EVOLUTION OF THE IMPACT OF USDA INFORMATION IN CROP AND LIVESTOCK MARKETS

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Abstract

This study examines how the impact of USDA information has changed over time due to changes in the U.S. agricultural sector. Our findings demonstrate that despite the growth of private information sources that have emerged over the last 10-20 years, most USDA reports relevant to the crop markets showed a dramatic increase in market impact over time. This suggests that public information is becoming more valuable in crop markets likely due to its strong reputation, greater market uncertainty and improved accessibility. On the other hand, the impact of USDA reports in the livestock markets has decreased substantially. This outcome is likely the result of structural changes that led to higher market concentration and vertical integration in the livestock sector.

Key words: Announcement effects, crops, futures, livestock, market impact, price reaction, USDA reports, value of information.

JEL codes: Q18, Q02

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Introduction

The landscape of American agriculture and the role of the United States Department of Agriculture (USDA) has changed dramatically over the last half a century. Lusk (2016) describes "The farms today that supply the bulk of the nation's food are larger and more sophisticated than in the past. The farmers have access to crop consultants and online information is at their fingertips…Futures markets are available to hedge against price risk, and, in many cases, producers have access to more vertically integrated markets that offer contracts that reduce price or production risk." (p. 52-53) At the same time, USDA continues to spend millions of dollars to collect and disseminate market information to the public. The Office of Management and Budget reports that out of "$6.6 billion in total direct funding for major statistical programs across all Federal agencies in 2012, USDA accounted for about $521 million or 7.8% of the total." (C-FARE, 2013, p. 4) Over 30% of these funds are allocated to National Agricultural Statistical Service (NASS), an agency primarily responsible for data collection and dissemination.

The justification for this investment in USDA's data products is that in many cases public data are necessary because they facilitate the efficient functioning of the markets, reduce information asymmetries and inform the policy and program formation, operation and evaluation processes (C-FARE, 2013). However, the emergence of private information sources facilitated by the recent advances in technology and the increased levels of market concentration and vertical integration in some sectors call the relevance of public data into question especially in the times of budget shortfalls.

The impact of USDA's situation and outlook programs has been examined in numerous previous studies (e.g., Garcia et al., 1997; Isengildina-Massa et al., 2008; McKenzie, 2008; Myers, Sexton, and Tomek, 2010; Adjemian, 2012; Karali, 2012). However, previous studies provide very limited information on how the impact of USDA reports has changed over time. Fortenbery and Sumner (1993) found that the impact of WASDE reports on corn and soybean markets declined during 1982-1989 relative to 1969-1982. On the other hand, Isengildina-Massa et al. (2008) demonstrated that the impact of WASDE reports on corn and soybean markets increased over 1985 to 2006. Ying, Chen and Dorfman (2017) showed that the impact of Acreage, Prospective Plantings, Grain Stocks, WASDE and Crop Production reports on corn and soybean markets increased from 1995-2015, while the impact of other reports, such as crop progress and oil crop outlook, declined. Thus, most previous analyses are limited to single reports (mostly WASDE) or commodities (corn and soybeans) and over relatively short time periods (at most 20 years). This study will address this gap in knowledge by assessing the evolution of the market impact of USDA information spanning multiple commodities (corn, soybeans, wheat, cotton, orange juice, live cattle, and lean hogs), multiple reports (Prospective Plantings, Acreage, Crop Production, Crop Production Annual Summary, Grain Stocks, Cattle on Feed, and Hogs and Pigs), and an extended period of time (1970-2016).

The task of measuring changes in market impact of USDA information over time will be accomplished using a traditional event study approach following a number of previous studies (e.g., Colling and Irwin, 1990; Fortenbery and Sumner, 1993; Grunewald, McNulty, and Biere, 1993; Garcia et al., 1997; Isengildina-Massa et al., 2008). While other, more sophisticated techniques have been proposed in the literature to assess various aspects of market impact[1], we

[1] For example, Adjemian (2012) explored how the impacts of the reports vary by month, inventory conditions and delivery horizon given the overlapping nature of futures contracts.

believe that the event study approach offers the most direct, flexible and intuitive assessment of changes in market impact over time. 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, Lo, and MacKinlay, 1997). In our study, the events are the releases of major USDA reports. Daily returns of either nearby or new crop futures contracts for each commodity over 1970-2016 are used to measure market reaction. The impact of the reports is assessed by comparing futures return variability on report release sessions versus pre- and post-release sessions. Parametric and nonparametric tests are used to measure changes in futures return variability in response to report releases. Since the focus is on the changes in the impact of USDA information over time, market reaction tests are conducted for the full sample as well as three sub-samples, 1970-1984, 1985-2000, and 2001-2016. These sub-samples are consistent with shifts in government policy and market conditions, provide enough observations for statistical analysis and allow comparison with the findings of previous studies (e.g, Garcia et al., 1997; Egelkraut et al., 2003).

Our results demonstrate that most reports relevant to crop markets showed a dramatic increase in impact over time. This is surprising as these reports compete with increasing number of private information sources that have emerged over the last 10-20 years. The only evidence of decreasing market reaction was observed in Crop Production reports, particularly those released later in the growing season. This finding stands in sharp contrast to the evidence of decreasing impact of USDA reports on livestock markets. The implications of these findings and likely changes in the role of USDA information are important for updating USDA's mission, function and activities in order to meet new challenges of modern agricultural sector.

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, July 1 to June 30 for oranges, January 1 to December 31 for cattle, and December 1 to November 30 for hogs. Table 1 describes NASS forecasting cycles for commodities included in this study. For spring planted crops, such as corn, soybeans, cotton, and spring wheat, the annual forecasting cycle starts with Prospective Plantings reports. These reports, typically released at the end of March, contain information about producer planting intentions based on producer responses to the March Agricultural Survey.[2] 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. 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 1995-2012, 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

[2] From 1975 through 1981 Prospective Plantings reports were released twice a year, in January and March (or April).

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 for wheat are published in September Small Grains Annual Summary reports. Orange production forecasts are published from September through July and finalized in the September Citrus Summary report. 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, at the end of December, March, June, and September and describe stocks in storage at the beginning of these months. 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 am EST release time from September 1994-September 2012 and 12pm EST release time from January 2013 to present.

Cattle on Feed and Hogs and Pigs reports provide production information relevant to the livestock markets. 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

[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.

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, Waterbury, and Mark, 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. This list is not comprehensive as NASS publishes more than 400 reports every year and it does not include reports published by other agencies and interagency committees of USDA. At the same time, this list includes all major NASS reports shown to have market impact in the previous studies. Including additional reports would increase problems associated with overlapping or clustering of information when several reports are released on the

[5] There were 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.

same day. This problem is partially illustrated in table 1, which shows Grain Stocks reports released together with Small Grain Annual Summaries and Crop Production Annual Summaries within the same marketing year. Report clustering is illustrated in further detail in table 2, which documents the incidence of simultaneous releases relative to total releases for each report during each sub-period. For example, while all 25 Prospective Plantings reports were released separately during 1970-1984, due to changes in release schedule, 14 out of 16 Prospective Plantings reports were released together with Grain Stocks reports during 1985-2000. When several reports are released simultaneously on the same day, it is not possible to decompose their individual impacts using the data available for this study and the combined impact of multiple reports should be recognized in the interpretation of results. On the other hand, livestock reports were not significantly affected by clustering.

Futures Data and Statistical Tests

Based on the theory of efficient markets, 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 is to determine whether futures return variability on event sessions is significantly different from normal variability on non-event days.

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 will affect the trading session the following day. With the evolution of electronic trading, changes in trading hours have been taking place in all commodities during recent years, which has led to many reports being released during regular trading hours. Thus, the reaction to these reports may 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. While some previous studies (e.g., Isengildina et al., 2008) argue that using close-to-close returns may mask some of the reaction that would be more visible in close-to-open returns, it is necessary to use close-to-close returns in our study due to changes in trading times and the emergence of electronic trading. Consequently, our results may be viewed as a conservative measure of market reaction to USDA reports. Consistency in this measure is critical since our goal is to assess changes in market reaction over time.

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, Kansas City Board of Trade (KCBT) hard red winter wheat futures, and the Minneapolis Grain Exchange (MGEX) hard red spring wheat contracts were collected. Cotton and Orange Juice 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 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, September contracts for corn, August and September contracts for soybeans, October contracts for cotton, and May contracts for KCBT wheat and lean hogs were eliminated. New crop futures series concentrate on the harvest contract for all months prior to its expiration and a nearby contract for information released after harvest contract's expiration. Table 3 shows specific futures contract maturities used in market reaction tests for each commodity. Due to the informational content of the reports, new crop futures are used to examine market reaction to Prospective Plantings, Acreage, and Crop Production reports in corn, soybeans, wheat and cotton as these reports are related to new crop conditions. Nearby futures are used to assess the impact of Grain Stocks reports on corn, soybeans and wheat as these reports relate directly to old crop market conditions. The impact of Crop Production reports on orange juice as well as that of Cattle on Feed and Hogs and Pigs reports on live cattle and lean hog markets are assessed using nearby futures series as well.

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). 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 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 (same approach was used in previous studies, e.g., Garcia et al., 1997). The reaction window was also adjusted to include five post-report days.

Table 3 shows descriptive statistics of close-to-close returns during event windows for new crop futures for corn, soybeans, wheat, and cotton and nearby futures for orange juice, live cattle, and lean hogs over 1970-2016. While the mean return is not significantly different from zero for each series, the mean of absolute return, which reflects variability in price movements, is significantly greater than zero. All series exhibit significant skewness and kurtosis, hence, it is not surprising that normality is rejected by the Jarque-Bera test in all cases at the 1% significance level. Therefore, both parametric and non-parametric tests should be used in empirical analysis. The analysis is conducted for the entire sample, 1970-2016, as well as three sub-samples, 1970-1984, 1985-2000, and 2001-2016. The selected sub-samples reflect shifts in government policy and market conditions, provide enough observations for statistical analysis and allow comparison with the findings of previous studies.[8]

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

[8] We decided to use sub-samples rather than the continuous estimation approach proposed by Ying, Chen and Dorfman (2017) because their procedure is parametric and may lack statistical power, especially for smaller samples.

tested with parametric tests including the F-test, Levene and Brown-Forsythe test, as well as a non-parametric Siegel-Tukey test. The F-test is a simple ratio of return variance on the report days relative to non-report day variance:

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

where k is a trading day index for non-release days, $k = -5, \ldots, -1, +1, \ldots, +5$, and independent normal samples are assumed. 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).

Results

The discussion of the results follows the marketing year report cycle illustrated in Table 1. Table 5 describes crop market reaction to Prospective Plantings reports.[9] The results are shown in several alternative ways: standard deviations describe average levels of volatility on

[9] Since 1985, Prospective Plantings reports were often released on the same day with Grain Stocks reports. The Grain Stocks reports should mainly affect the nearby futures, but through storage linkages, this impact may also extend to the new crop futures used to analyze the impact of Prospective Plantings reports in this study, therefore the results likely show the combined impact of both reports released on the same day.

report and non-report days, while the differences in these standard deviations show how much the reports move the markets in each sub-period. While these differences are informative, they cannot be compared across sub-periods due to the different levels of volatility on non-report days. An F-test, calculated as a ratio of variances on report versus non-report days is more appropriate for this purpose, therefore we focus on this measure in the discussion of our results. Our findings reveal that the impact of Prospective Plantings reports has increased over time in almost all commodities. The largest impact was observed in corn markets where the volatility of December futures increased by about 9.36 times on report days during 2001-2016, a sharp increase relative to 3.15 times reaction recorded in the previous sub-period. Wheat market reaction of 4.97 times the non-report volatility during 2001-2016 was also much higher than that in the previous sub-periods. The cotton market showed a slow and steady increase in the impact of Prospective Plantings reports which grew from 2.71 times normal volatility during 1970-1984 to 3.49 times during 2001-2016. The only decrease in market reaction to these reports from the previous sub-period was observed in soybeans, where November futures volatility was 5.25 times higher than normal in response to these reports during 2001-2016, but it was a decline from 7.87 times impact in the previous sub-period.[10]

Table 6 shows that the average impact of Acreage reports[11] was very consistent across commodities, increasing normal volatility by 2.3 times in wheat to 2.7 times in corn. The impact of Acreage reports has increased over time in all crops included in this study. The largest increase and the highest impact in the most recent sub-period was observed once again in corn

[10] A more detailed look at this result reveals that even though the difference in standard deviations on report versus non-report days was slightly higher during 2001-2016, compared to a higher standard deviation on non-report days during this sub-period, it resulted in a smaller reaction ratio, which was still very substantial, especially relative to the impact in other commodities (cotton and wheat).
[11] Acreage reports were often released together with Grain Stocks reports.

where volatility jumped 4.19 times higher than normal on report release days during 2001-2016. Wheat and soybeans revealed a similar reaction of 3.88 and 3.45 times normal volatility, respectively, followed by cotton market reaction of 2.48 times. In all cases, the market reaction to Acreage reports in the previous 1985-2000 sub-period was not significantly different from zero. Even during 1970-1984, the only consistent evidence of significant market reaction to these reports was in soybeans, where volatility was 2.97 times greater than normal on report release days. A plausible explanation for the sharp increase in the market reaction to Acreage reports after 2000 is the implementation of the 1996 Freedom to Farm Act. This "farm bill" eliminated most of the direct government acreage controls for major crops in the U.S. that had been in place since the 1930s. It would be natural for Acreage reports to be more valuable in an environment where producers have significantly more flexibility in changing crop acreages from year-to-year. On the other hand, this increase in the impact of Acreage reports during the most recent sub-period is surprising, as the information contained in these reports may be observable via satellite and recorded using precision farming equipment.

Crop Production reports also compete with multiple alternative sources of information. Table 7 shows that the impact of crop production reports has declined in the last sub-period after peaking during 1985-2000 in corn, soybeans, cotton and orange juice. Wheat prices showed lack of significant reaction to crop production reports after 1984.[12] While these changes are not dramatic and the market reaction to these reports is still very strong, it is the first consistent evidence of declining reaction to USDA reports detected in this study. We conducted additional tests after splitting the most recent sub-period in two halves to get a better sense for the timing of this change. It appears that market reaction to Crop Production reports in corn and orange juice

[12] These results show market reaction using CBOT SRW wheat contracts. Similar results were obtained for KCBT and MGEX wheat contracts.

was still very strong in the beginning of the last sub-period (2001-2008), but declined in the most recent 8 years (2009-2016), a pattern consistent with the impact of new information sources. A similar pattern, but at a much smaller magnitude was observed in cotton, but not in soybeans. Thus, the impact of crop production reports on corn market volatility decreased from 3.3 times normal volatility during 2001-2008 to 1.88 times during 2009-2016. The impact of crop production reports on soybean market volatility changed from 2.63 to 2.89 between these sub-samples. In cotton, the impact decreased from 1.75 to 1.59, and in orange juice the impact dropped from 3.08 to 1.52.

Figure 1 breaks down changes in the impact of crop production reports by report month and shows that the decrease in impact affected different reports to a different extent. In corn, August and November reports were the most influential during 1985-2000. While the impact of the August report has only decreased slightly during 2001-2016, the impact of the November report was no longer statistically significant. October crop production report has moved the soybean markets the most during 1985-2000 and continued to be the most influential report during 2001-2016, followed by the August report. On the other hand, the impact of the November report in soybeans became insignificant, just like in corn. Similarly, August crop production report continues to be influential in cotton, while the impact of the October report disappears. May crop production reports also maintained a significant impact on the cotton markets, but these reports reflect information on cotton ginnings, the values that are not directly observable by big data. The patterns observed in figure 1 suggest that competition from alternative information sources had the largest impact on the crop production reports released later in the growing season, when production was more directly measurable using satellite and precision agriculture tools. A markedly smaller impact on August crop production reports

suggests that big data tools are much less adept to measuring production earlier in the growing season. This observation is also consistent with the lack of impact of the big data on Acreage reports.

Table 8 reveals that even though the impact of crop production reports may be decreasing, the final USDA production estimate[13] is extremely important to the markets. Some of the strongest market reactions across all reports are observed in response to Crop Production Annual Summary reports with corn market volatility increasing by 8.94 times, soybean by 8.05 times and wheat by 6.55 times on report release days during 2001-2016. In all three cases, this reaction is substantially larger than in the previous sub-periods. Thus, there is a very strong evidence of the increasing impact of these reports. Small Grains Annual Summary reports contained the final estimates of the wheat crop from 1994 till 2002, when spring wheat estimates were discontinued and included in CPAS in subsequent years. Our results show a significant impact of these reports on the markets, but it is hard to judge the changes in impact over time due to a changing information content in these reports. Differently from other crops, crop production reports do not appear to significantly affect cotton markets.[14] One possible explanation is that these estimates are frequently revised in the following May when ginning data becomes available.

Results shown in table 9 suggest that nearby futures reaction to Grain Stocks reports has increased over time in all three markets (corn, soybeans, and wheat).[15] The magnitude of market

[13] Crop Production Annual Summary reports were often released together with Grain Stocks reports. The number of Grain Stocks reports released on the same day with CPAS reports listed in table 7 shows the degree of clustering between two reports.

[14] A significant decrease in market volatility during 1970-1984 on report release days is not a sign of market impact as we are looking for spikes in volatility as markets a trying to find a new equilibrium in response to new information.

[15] January, March and June Grain Stocks reports are significantly affected by clustering with other reports, only September reports would provide a clear picture of the Grain Stocks impact in most cases.

reaction approximately doubled in corn and wheat markets between the last two sub-periods, growing from 2.46 (2.07) times normal volatility during 1985-2000 to 5.57 (4.06) times during 2001-2016 in corn (wheat). In soybean markets, the reaction increased from 2.38 times normal volatility during 1985-2000 to 3.6 times during 2001-2016. Additional set of results for the two halves of the most recent sub-period indicate that most of the increase in market reaction took place in the most recent eight years, especially in corn and wheat markets.

Figure 2 shows changes in crop market reaction to each of the quarterly Grain Stocks reports. January results for all crops illustrate an increasing market impact possibly associated with Crop Production Annual Summary reports. March results show that market impact of Grain Stocks reports often released together with Prospective Plantings reports has been increasing in corn and wheat and decreased slightly in soybeans across the last two sub-periods. June results demonstrate an increasing corn and wheat market reaction to Grain Stocks released together with Acreage reports. Our findings show that September Grain Stocks reports released during 2001-2016 increased the volatility of corn markets by 2.61 times. The impact of these reports on the soybean markets was not significant. While a decrease in the impact of September Grain Stocks reports on the wheat markets has been observed, it is still significant and likely associated with the changes in information content of the Small Grains Annual Summary reports discussed above.

Finally, table 10 describes livestock market reaction to relevant USDA reports. Our findings show that the live cattle market reaction to Cattle on Feed reports has deteriorated over time. The strongest market reaction was observed during 1985-2000 when live cattle futures

September Grain Stocks reports were often released on the same day as Small Grain Annual Summary reports during the last two sub-periods, which would affect the results for wheat.

volatility increased by 1.73 times following these reports. However, in the most recent 2001-2016 sub-period cattle market reaction to these reports was not significantly different from zero. A significant reaction of live cattle market to Hogs and Pigs reports of about 1.62 times normal volatility in the second sub-period also deteriorated to an insignificant reaction during 2001-2016. A similar pattern was observed in the lean hog futures reaction to Hogs and Pigs reports, which peaked during 1985-2000 at 3.82 times normal volatility and declined to 1.37 times in the most recent sub-period. These findings demonstrate that the impact of USDA information in the livestock markets deteriorated substantially in the last 15 years.

Figure 3 summarizes the findings and describes relative importance of various reports in various markets across sub-periods. This figure shows that Crop Production Annual Summary reports are the most important reports in corn, soybeans, and wheat. The impact of CPAS reports increased dramatically in the last sub-period. This finding illustrates that final estimates released by USDA in these reports continue to function as a benchmark to which other forecasts are compared (as argued by Irwin, Gerlow, and Liu, 1994; Kastens, Schroeder and Plain, 1998). Prospective Plantings are the second most important reports and their impact has increased across all crops included here. The only evidence of decreased impact of USDA reports is detected in Crop Production reports in crops and both Cattle on Feed and Hogs and Pigs reports in livestock. While the decrease in the impact of Crop production reports may be attributed to the competition with private information sources and "big data," the decrease in the impact of livestock related reports is likely driven by changes associated with increased market concentration and vertical integration in cattle and hogs. Acreage reports follow the Prospective Plantings reports in importance and their impact has increased dramatically as well. Across

commodities, the USDA information appears to have the largest impact on corn and soybean markets and smaller impact on wheat and cotton markets, followed by hog and cattle markets.

Additional analysis was conducted to assess the sensitivity of our finding to the selection of the sub-periods with alternative specification consisting of 1970-1984, 1985-1994, 1995-2006, and 2007-2016 sub-periods and the results were very similar. While the main set of results for wheat presented here uses Chicago Board of Trade (CBOT) contracts to measure market reaction, additional analysis conducted using Kansas City Board of Trade (KCBT) and Minneapolis Grain Exchange (MGEX) contracts yielded very similar results.

Summary and Conclusions

This study examines how the impact of USDA information has changed over time due to changes in the US agricultural sector. We assessed changes in the impact of multiple reports, namely Prospective Plantings, Acreage, Crop Production, Crop Production Annual Summary, Grain Stocks, Cattle on Feed, and Hogs and Pigs, on various futures markets including corn, soybeans, wheat, cotton, orange juice, live cattle and lean hogs across several sub-periods: 1970-1984, 1985-2000, 2001-2016. The results indicate that in general, the USDA information tends to move corn and soybean markets the most and hog and cattle markets the least. Our findings demonstrate that despite the growth of private information sources that have emerged over the last 10-20 years, most USDA reports relevant to the crop markets showed a dramatic increase in market impact over time. The largest increase was observed for Prospective Plantings and Crop Production Annual Summary reports, followed by Acreage and Grain Stocks reports. The only evidence of decreasing market reaction was observed in Crop Production reports, particularly those released later in the growing season. However, it is important to note that even with a

slight decrease in impact, Crop Production reports continue to have a strong and statistically significant effect on most commodities and are in no way redundant to existing market data.

Why does the USDA data become more important in the environment when more information is available? Some of it may have to do with the unknown quality of the new information sources relative to a long track record USDA has in providing accurate and reliable information. It is also important that the public nature of USDA information implies lack of bias and incentive for market manipulation that may be present in private information sources. Furthermore, the emergence of multiple sources of information that may not necessarily agree with each other may result in increased market uncertainty, an environment where a reliable source of information becomes more valuable. Finally, just like other information sources, USDA data became easier to access and use with an expansion of internet and broadband access.

Our findings of the increased impact of USDA reports in crop markets stands in sharp contrast to the evidence of deteriorating impact of USDA reports in livestock markets. Both Cattle on Feed and Hogs and Pigs reports failed to significantly effect cattle markets in the most recent sub-period, while the impact of Hogs and Pigs reports on the hog markets decreased substantially in the last 15 years. However, it is not likely that this decrease in impact is due to the emergence of new information sources in the form of satellites and precision agriculture. Livestock markets have undergone substantial changes since 1990s due to increased vertical integration in the supply chain, which led to higher market concentration among the existing firms. These structural changes are likely the primary drivers of changes in livestock market reaction to USDA information. Does it mean that highly concentrated markets do not need public information? Little is known about the role of public information in highly concentrated markets and this issue needs to be further investigated in the future.

How is the role of public information expected to develop moving forward? Some argue that it will increase further. Lusk (2016) argues that "solid economic justifications for farm subsidies, which cost taxpayers $20 billion annually, are virtually nonexistent" (p. 53) in modern American agriculture. Instead, they suggest that increased focus on activities and policies that make American agriculture more productive and efficient and reduces barriers for development of well-functioning private markets should be the goal. This means that the role of public information, such as "ensuring that accurate data are available on price and delivery of insurance" (p. 54) will become increasingly important. C-FARE (2013) study echoes these conclusions by recommending further analysis of the value of USDA information; better understanding of "how data products are used within and across various federal agencies"; better understanding of "the relative importance of competing priorities associated with public data products in order to determine funding priorities" and alteration rather than elimination of existing data products. (p. 25-26) The findings of this study shed light on changes in the value of USDA information. Other aspects of USDA data products provide interesting opportunities for future research.

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Table 1. Main NASS Reports for Corn, Soybeans, Wheat, Cotton, Oranges, Cattle and Hogs.

	Corn	Soybeans	Winter Wheat*	Spring Wheat*	Cotton	Oranges	Cattle	Hogs
$December_{t-1}$								HPR
$January_t$			WWS			CP	COF	
$February_t$						CP	COF	
$March_t$	PP	PP		PP	PP	CP	COF	HPR
$April_t$						CP	COF	
May_t			CP			CP	COF	
$June_t$	Acr	Acr	CP	Acr	Acr	CP	COF	HPR
$July_t$			CP	CP		CP	COF	
$August_t$	CP	CP	CP	CP	CP		COF	
$September_t$	CP	CP	SGAS, GS	GS	CP	CP	COF	HPR
$October_t$	CP	CP			CP	CP	COF	
$November_t$	CP	CP			CP	CP	COF	
$December_t$					CP	CP	COF	
$January_{t+1}$	CPAS, GS	CPAS, GS	CPAS, GS	CPAS, GS	CPAS			
$February_{t+1}$								
$March_{t+1}$	GS	GS	GS	GS				
$April_{t+1}$								
May_{t+1}					CP			
$June_{t+1}$	GS	GS	GS	GS				
$July_{t+1}$								
$August_{t+1}$								
$September_{t+1}$	GS	GS						
$October_{t+1}$								

Notes: *Final estimates for wheat are published in Small Grains Annual Summary released at the end of September starting in 1994. September and October crop production estimates for Spring wheat were discontinued in 2002 and are not included in the analysis. The subscript, t or t + 1, refers to the production year. Shaded area highlights the marketing year for each commodity. Abbreviations: WWS=Winter Wheat Seedings, PP=Prospective Plantings, Acr=Acreage, CP=Crop Production, CPAS=Crop Production Annual Summary, SGAS=Small Graings Annual Summary, COF=Cattle on Feed, HPR=Hogs and Pigs Reports.

Table 2. Overlap in Release Across Grain Stocks and Prospective Plantings, Acreage, Crop Production Annual Summary and Small Grains Annual Summary Reports.

	PP	PP+GS	PP Total	ACR	ACR+GS	ACR Total	CPAS	CPAS+GS	CPAS Total	SGAS+GS	GS	GS Total
	Panel A: Corn											
1970-1984	25	0	25	10	0	10	15	0	15	0	62	62
1985-2000	2	14	16	12	4	16	1	15	16	7	24	64
2001-2016	0	16	16	0	16	16	0	16	16	16	0	64
1970-2016	27	30	57	22	20	42	16	31	47	23	86	190
	Panel B: Soybeans											
1970-1984	25	0	25	10	0	10	15	0	15	0	62	62
1985-2000	2	14	16	12	4	16	1	15	16	7	24	64
2001-2016	0	16	16	0	16	16	0	16	16	16	0	64
1970-2016	27	30	57	22	20	42	16	31	47	23	86	190
	Panel C: Wheat											
1970-1984	25	0	25	10	0	10	15	0	15	0	62	62
1985-2000	1	15	16	12	4	16	1	15	16	7	24	65
2001-2016	1	15	16	1	15	16	1	15	16	16	0	61
1970-2016	27	30	57	23	19	42	17	30	47	23	86	188

Abbreviations: PP=Prospective Plantings, Acr=Acreage, CPAS=Crop Production Annual Summary, SGAS=Small Graings Annual Summary, GS=Grain Stocks.

Table 3. Maturities of Futures Contracts Used in Empirical Analyses

	Corn (CBOT)		Soybeans (CBOT)		Winter Wheat (CBOT/KCBT)			Spring Wheat (MGEX)		Cotton (ICE)		Live Cattle (CME)	Lean Hogs (CME)
Calendar Month	Nearby	New Crop	Nearby	New Crop	Nearby (CBOT)	Nearby (KCBT)	New Crop	Nearby	New Crop	Nearby	New Crop	Nearby	Nearby
January$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Mar$_t$	Feb$_t$	Feb$_t$
February$_t$	Mar$_t$	Dec$_t$	Mar$_t$	Nov$_t$	Mar$_t$	Mar$_t$	Jul$_t$	Mar$_t$	Sep$_t$	Mar$_t$	Dec$_t$	Apr$_t$	Apr$_t$
March$_t$	May$_t$	Dec$_t$	May$_t$	Nov$_t$	May$_t$	Jul$_t$	Jul$_t$	May$_t$	Sep$_t$	May$_t$	Dec$_t$	Apr$_t$	Apr$_t$
April$_t$	May$_t$	Dec$_t$	May$_t$	Nov$_t$	May$_t$	Jul$_t$	Jul$_t$	May$_t$	Sep$_t$	May$_t$	Dec$_t$	Jun$_t$	Jun$_t$
May$_t$	July$_t$	Dec$_t$	Jul$_t$	Nov$_t$	Jul$_t$	Jul$_t$	Jul$_t$	Jul$_t$	Sep$_t$	Jul$_t$	Dec$_t$	Jun$_t$	Jun$_t$
June$_t$	July$_t$	Dec$_t$	Jul$_t$	Nov$_t$	Jul$_t$	Jul$_t$	Jul$_t$	Jul$_t$	Sep$_t$	Jul$_t$	Dec$_t$	Aug$_t$	Jul$_t$
July$_t$	Dec$_t$	Dec$_t$	Nov$_t$	Nov$_t$	Sep$_t$	Sept$_t$	Sep$_t$	Sep$_t$	Sep$_t$	Dec$_t$	Dec$_t$	Aug$_t$	Aug$_t$
August$_t$	Dec$_t$	Dec$_t$	Nov$_t$	Nov$_t$	Sep$_t$	Sep$_t$	Sep$_t$	Sep$_t$	Sep$_t$	Dec$_t$	Dec$_t$	Oct$_t$	Oct$_t$
September$_t$	Dec$_t$	Dec$_t$	Nov$_t$	Nov$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Oct$_t$	Oct$_t$
October$_t$	Dec$_t$	Dec$_t$	Nov$_t$	Nov$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$
November$_t$	Dec$_t$	Dec$_t$	Jan$_{t+1}$	Jan$_{t+1}$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$	Dec$_t$
December$_t$	Mar$_{t+1}$	Mar$_{t+1}$	Jan$_{t+1}$	Jan$_{t+1}$	Mar$_{t+1}$	Mar$_{t+1}$	Mar$_{t+1}$	Mar$_{t+1}$	Mar$_{t+1}$	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.

Table 4. Descriptive Statistics for Close-to-Close Futures Returns During Event Windows, 1970 – 2016.

Statistics	N	Mean	Median	Variance	Skewness	Kurtosis	Jarque-Bera
Corn							
r	4,315	-0.02	0.00	2.43	0.07 *	5.56 ***	1181 ***
|*r*|	4,315	1.12 ***	0.79	1.18	1.93 ***	8.08 ***	7336 ***
Soybeans							
r	4,315	-0.03	0.00	2.48	-0.19 ***	4.78 ***	592 ***
|*r*|	4,315	1.15 ***	0.83	1.17	1.70 ***	6.43 ***	4194 ***
Wheat							
r	4,249	-0.01	0.00	3.07	0.05	5.31 ***	949 ***
|*r*|	4,249	1.28 ***	0.96	1.43	1.90 ***	8.16 ***	7254 ***
Cotton							
r	4,716	0.00	0.00	1.96	0.03	4.80 ***	641 ***
|*r*|	4,716	1.02 ***	0.72	0.92	1.68 ***	6.62 ***	4795 ***
Orange Juice							
r	5,695	-0.004	0.00	3.71	0.56 ***	14.57 ***	32050 ***
|*r*|	5,695	1.32 ***	0.91	1.97	3.49 ***	32.35 ***	216038 ***
Live Cattle							
r	7,353	0.01	0.00	1.03	-0.12 ***	4.11 ***	395 ***
|*r*|	7,353	0.76 ***	0.57	0.45	1.42 ***	5.52 ***	4405 ***
Lean Hogs							
r	7,353	0.010	0.00	2.26	-0.08 ***	3.91 ***	261 ***
|*r*|	7,353	1.14 ***	0.86	0.97	1.38 ***	5.11 ***	3687 ***

Notes: New crop futures are used for corn, soybeans, wheat (CBOT) and cotton and nearby futures are used for orange juice, live cattle and lean hogs. Returns (r) are computed as the difference in the natural logarth of price multiplied by 100. Asterisks show statistical significance: *p<0.10, **p<0.05, ***p<0.01.

Table 5. Crop Market Reaction to Prospective Plantings Reports.

	N	Non-report day std. dev.	Report day std. dev.	Diff. of std. devs.	F-test	Brown Forsythe	Siegel–Tukey test
	Panel A: Corn						
1970-1984	25	1.07	1.40	0.33	1.71	2.75*	1.43
1985-2000	16	0.88	1.56	0.68	3.15**	13.58***	2.89***
2001-2016	16	1.17	3.59	2.41	9.36***	82.92***	4.86***
1970-2016	57	1.05	2.24	1.19	4.52***	65.32***	4.96***
	Panel B: Soybeans						
1970-1984	25	1.43	1.96	0.54	1.89*	6.61**	2.83***
1985-2000	16	0.81	2.27	1.46	7.87***	66.41***	4.92***
2001-2016	16	1.21	2.78	1.56	5.25***	16.69***	3.39***
1970-2016	57	1.22	2.27	1.05	3.45***	51.93***	6.24***
	Panel C: Wheat						
1970-1984	25	1.58	1.89	0.31	1.43	1.43	1.62
1985-2000	16	1.22	1.76	0.53	2.06	4.35**	2.09**
2001-2016	16	1.79	4.00	2.20	4.97***	33.90***	3.73***
1970-2016	57	1.56	2.60	1.04	2.78***	26.09***	3.83***
	Panel D: Cotton						
1970-1984	25	1.12	1.84	0.72	2.71***	16.97***	4.00***
1985-2000	16	0.88	1.59	0.71	3.28**	13.17***	3.28***
2001-2016	16	1.16	2.16	1.00	3.49***	6.44**	0.84
1970-2016	57	1.07	1.87	0.80	3.05***	39.43***	4.89***

Notes: N=Number of reports released. The tests are conducted using new crop futures returns. CBOT contracts are used for wheat. Additional results for KCBT wheat and MGEX wheat are not shown here but available from the authors upon request. Asterisks show statistical significance: *p<0.10, **p<0.05, ***p<0.01.

Table 6. Crop Market Reaction to Acreage Reports.

	N	Non-report day std. dev.	Report day std. dev.	Diff. of std. devs.	F-test	Brown Forsythe	Siegel–Tukey test
	Panel A: Corn						
1970-1984	10	1.57	1.72	0.15	1.20	0.12	1.09
1985-2000	16	1.92	2.23	0.32	1.36	0.41	1.23
2001-2016	16	2.12	4.33	2.22	4.19***	12.41***	3.36***
1970-2016	42	1.94	3.20	1.25	2.71***	18.16***	2.91***
	Panel B: Soybeans						
1970-1984	10	1.92	3.30	1.39	2.97*	11.02***	3.08***
1985-2000	16	2.03	2.47	0.44	1.48	1.42	1.30
2001-2016	16	1.89	3.50	1.62	3.45***	19.76***	3.65***
1970-2016	42	1.95	3.04	1.08	2.42***	25.19***	4.44***
	Panel C: Wheat						
1970-1984	10	1.90	2.10	0.20	1.22	0.05	0.11
1985-2000	16	1.69	1.83	0.14	1.17	0.13	1.23
2001-2016	16	1.99	3.92	1.93	3.88***	16.93***	2.45**
1970-2016	42	1.87	2.83	0.96	2.30***	6.86***	0.81
	Panel D: Cotton						
1970-1984	10	1.37	2.19	0.83	2.57	6.97***	2.34**
1985-2000	16	1.20	1.67	0.47	1.93	2.24	2.67***
2001-2016	16	1.53	2.58	1.05	2.84**	13.36***	3.43***
1970-2016	42	1.38	2.17	0.79	2.48***	26.48***	4.88***

Notes: N=Number of reports released. Acreage reports are released annually since 1975. The tests are conducted using new crop futures returns. CBOT contracts are used for wheat. Additional results for KCBT wheat and MGEX wheat are not shown here but available from the authors upon request. Asterisks show statistical significance: *p<0.10, **p<0.05, ***p<0.01.

Table 7. Crop market reaction to Crop Production reports

Report Group	N	Non-report day std. dev.	Report day std. dev.	Diff. of std. devs.	F-test	Brown Forsythe	Siegel–Tukey test
Panel A: Corn							
1970-1984	60	1.37	2.24	0.87	2.67***	45.45***	5.52***
1985-2000	64	1.10	1.92	0.82	3.04***	31.90***	3.76***
2001-2016	63	1.78	2.84	1.05	2.53***	37.07***	5.99***
2001-2008	32	1.74	3.16	1.42	3.30***	33.62***	5.52***
2009-2016	31	1.83	2.51	0.68	1.88**	7.43***	2.92***
1970-2016	187	1.44	2.35	0.91	2.65***	106.00***	8.80***
Panel B: Soybeans							
1970-1984	60	1.56	2.62	1.06	2.82***	62.29***	7.09***
1985-2000	64	1.15	2.07	0.92	3.24***	39.05***	4.02***
2001-2016	63	1.60	2.64	1.04	2.71***	34.70***	5.05***
2001-2008	32	1.70	2.76	1.06	2.63***	16.80***	3.64***
2009-2016	31	1.50	2.55	1.05	2.89***	18.28***	3.59***
1970-2016	187	1.45	2.45	1.00	2.85***	131.93***	9.27***
Panel C: Wheat							
1970-1984	60	1.73	2.20	0.47	1.62**	5.91**	2.14**
1985-2000	64	1.46	1.55	0.10	1.14	0.42	0.26
2001-2016	64	2.08	2.15	0.07	1.07	0.83	1.59
2001-2008	32	2.02	2.00	-0.02	1.02	0.16	1.10
2009-2016	32	2.14	2.24	0.10	1.10	0.76	1.33
1970-2016	188	1.77	2.00	0.22	1.27**	6.04**	2.36**
Panel D: Cotton							
1970-1984	93	1.20	1.66	0.47	1.93***	19.90***	3.27***
1985-2000	96	1.26	1.95	0.69	2.41***	47.63***	5.63***
2001-2016	94	1.69	2.17	0.48	1.66***	14.28***	3.68***
2001-2008	47	1.83	2.43	0.59	1.75**	12.10***	3.98***
2009-2016	47	1.51	1.90	0.40	1.59*	3.41*	1.44
1970-2016	283	1.40	1.93	0.54	1.92***	69.11***	7.31***
Panel E: Orange Juice							
1970-1984	173	1.64	2.82	1.18	2.94***	86.38***	6.35***
1985-2000	175	1.76	3.62	1.86	4.22***	32.71***	2.35**
2001-2016	175	1.88	2.76	0.88	2.15***	20.27***	2.67***
2001-2008	88	1.69	2.97	1.28	3.08***	18.60***	2.28**
2009-2016	87	2.06	2.54	0.48	1.52**	4.82**	1.60
1970-2016	523	1.77	3.10	1.33	3.07***	121.78***	6.56***

Notes: N=Number of reports released. The tests are conducted using new crop futures returns except for orange juice where nearby futures were used. CBOT contracts are used for wheat. Additional results for KCBT wheat and MGEX wheat are not shown here but available from the authors upon request. Asterisks show statistical significance: *p<0.10, **p<0.05, ***p<0.01.

Table 8. Crop market reaction to Crop Production Annual Summary and Small Grains Annual Summary reports.

	N	Non-report day std. dev.	Report day std. dev.	Diff. of std. devs.	F-test	Brown Forsythe test	Siegel–Tukey test
	Panel A: Corn						
1970-1984	15	1.10	1.27	0.18	1.35	0.57	0.94
1985-2000	16	0.96	2.24	1.28	5.49***	26.46***	4.06***
2001-2016	16	1.51	4.52	3.01	8.94***	64.93***	4.88***
1970-2016	47	1.21	3.00	1.78	6.10***	77.48***	5.48***
	Panel B: Soybeans						
1970-1984	15	1.46	2.13	0.67	2.14	2.37	0.54
1985-2000	16	0.87	1.98	1.11	5.22***	19.99***	2.45**
2001-2016	16	1.25	3.56	2.30	8.05***	58.30***	4.84***
1970-2016	47	1.21	2.63	1.42	4.72***	61.26***	4.55***
	Panel C: Wheat (reaction to CPAS)						
1970-1984	15	1.63	1.59	-0.04	1.05	0.41	0.91
1985-2000	16	1.10	1.72	0.61	2.42*	3.18*	1.41
2001-2016	16	1.59	4.07	2.48	6.55***	28.58***	3.48***
1970-2016	47	1.46	2.68	1.22	3.38***	17.55***	1.95*
	Panel D: Wheat (reaction to SGAS)						
1985-2000	7	1.30	2.62	1.32	4.07*	9.19***	3.11***
2001-2016	16	2.00	2.97	0.97	2.20*	3.50*	1.35
1970-2016	23	1.82	2.81	0.99	2.39**	8.95***	2.89***
	Panel E: Cotton						
1970-1984	15	1.38	1.16	-0.22	1.41	1.11	1.58
1985-2000	16	1.18	0.81	-0.37	2.11*	1.19	0.47
2001-2016	16	1.44	2.04	0.60	2.01	0.51	0.46
1970-2016	47	1.33	1.41	0.08	1.12	0.32	1.25

Notes: N=Number of reports released. The tests are conducted using new crop futures returns. CBOT contracts are used for wheat. Additional results for KCBT wheat and MGEX wheat are not shown here but available from the authors upon request. Asterisks show statistical significance: *p<0.10, **p<0.05, ***p<0.01.

Table 9. Crop market reaction to Grain Stocks reports

Report Group	N	Non-report day std. dev.	Report day std. dev.	Diff. of std. devs.	F-test	Brown Forsythe test	Siegel–Tukey test
Panel A: Corn							
1970-1984	62	1.22	1.77	0.54	2.09***	21.39***	3.91***
1985-2000	64	1.41	2.22	0.80	2.46***	26.27***	4.59***
2001-2016	64	1.75	4.14	2.39	5.57***	143.27***	8.18***
2001-2008	32	1.70	3.03	1.33	3.17***	28.39***	4.84***
2009-2016	32	1.81	5.07	3.26	7.83***	127.44***	6.66***
1970-2016	190	1.48	2.92	1.44	3.89***	176.43***	9.36***
Panel B: Soybeans							
1970-1984	62	1.69	2.09	0.40	1.53**	6.53**	2.38**
1985-2000	64	1.30	2.00	0.70	2.38***	27.14***	4.65***
2001-2016	64	1.52	2.88	1.36	3.60***	82.04***	7.47***
2001-2008	32	1.61	2.91	1.30	3.26***	24.13***	5.77***
2009-2016	32	1.43	2.88	1.45	4.08***	35.53***	4.70***
1970-2016	190	1.51	2.37	0.87	2.48***	98.53***	8.45***
Panel C: Wheat							
1970-1984	62	1.55	1.84	0.29	1.41*	4.13**	2.34**
1985-2000	65	1.49	2.14	0.65	2.07***	18.58***	3.76***
2001-2016	61	1.90	3.82	1.92	4.06***	75.27***	5.56***
2001-2008	32	1.93	3.42	1.49	3.14***	23.67***	3.42***
2009-2016	29	1.86	4.28	2.42	5.28***	56.61***	4.45***
1970-2016	190	1.64	2.72	1.08	2.74***	79.91***	6.31***

Notes: N=Number of reports released. The tests are conducted using nearby futures returns. CBOT contracts are used for wheat. Additional results for KCBT wheat and MGEX wheat are not shown here but available from the authors upon request. Asterisks show statistical significance: *p<0.10, **p<0.05, ***p<0.01.

Table 10. Livestock market reaction to relevant USDA reports.

Report Group	N	Non-report day std. dev.	Report day std. dev.	Diff. of std. devs.	F-test	Brown-Forsythe test	Siegel–Tukey test
Panel A: Live Cattle reaction to COF reports							
1970-1984	180	1.18	1.48	0.30	1.57***	22.24***	4.04***
1985-2000	192	0.82	1.08	0.26	1.73***	23.55***	3.69***
2001-2016	192	0.97	0.99	0.03	1.05	0.37	0.70
1970-2016	564	1.00	1.20	0.21	1.46***	34.36***	4.78***
Panel B: Live Cattle reaction HPR reports							
1970-1984	59	1.24	1.47	0.23	1.41*	6.44**	3.08***
1985-2000	64	0.82	1.05	0.22	1.62**	4.84**	1.30
2001-2016	86	1.02	1.18	0.16	1.33	1.39	0.46
1970-2016	209	1.03	1.23	0.19	1.41***	11.27***	2.74***
Panel C: Lean Hog reaction to COF reports							
1970-1984	180	1.60	1.70	0.09	1.12	1.07	0.83
1985-2000	192	1.35	1.43	0.07	1.11	0.39	0.32
2001-2016	192	1.49	1.42	-0.07	1.10	0.53	0.74
1970-2016	564	1.48	1.52	0.04	1.05	0.33	0.26
Panel D: Lean Hog reaction to HPR reports							
1970-1984	59	1.69	2.70	1.01	2.56***	66.86***	7.55***
1985-2000	64	1.26	2.46	1.20	3.82***	118.25***	8.41***
2001-2016	86	1.52	1.77	0.26	1.37*	5.25**	2.38**
1970-2016	209	1.50	2.30	0.80	2.36***	138.74***	10.52***

Notes: COF=Cattle on Feed, HPR=Hogs and Pigs reports. N=Number of reports released. The tests are conducted using nearby futures returns. Asterisks show statistical significance: *p<0.10, **p<0.05,

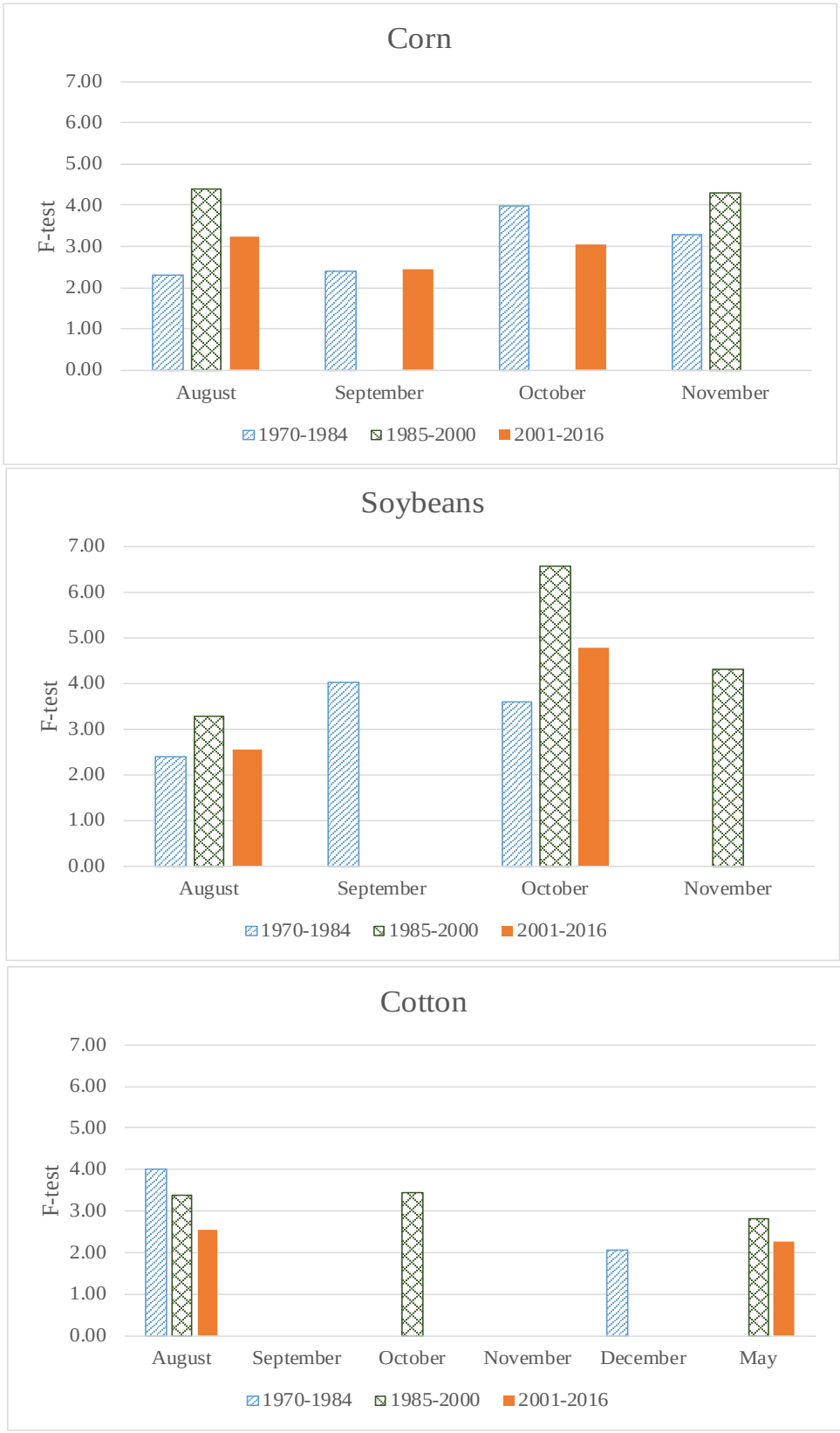

Figure 1. Changes in crop market reaction to crop production reports.

Note: The bars represent the ratios of report day variance to non-report day variance.

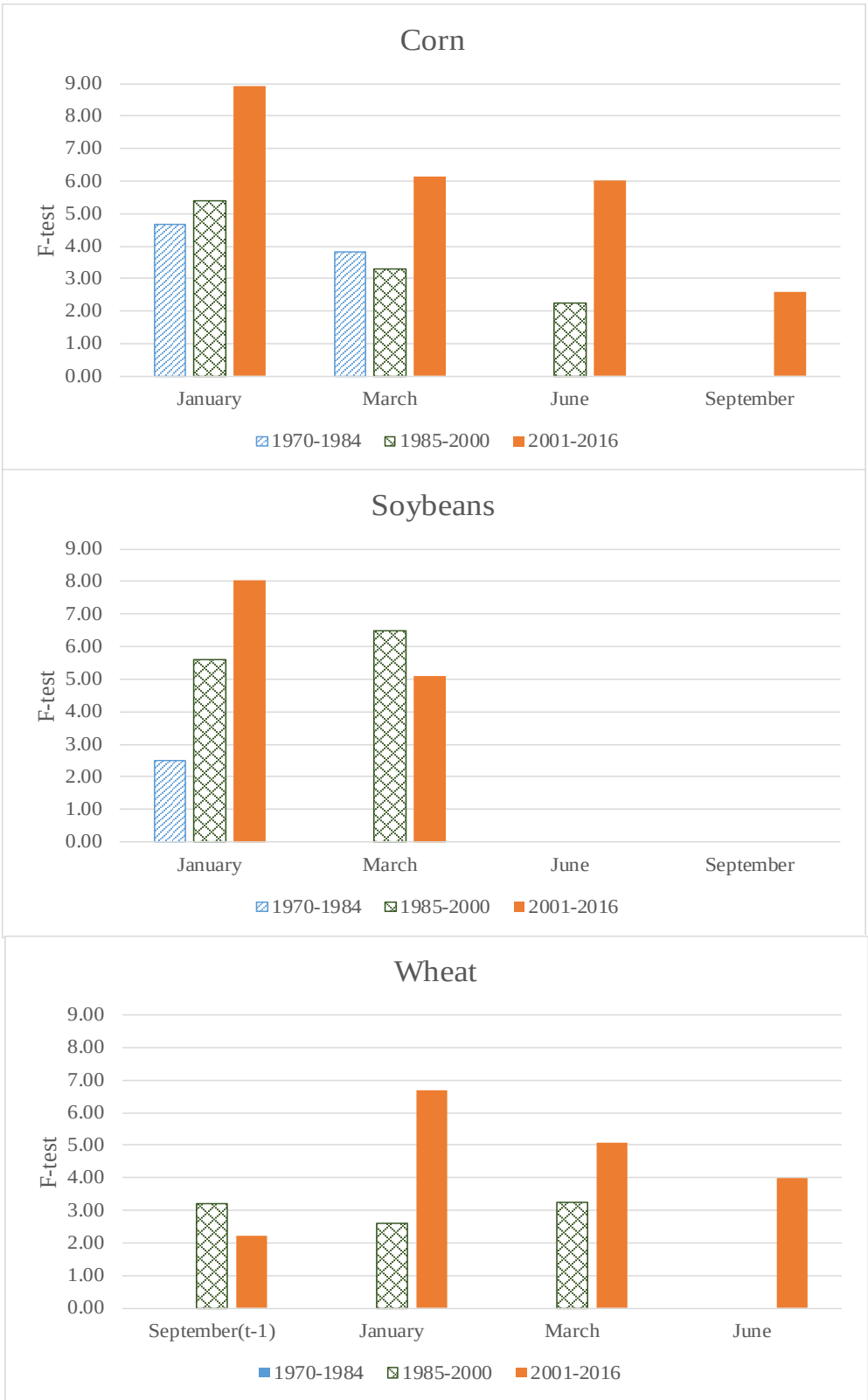

Figure 2. Changes in crop market reaction to Grain Stocks reports, 1970-2016.
Note: The bars represent the ratios of report day variance to non-report day variance. The release schedule has changed over time with early forecasts released in January, April, July and October.

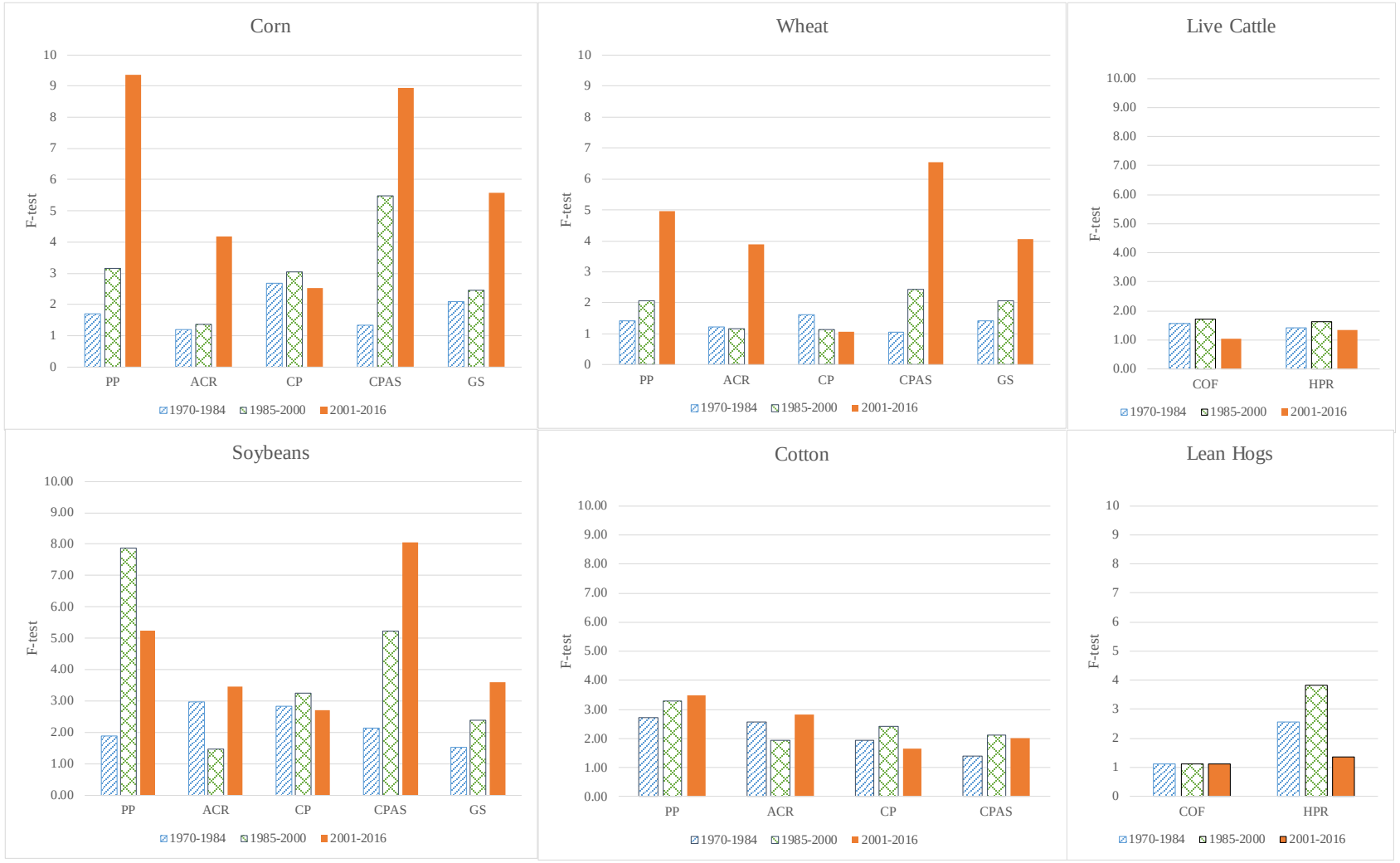

Figure 3. Commodity market reaction to USDA reports, 1970-2016.

Note: The bars represent the ratios of report day variance to non-report day variance. PP= Prospective Plantings, ACR=Acreage, CP=Crop Production, CPAS=Crop Production Annual Summary, GS=Grain Stocks, COF=Cattle on Feed, HPR=Hogs and Pigs report.