in the value of public information.

"Spike" Analysis Results

Tables 6-14 show the first set of results associated with "spike" analysis for each report included in this study. Market reaction to WASDE reports released separately from Crop Production reports, i.e. reports that contain mostly outlook information according to Isengildina et al. (2008), is described in table 6. Consistently with the findings of the previous studies (e.g., Isengildina et al., 2008; Fortenbery and Sumner, 1993), almost no evidence of market reaction to these reports was detected in corn and soybeans. In fact, the only statistically significant reaction was detected in the corn markets during 1970-1984 sub-period when the volatility of corn prices increased by about 11% in response to WASDE separate report releases. Limited evidence of market reaction to these reports was found in cotton, where sub-sample results were statistically significant according to only one out of four tests in most cases. On the contrary, a much stronger market reaction to these reports was detected in wheat, where price volatility increased by as much as 37% in response to these reports during 2007-2016 sub-period. These findings suggest that the outlook information contained in WASDE reports was most relevant in the

wheat markets and its impact has only strengthened over time rather than being replaced by the big data.

Table 7 examines market reaction to WASDE reports released simultaneously with Crop Production, i.e. reports focusing on situation (or inventory) information and reveals an opposite pattern to the previous set of results. Corn market volatility increased by an average of 83% in response to this group of reports during the study period with the strongest reaction of 122% observed in the 1995-2006 sub-sample. Similar pattern was observed in soybeans with an average reaction of 85% and strongest reaction of 101% during 1995-2006 sub-period. In cotton, a weaker but similar pattern was detected as well with 35% average and 51% strongest reaction in the same sub-period. In wheat, the only statistically significant reaction to this group of reports is detected in the 1995-2006 sub-period. Overall, this set of results demonstrate that USDA inventory information had the highest impact on the markets during 1995-2006 sub-period, the impact has weakened since, but continues to be strong in corn, soybean, and cotton markets.

Table 8 describes market reaction to inventory information contained in Crop Production reports. For the crops discussed above this table presents test results for 1970-1984 sub-period when these reports were released separately from WASDE reports relative to the entire study period when most reports were released simultaneously with WASDE reports as shown in table 7. These results demonstrate that the impact of these reports during 1970-1984 was consistent with the full sample average in most cases except for wheat, where it was about twice as strong in this early sub-sample. A new set of results presented for orange juice demonstrates that the impact of USDA situation information was the strongest from 1985 to 2006 and has sharply decreased since. So far this is the first evidence of USDA information potentially being replaced by big data.

Supply information for most major crops in WASDE reports in the beginning of the marketing year is based on survey data collected in March and released at the end of March in Prospective Plantings reports. Market reaction to Prospective Plantings reports shown in table 9 reveals that the reaction was the strongest in the most recent 2007-2016 sub-period in corn and wheat with increases in variance of 145% and 130%, respectively. Soybean market reaction to these reports was also very strong (163%), although not the strongest in our sample. A different pattern was observed in cotton, where market reaction to Prospective Plantings reports decreased over time with the highest reaction of 81% observed in 1970-1984 sub-period and the lowest reaction of 45% (not statistically significant) in 2007-2016 sub-period.

Acreage reports provide an updated supply information based on July acreage survey. According to “spike” analysis results shown in table 10 these reports had the most impact on corn and wheat market during 2007-2016 sub-sample with return volatility increasing by 199% and 131%, respectively. Soybean market reaction during 2007-2016 was average relative to the other sub-periods with volatility increasing by 62%. Cotton market reaction to Acreage reports has decreased over time and was not significantly different from zero in the most recent decade.

Market reaction to Grain Stocks reports shown in table 11 appears to increase over time. In corn markets it went from a 38% increase in variance during 1985-1994 sub-period to almost 150%

during 2007-2016 sub-period. In soybeans the smallest reaction was observed in the 1970-1984 sub-period (22%) and the largest in the 2007-2016 sub-period (107%). A similar pattern was observed in wheat with reactions of 22% and 118% in the same sub-periods, respectively. This evidence suggests that inventory information contained in Grain Stocks reports is not being replaced by big data and has become more valuable to market participants in the recent decade.

Tables 12-14 describe market reaction to USDA reports relevant to the livestock markets. Table 12 shows that the impact of Cattle on Feed reports on the live cattle market has decreased over time and did not significantly affect live hog markets. Table 13 shows that the impact of Hogs and Pigs reports has also decreased over time with the largest reaction of 93% detected in 1985-1994 sub-period while the market reaction during the most recent 2007-2016 sub-period was not significantly different from zero. According to table 14 WASDE reports had a significant impact on cattle markets only during 1995-2006 sub-period.

Overall, the results of the "spike" analysis discussed above demonstrate that the answer to the question whether the USDA information is being replaced by big data is not straightforward. There is some evidence of the impact of Cattle on Feed and Hogs and Pigs reports as well as Prospective Plantings and Acreage reports in cotton and Crop Production reports in orange juice decreasing over time. On the other hand, Prospective Plantings, Acreage, and Grain Stocks reports have increased their impact on corn, soybean, and wheat markets.

GARCH Model Results

The null hypothesis tested using GARCH models is similar to the "spike" analysis: whether conditional volatility is significantly different on report days from non-report days. Close-to-close return volatility in GARCH models is conditional on seasonality and day-of-the-week effects. This approach also accounts for clustering by disentangling the effects of individual reports when several reports are released on the same day. Table 15 demonstrates that during the period of study Acreage reports had the highest impact on the corn market increasing conditional variance of close-to-close returns by a factor of 2.025. This impact appears to increase over time with the largest reaction of 4.482 observed in the most recent 2007-2016 sub-period. WASDE reports containing Crop Production information were the second most important in the corn markets increasing conditional volatility by an average of 0.520 during the entire sample and 1.659 in the most recent sub-period. The impacts of other reports, including WASDE (without Crop Production), Grain Stocks and Prospective Plantings reports also appears to grow over time with reactions of 0.531, 0.970, and 3.001, respectively, in the most recent sub-period. These findings show no evidence of USDA information being replaced by big data, on the contrary the impact of this information appears enhanced in the presence of big data.

A different pattern is shown in table 15 for the soybean markets. While Acreage reports appear to have the largest impact in the whole sample (1.350), their impact is statistically significant only in the earliest sub-sample (1970-1984). The impact of Prospective Plantings reports was also statistically significant only in the earliest sub-sample. The impact of WASDE only reports was not statistically significant in any of the sub-samples. Only WASDE reports including Crop Production information and Grain Stocks reports appear to have consistently significant and

increasing impact on soybean markets, increasing conditional volatility of soybean returns by a factor of 0.873 and 0.920, respectively, in the most recent sub-period.

Yet another pattern is found in table 16 for the wheat markets. In wheat markets Acreage reports do not have a statistically significant impact on return volatility. On the other hand, WASDE only reports had a significant impact on the wheat markets in the two most recent sub-periods. The largest impact in the most recent sub-period is attributed to Prospective Plantings reports (2.176), followed by Grain Stocks reports (0.811) and WASDE only reports (0.520). These findings demonstrate that in the wheat markets the impact of Acreage and WASDE containing Crop Production information is weak or not significant but other reports continue to remain relevant.

Table 16 also shows that WASDE reports that contain Crop Production information are the only reports that have consistent significant impact in the cotton market which has been increasing over time. The impact of other reports appears to have weakened over time and was not statistically significant in the most recent sub-period, suggesting that this information may be being replaced by the big data.

On the other hand, the impact of Crop Production reports in the orange juice market is consistently significant and appears to grow over time with the impact of 1.542 on the conditional volatility of futures returns in the most recent sub-period.

Table 17 presents GARCH model results for livestock markets. Our results demonstrate that Cattle on Feed and Hogs and Pigs reports have had consistently significant impact on the live cattle futures market, but this impact appears to have decreased over time. Thus, Cattle on Feed reports had the highest impact of 0.205 on the conditional volatility of close-to-close cattle futures returns during 1985-1994 sub-period, but this impact decreased to 0.097 in 2007-2016 sub-period. Similarly, Hogs and Pigs reports had the highest impact of 0.220 on the conditional volatility of cattle futures returns during 1985-1994 sub-period, but this impact decreased to 0.106 in the 2007-2016 sub-period.

Finally, our results for lean hog markets shown in table 17 demonstrate that only Hogs and Pigs reports have had a consistently significant impact on these markets, but again this impact appears to have declined over time from the high of 0.797 during 1985-1994 sub-period to the low of 0.649 during the most recent 2007-2016 sub-period.

Overall, these findings once again demonstrate that the answer to the question of whether USDA information is being replaced by big data is often commodity and report specific. While Acreage, Prospective Plantings, and Crop Production reports continue to have strong impacts on most crop markets, most relevant Cattle of Feed and Hogs and Pigs reports appear to lose ground in livestock markets.

Conclusions and Implications

This study sought to examine how the role and impact of USDA information has evolved in the era of big data and better access to information. Market reaction to USDA information over time

was evaluated using several alternative approaches and statistical tests across multiple commodities including corn, soybeans, wheat, cotton, orange juice, live cattle, and lean hogs. Our findings indicate that changes in the impact of USDA information over time are often commodity and report specific. Additionally, we found that results were not always consistent across alternative approaches, "spike" versus GARCH analysis. While the "spike" analysis is more intuitive, GARCH results are likely more reliable as they take into account additional factors, such as clustering, seasonality and day-of-the-week effects.

Table 18 presents a summary qualitative comparison of the impact of USDA reports during 2007-2016 relative to 1970-2006 to help us answer the question about the relative importance of USDA information during the most recent decade in the presence of big data. The results are in complete agreement about the increasing impact of Grain Stocks reports across all relevant commodities (corn, soybeans, and wheat). There is also very strong evidence about the increasing impact of Prospective Plantings reports in corn, soybeans, wheat, and cotton (except "spike" results). The impact of Acreage reports has increased in corn markets, but the results in the other markets are mixed. The same can be said about the impact of WASDE report released separately from Crop Production reports that increased in the wheat markets, but not necessarily in other markets. These findings point to relative importance of domestic versus international information in the reports. While Grain Stocks, Prospective Plantings, and Acreage reports focus on domestic supply and inventory information, WASDE reports contain both domestic and international information that appear to be particularly important to heavily export oriented wheat markets.

The difference between situation and outlook information is typically examined by juxtaposing the impact of WASDE reports that contain Crop Production (situation) information versus WASDE only reports that focus on the outlook information. It was surprising to find extensive evidence of the decreasing impact of WASDE + Crop Production reports, especially in wheat and cotton markets. Further investigation of the conditions in the wheat and cotton markets is required to explain these findings.

The biggest contrast was found between crops and livestock, with the impact of USDA information decreasing in livestock but staying strong and even increasing in crops. Recent developments in the livestock markets resulted in higher concentration, vertical coordination, and reduction of trading in the spot markets. All these factors may have contributed to the fact that bigger firms have more resources to collect and analyze information internally and rely less on USDA data. On the other hand, crop markets are still very competitive with strong cash market sales. In this environment, the role of USDA data seems to be increasing as more information is needed to support these markets.

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Table 1. Main USDA Report Releases by Commodity, January 1970 – February 2016.

Report	Corn	Soybeans	Wheat	Cotton	Orange Juice	Live Cattle	Lean Hogs
WASDE and Crop Production	155	155	152	202			
Crop Production only	64	64	69	117	503		
WASDE only	395	395	396	347			
WASDE all						550	550
Grain Stocks	174	174	174				
Acreage	36	36	36	36			
Prospective Plantings	48	48	48	48			
Cattle on Feed						541	541
Hogs and Pigs						205	205

Table 2. Informational Content of Crop Production Reports.

	Corn	Soybeans	Wheat	Cotton	OJ
Annual	x	x	x	x	
January					x
February					x
March					x
April					x
May			x		x
June			x		x
July			x		x
August	x	x	x	x	
September	x	x		x	
October	x	x		x	x
November	x	x		x	
December				x	x

Table 3. Main USDA Report Releases for Corn and Soybeans by Sub-Period, January 1970 – February 2016.

Report	1970-2016	1970-1984	1985-1994	1995-2006	2007-2016
WASDE	550	176	121	145	108
WASDE only	395	175	71	85	64
WASDE and CP	155	1	50	60	44
Crop Production only	64	64	0	0	0
Crop Production	547	178	118	144	107
Grain Stocks	174	47	41	49	37
Acreage	36	10	5	12	9
Prospective Plantings	48	17	10	12	9
Cattle on Feed	541	169	120	144	108
Hogs and Pigs	205	59	40	70	36

Table 4. Maturities of Futures Contract Used in Market Reaction Tests.

Calendar Month	Corn	Soybeans	Wheat	Cotton	Orange Juice	Live Cattle	Lean Hogs
$January_t$	$March_t$	$March_t$	$March_t$	$March_t$	$March_t$	$February_t$	$February_t$
$February_t$	$March_t$	$March_t$	$March_t$	$March_t$	$March_t$	$April_t$	$April_t$
$March_t$	May_t	May_t	May_t	May_t	May_t	$April_t$	$April_t$
$April_t$	May_t	May_t	May_t	May_t	May_t	$June_t$	$June_t$
May_t	$July_t$	$July_t$	$July_t$	$July_t$	$July_t$	$June_t$	$June_t$
$June_t$	$July_t$	$July_t$	$July_t$	$July_t$	$July_t$	$August_t$	$July_t$
$July_t$	$December_t$	$December_t$	$December_t$	$December_t$	$September_t$	$August_t$	$August_t$
$August_t$	$December_t$	$December_t$	$December_t$	$December_t$	$September_t$	$October_t$	$October_t$
$September_t$	$December_t$	$December_t$	$December_t$	$December_t$	$November_t$	$October_t$	$October_t$
$October_t$	$December_t$	$December_t$	$December_t$	$December_t$	$November_t$	$December_t$	$December_t$
$November_t$	$December_t$	$December_t$	$December_t$	$December_t$	$January_{t+1}$	$December_t$	$December_t$
$December_t$	$March_{t+1}$	$March_{t+1}$	$March_{t+1}$	$March_{t+1}$	$January_{t+1}$	$February_{t+1}$	$February_{t+1}$

Notes. 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.

Table 5. Descriptive Statistics for Close-to-Close Futures Returns and Volatility, January 1970 – February 2016.

	Corn		Soybeans	
Statistics	r	$\|r\|$	r	$\|r\|$
N	11589	11589	11587	11587
Mean	-0.0146	1.0581***	0.0122	1.0975***
Median	0.0000	0.7581	0.0372	0.8013
Variance	2.1630	1.0435	2.2675	1.0629
Skewness	0.0219	1.9875***	-0.1558***	2.0336***
Kurtosis	5.7517***	8.8865***	6.1233***	11.0993***
Jarque-Bera	3657***	24362***	4756***	39657***

	Wheat		Cotton	
Statistics	r	$\|r\|$	r	$\|r\|$
N	11589	11589	11534	11592
Mean	-0.0211	1.2359***	0.0060	1.0578***
Median	0.0000	0.9449	0.0000	0.7628
Variance	2.7731	1.2460	2.3526	1.0873
Skewness	0.0481**	1.9009***	-0.0146	2.1062***
Kurtosis	5.2180***	8.5616***	5.1241***	9.2371***
Jarque-Bera	2380***	21916***	2169***	27360***

	Orange Juice	
Statistics	r	$\|r\|$
N	11521	11521
Mean	-0.0029	1.2648***
Median	0.0000	0.8757
Variance	3.3634	1.7636
Skewness	0.3741***	3.1511***
Kurtosis	12.3787***	26.7421***
Jarque-Bera	42493***	289660***

	Live Cattle		Lean Hogs	
Statistics	r	$\|r\|$	r	$\|r\|$
N	11595	11595	11595	11595
Mean	0.0118	0.7705***	0.0043	1.1387***
Median	0.0000	0.5812	0.0000	0.8692
Variance	1.0490	0.4555	2.2537	0.9570
Skewness	-0.1031***	1.3451***	-0.0828***	1.3504***
Kurtosis	3.9060***	5.0365***	3.8371***	5.0204***
Jarque-Bera	417***	5500***	352***	5496***

Table 6. Changes in Close-to-Close Futures Return Volatility in Response to WASDE Reports Released Separately from Crop Production Reports, January 1970– February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
	Panel A: Corn							
1970-1984	175	1.30	1.44	10.77%	0.82*	4.19**	3.96**	2.65***
1985-1994	70	1.25	1.01	-19.20%	1.54**	0.84	0.83	0.10
1995-2006	84	1.42	1.42	0.00%	1.00	0.17	0.24	0.89
2007-2016	64	1.91	1.87	-2.09%	1.04	0.48	0.28	1.33
1970-2016	393	1.44	1.45	0.69%	0.99	0.95	0.91	1.77*
	Panel B: Soybeans							
1970-1984	175	1.74	1.79	2.87%	0.94	0.29	0.29	0.55
1985-1994	70	1.25	0.99	-20.80%	1.59**	1.70	1.71	0.77
1995-2006	84	1.35	1.33	-1.48%	1.03	0.00	0.01	0.71
2007-2016	64	1.45	1.37	-5.52%	1.12	0.36	0.38	0.64
1970-2016	393	1.52	1.51	-0.66%	1.02	0.00	0.00	0.29
	Panel C: Wheat							
1970-1984	176	1.62	1.90	17.48%	0.72***	6.94***	6.84***	2.42**
1985-1994	72	1.08	1.31	20.54%	0.69**	2.97*	2.94*	0.76
1995-2006	85	1.53	1.69	10.28%	0.82	2.39	1.99	1.81*
2007-2016	63	2.12	2.91	37.13%	0.53***	6.52**	6.47**	2.00**
1970-2016	396	1.61	1.97	22.44%	0.67***	18.62***	18.62***	3.60***
	Panel D: Cotton							
1970-1984	175	1.37	1.57	14.60%	0.76***	1.90	1.85	0.79
1985-1994	57	1.27	1.34	5.51%	0.89	1.29	1.32	1.79*
1995-2006	67	1.55	1.83	18.06%	0.71**	1.63	1.57	0.55
2007-2016	46	1.87	2.06	10.16%	0.82	0.01	0.01	0.63
1970-2016	345	1.47	1.66	12.93%	0.78***	3.57*	3.57*	1.14

Table 7. Changes in Close-to-Close Futures Return Volatility in Response to WASDE Reports Released Simultaneously with Crop Production Reports, January 1985– February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
	Panel A: Corn							
1970-1984	1	1.03	N/A	N/A	N/A	N/A	N/A	N/A
1985-1994	50	1.06	1.56	46.80%	0.46***	8.39***	7.91***	1.87*
1995-2006	60	1.25	2.77	121.57%	0.20***	139.85***	109.49***	9.00***
2007-2016	44	1.99	3.45	73.38%	0.33***	28.69***	28.07***	4.35***
1970-2016	155	1.45	2.67	83.41%	0.30***	129.24***	127.37***	8.72***
	Panel B: Soybeans							
1970-1984	1	1.77	N/A	N/A	N/A	N/A	N/A	N/A
1985-1994	50	1.11	1.88	69.20%	0.35***	23.61***	22.44***	2.72***
1995-2006	60	1.25	2.52	100.79%	0.25***	79.77***	74.04***	6.15***
2007-2016	44	1.67	3.06	82.72%	0.30***	35.42***	34.74***	4.60***
1970-2016	155	1.35	2.50	84.52%	0.29***	122.82***	121.94***	7.73***
	Panel C: Wheat							
1970-1984	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1985-1994	48	1.37	1.45	6.37%	0.88	1.04	0.68	1.11
1995-2006	59	1.59	1.90	19.95%	0.70**	6.64**	6.55**	2.65***
2007-2016	45	2.24	2.19	-2.50%	1.05	0.00	0.00	0.39
1970-2016	152	1.75	1.86	6.55%	0.88	3.69*	3.58*	2.39**
	Panel D: Cotton							
1970-1984	0	N/A	N/A	N/A	N/A	N/A	N/A	0.00
1985-1994	64	1.29	1.75	35.17%	0.55***	9.80***	9.18***	2.62***
1995-2006	75	1.51	2.27	50.96%	0.44***	37.48***	36.85***	5.51***
2007-2016	62	1.71	2.05	19.77%	0.70**	3.18*	3.11*	1.66*
1970-2016	201	1.51	2.04	34.84%	0.55***	38.89***	38.88***	5.56***

Table 8. Changes in Close-to-Close Futures Return Volatility in Response to Crop Production Reports, January 1970–February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
	Panel A: Corn							
1970-1984	65	1.23	2.08	68.89%	0.35***	50.77***	43.48***	5.50***
1970-2016	219	1.39	2.51	80.19%	0.31***	180.84***	178.15***	10.35***
	Panel B: Soybeans							
1970-1984	65	1.56	2.55	63.91%	0.37***	58.48***	52.41***	6.56***
1970-2016	219	1.42	2.51	76.57%	0.32***	179.30***	179.10***	10.08***
	Panel C: Wheat							
1970-1984	69	1.62	2.16	33.47%	0.56***	10.39***	10.27***	3.09***
1970-2016	222	1.71	1.98	15.85%	0.75***	12.95***	12.79***	3.71***
	Panel D: Cotton							
1970-1984	103	1.23	1.62	31.56%	0.58***	22.61***	22.59***	4.37***
1970-2016	316	1.42	1.88	32.35%	0.57***	57.37***	57.33***	6.91***
	Panel E: Orange Juice							
1970-1984	163	1.64	2.78	69.74%	0.35***	84.40***	81.87***	6.19***
1985-1994	108	1.63	3.40	108.48%	0.23***	19.55***	19.55***	1.90*
1995-2006	130	1.75	3.55	103.23%	0.24***	34.09***	30.47***	2.21**
2007-2016	98	2.09	2.71	29.74%	0.59***	11.38***	10.72***	2.68***
1970-2016	499	1.76	3.12	77.13%	0.32***	128.43***	127.79***	6.77***

Table 9. Changes in Close-to-Close Futures Return Volatility in Response to Prospective Plantings Reports, January 1970–February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
	Panel A: Corn							
1970-1984	16	1.10	1.26	14.71%	0.76	0.42	0.29	0.86
1985-1994	10	0.87	1.42	63.95%	0.37**	1.61	1.60	2.19**
1995-2006	12	1.16	2.43	109.98%	0.23***	19.19***	19.03***	2.99***
2007-2016	9	1.91	4.69	145.35%	0.17***	32.65***	26.72***	3.97***
1970-2016	47	1.26	2.51	98.61%	0.25***	43.19***	42.58***	4.30***
	Panel B: Soybean							
1970-1984	16	1.61	2.38	47.67%	0.46**	6.87***	6.23**	2.58***
1985-1994	10	0.78	2.63	237.76%	0.09***	43.39***	41.59***	3.74***
1995-2006	12	1.16	1.69	46.01%	0.47**	5.08**	5.07**	2.04**
2007-2016	9	1.41	3.71	163.31%	0.14***	38.09***	31.60***	3.75***
1970-2016	47	1.32	2.54	92.17%	0.27***	62.45***	61.38***	5.85***
	Panel C: Wheat							
1970-1984	16	1.58	2.00	26.35%	0.63	2.00	1.67	2.05**
1985-1994	10	1.25	1.67	33.49%	0.56	1.11	0.40	1.63
1995-2006	12	1.40	2.34	67.08%	0.36***	5.71**	5.71**	1.99**
2007-2016	9	2.34	5.39	129.81%	0.19***	28.32***	17.50***	3.61***
1970-2016	47	1.65	2.93	78.02%	0.32***	33.87***	32.21***	4.18***
	Panel D: Cotton							
1970-1984	16	1.21	2.20	81.16%	0.30***	19.76***	18.22***	3.62***
1985-1994	10	0.99	1.76	78.63%	0.31***	9.22***	8.76***	2.65***
1995-2006	12	1.46	2.22	51.47%	0.44**	5.43**	5.38**	1.95*
2007-2016	9	1.62	2.34	44.72%	0.48*	1.42	0.94	0.19
1970-2016	47	1.32	2.18	64.56%	0.37***	32.18***	32.13***	4.32***

Table 10. Changes in Close-to-Close Futures Return Volatility in Response to Acreage Reports, January 1970– February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
	Panel A: Corn							
1970-1984	10	1.57	1.37	-12.22%	1.30	0.29	0.40	0.16
1985-1994	5	1.84	2.44	32.60%	0.57	0.70	0.62	0.96
1995-2006	12	1.83	3.11	70.34%	0.34***	5.75**	5.68**	1.57
2007-2016	9	2.23	6.67	198.91%	0.11***	47.95***	33.67***	3.93***
1970-2016	36	1.87	3.83	104.65%	0.24***	30.05***	29.06***	3.19***
	Panel B: Soybean							
1970-1984	10	2.02	3.50	73.01%	0.33***	11.44***	11.44***	2.95***
1985-1994	5	1.71	2.72	58.49%	0.40	2.48	2.38	1.55
1995-2006	12	1.81	2.52	39.84%	0.51*	5.57**	5.56**	2.48**
2007-2016	9	1.65	2.67	61.61%	0.38**	4.36**	3.91*	2.06**
1970-2016	36	1.82	2.85	56.74%	0.41***	25.35***	23.67***	4.65***
	Panel C: Wheat							
1970-1984	10	1.81	2.15	18.96%	0.71	0.08	0.10	0.23
1985-1994	5	1.38	1.19	-13.87%	1.35	0.14	0.12	0.21
1995-2006	12	1.62	1.97	21.92%	0.67	0.00	0.00	0.91
2007-2016	9	2.17	5.02	130.97%	0.19***	18.96***	12.94***	3.99***
1970-2016	36	1.80	2.99	66.14%	0.36***	11.53***	10.65***	1.19
	Panel D: Cotton							
1970-1984	10	1.72	2.77	60.94%	0.39**	7.70***	5.52**	2.48**
1985-1994	5	1.80	3.21	78.04%	0.32**	2.21	0.46	0.64
1995-2006	12	2.24	2.43	8.44%	0.85	0.00	0.02	0.74
2007-2016	9	1.92	1.98	3.51%	0.93	0.47	0.35	1.49
1970-2016	36	1.96	2.62	33.45%	0.56**	3.94**	3.93**	1.72*

Table 11. Changes in Close-to-Close Futures Return Volatility in Response to Grain Stocks Reports, January 1970– February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
Panel A: Corn								
1970-1984	47	1.22	1.83	49.70%	0.45***	17.38***	17.23***	3.26***
1985-1994	41	1.38	1.90	38.15%	0.52***	11.12***	11.07***	3.48***
1995-2006	49	1.35	2.62	94.23%	0.27***	60.58***	58.23***	5.30***
2007-2016	36	2.01	5.03	149.75%	0.16***	124.27***	123.88***	6.98***
1970-2016	173	1.49	2.99	101.10%	0.25***	175.55***	174.32***	8.97***
Panel B: Soybean								
1970-1984	47	1.75	2.14	22.45%	0.67**	4.39**	4.09**	2.46**
1985-1994	41	1.31	2.07	58.77%	0.40***	21.97***	21.83***	4.18***
1995-2006	49	1.31	2.13	62.35%	0.38***	33.18***	28.25***	5.18***
2007-2016	36	1.59	3.30	107.42%	0.23***	60.41***	56.70***	5.85***
1970-2016	173	1.50	2.42	61.26%	0.38***	107.47***	107.20***	8.71***
Panel C: Wheat								
1970-1984	47	1.63	1.98	21.50%	0.68*	4.13**	4.04**	2.32**
1985-1994	41	1.41	1.85	30.78%	0.58**	8.41***	8.07***	3.06***
1995-2006	49	1.54	2.23	45.52%	0.47***	15.96***	15.62***	2.98***
2007-2016	36	2.12	4.62	118.27%	0.21***	80.55***	80.46***	5.83***
1970-2016	173	1.67	2.82	68.85%	0.35***	86.71***	86.00***	6.55***

Table 12. Changes in Close-to-Close Futures Return Volatility in Response to Cattle on Feed Reports, January 1970–February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
Panel A: Live Cattle								
1970-1984	169	1.20	1.45	21.05%	0.68***	13.97***	13.92***	3.21***
1985-1994	120	0.84	1.11	32.33%	0.57***	12.39***	12.39***	2.27**
1995-2006	144	0.93	1.00	7.93%	0.86	3.55*	3.47*	2.32**
2007-2016	108	0.89	0.97	8.44%	0.85	0.49	0.41	0.34
1970-2016	541	1.00	1.18	18.40%	0.71***	25.66***	25.53***	4.13***
Panel B: Live Hogs								
1970-1984	169	1.60	1.71	6.68%	0.88	1.30	1.16	0.79
1985-1994	120	1.19	1.22	1.90%	0.96	0.03	0.03	0.19
1995-2006	144	1.56	1.64	4.80%	0.91	0.79	0.72	0.72
2007-2016	108	1.41	1.25	-11.31%	1.27	2.10	2.42	1.58
1970-2016	541	1.47	1.51	2.35%	0.95	0.35	0.26	0.17

Table 13. Changes in Close-to-Close Futures Return Volatility in Response to Hogs and Pigs Reports, January 1970– February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
Panel A: Live Cattle								
1970-1984	59	1.22	1.51	22.94%	0.66**	7.85***	7.65***	3.21***
1985-1994	40	0.83	1.13	36.60%	0.54***	4.79**	4.65**	1.64
1995-2006	69	0.93	1.07	14.89%	0.76*	0.33	0.30	0.71
2007-2016	36	0.98	1.24	26.43%	0.63**	2.31	2.25	1.13
1970-2016	204	1.02	1.25	22.75%	0.66***	13.49***	13.46***	2.61***
Panel B: Live Hogs								
1970-1984	59	1.70	2.66	56.38%	0.41***	52.51***	51.91***	6.78***
1985-1994	40	1.15	2.21	93.03%	0.27***	65.91***	65.54***	5.55***
1995-2006	69	1.59	2.11	32.01%	0.57***	15.85***	15.39***	4.05***
2007-2016	36	1.31	1.56	19.19%	0.70	1.36	1.31	0.55
1970-2016	204	1.50	2.21	47.23%	0.46***	97.46***	97.44***	8.82***

Table 14. Changes in Close-to Close Futures Return Volatility in Response to WASDE Reports, January 1970– February 2016.

Report Group	N	Non-report day std. dev	Report day std. dev	% Difference of std. devs	F-test	Levene test	Brown-Forsythe test	Siegel–Tukey test
	Panel A: Live Cattle							
1970-1984	175	1.33	1.24	-6.85%	1.15	1.25	1.55	1.10
1985-1994	121	0.89	0.90	0.72%	0.99	0.06	0.07	0.28
1995-2006	144	0.90	1.11	23.64%	0.65***	10.54***	10.49***	2.58***
2007-2016	108	0.91	0.87	-5.15%	1.11	0.99	1.39	1.63
1970-2016	548	1.05	1.07	2.20%	0.96	0.20	0.17	0.13
	Panel B: Live Hogs							
1970-1984	175	1.75	1.76	0.24%	1.00	0.01	0.01	0.27
1985-1994	121	1.29	1.29	0.05%	1.00	0.00	0.00	0.11
1995-2006	144	1.60	1.71	6.86%	0.88	1.39	1.01	1.03
2007-2016	108	1.46	1.38	-5.46%	1.12	1.81	1.93	1.96**
1970-2016	548	1.55	1.58	1.47%	0.97	0.01	0.00	0.32

Table 15. Changes in Conditional Volatility of Corn and Soybeans Close-to-Close Returns in Response to USDA Reports.

	1970-1984	1985-1994	1995-2006	2007-2016	1970-2016
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Panel A: Corn					
WASDE+Crop Production		0.427*** (0.000)	0.596*** (0.000)	1.659*** (0.000)	0.520*** (0.000)
Crop Production only	0.526*** (0.000)				0.426*** (0.000)
WASDE only	-0.005 (0.924)	0.027 (0.680)	0.312*** (0.003)	0.531* (0.063)	0.000 (0.999)
Grain Stocks	0.155 (0.170)	0.173 (0.160)	0.235 (0.251)	0.970* (0.056)	0.219*** (0.007)
Acreage	1.957*** (0.009)	1.455 (0.137)	2.243** (0.027)	4.482*** (0.006)	2.025*** (0.000)
Prospective Plantings	0.004 (0.974)	0.022 (0.916)	0.680 (0.115)	3.001** (0.015)	0.093 (0.416)
Panel B: Soybeans					
WASDE+Crop Production		0.350*** (0.001)	0.495*** (0.001)	0.873*** (0.000)	0.460*** (0.000)
Crop Production only	0.853*** (0.000)				0.796*** (0.000)
WASDE only	-0.043 (0.640)	-0.045 (0.477)	0.140 (0.134)	0.013 (0.919)	-0.010 (0.838)
Grain Stocks	0.390* (0.084)	0.433*** (0.001)	0.443** (0.044)	0.920*** (0.002)	0.435*** (0.000)
Acreage	2.393** (0.012)	0.854 (0.221)	1.129 (0.113)	0.706 (0.275)	1.350*** (0.001)
Prospective Plantings	0.533* (0.086)	-0.029 (0.882)	0.025 (0.943)	-0.091 (0.850)	0.182 (0.215)

Table 16. Changes in Conditional Volatility of Wheat, Cotton and Orange Juice Close-to-Close Returns in Response to USDA Reports.

	1970-1984	1985-1994	1995-2006	2007-2016	1970-2016
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Panel A: Wheat					
WASDE+Crop Production		0.180 (0.199)	0.661*** (0.003)	0.522 (0.114)	0.328** (0.015)
Crop Production only	0.285* (0.067)				0.282* (0.058)
WASDE only	0.053 (0.500)	-0.018 (0.848)	0.435*** (0.007)	0.520* (0.056)	0.035 (0.582)
Grain Stocks	0.280 (0.198)	0.516*** (0.003)	0.426 (0.154)	0.811 (0.103)	0.455*** (0.000)
Acreage	0.455 (0.282)	0.373 (0.513)	-0.132 (0.811)	1.077 (0.293)	0.303 (0.281)
Prospective Plantings	0.191 (0.516)	-0.029 (0.940)	0.198 (0.727)	2.176** (0.041)	0.140 (0.514)
Panel B: Cotton					
WASDE+Crop Production		0.193* (0.091)	0.460*** (0.001)	0.583*** (0.001)	0.387*** (0.000)
Crop Production only	0.384*** (0.000)				0.186** (0.012)
WASDE only	-0.267*** (0.000)	-0.046 (0.700)	0.336** (0.041)	0.342 (0.157)	0.031 (0.447)
Acreage	0.075 (0.862)	0.161 (0.817)	-0.697* (0.076)	-0.479 (0.521)	-0.622*** (0.005)
Prospective Plantings	0.888*** (0.000)	0.444 (0.207)	0.230 (0.537)	0.247 (0.656)	0.436*** (0.002)
Panel C: Orange Juice					
Crop Production	0.432*** (0.000)	0.400*** (0.002)	0.638*** (0.000)	1.542*** (0.000)	0.509*** (0.000)

Table 17. Changes in Conditional Volatility of Live Cattle and Lean Hogs Close-to-Close Returns in Response to USDA Reports.

	1970-1984	1985-1994	1995-2006	2007-2016	1970-2016
	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Panel A: Live Cattle					
WASDE	0.069** (0.035)	-0.093*** (0.001)	0.052 (0.149)	0.095** (0.015)	0.007 (0.694)
Cattle on Feed	0.167*** (0.000)	0.205*** (0.000)	0.146*** (0.000)	0.097** (0.022)	0.152*** (0.000)
Hogs and Pigs	0.176** (0.024)	0.220*** (0.000)	0.097** (0.027)	0.106* (0.067)	0.132*** (0.000)
Panel B: Lean Hogs					
WASDE	0.209*** (0.008)	-0.100 (0.259)	0.182 (0.134)	-0.012 (0.906)	0.097** (0.049)
Cattle on Feed	-0.057 (0.502)	0.070 (0.438)	-0.111 (0.330)	0.073 (0.449)	-0.007 (0.908)
Hogs and Pigs	0.651*** (0.000)	0.797*** (0.000)	0.677*** (0.000)	0.649*** (0.000)	0.703*** (0.000)

Table 18. Qualitative Comparison of the Impact of USDA Reports during 2007-2016 Relative to 1970-2006 across Evaluation Measures.

		Corn	Soybeans	Wheat	Cotton	OJ	Live Cattle	Lean Hogs
WASDE+Crop Production	Spikes	-	-	-	-	-		
	GARCH	+	+	-	-	+		
WASDE only	Spikes			+	-			
	GARCH	+		+	+			
Grain Stocks	Spikes	+	+	+				
	GARCH	+	+	+	+			
Acreage	Spikes	+	+	+	-			
	GARCH	+	-					
Prospective Plantings	Spikes	+	+	+	-			
	GARCH	+		+	+			
WASDE	Spikes							
	GARCH						+	-
Cattle on Feed	Spikes						-	
	GARCH						-	
Hogs and Pigs	Spikes						=	-
	GARCH						-	-

Notes: "+" (-) indicates higher (lower) impact during 2007-2016 relative to 1970-2006. Only statistically significant results are included.