Journal of Agricultural and Resource Economics 44(3):591–604
ISSN 1068-5502

doi: 10.22004/ag.econ.292333

The Changing Role of USDA Inventory Reports in Livestock Markets

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Using traditional price volatility tests, we find that the market impact of USDA *Cattle on Feed* and *Hogs and Pigs* reports largely disappeared after 2000. In contrast, using market surprise tests, we find no evidence that the impact of *Cattle on Feed* information changed significantly after 2000. The evidence is mixed for *Hogs and Pigs* reports using market surprise tests, with market inventory information increasing in value and breeding inventory decreasing. The contrasting results can be explained by increasing market concentration in cattle and hogs leading to smaller market surprises and smaller futures price reactions.

Key words: announcement effects, cattle, concentration, futures markets, hogs, informational value, price reaction

Introduction

Traditional wisdom says that public information in agricultural markets helps facilitate efficiently functioning markets, reduce information asymmetries, and inform policy and program formation, operation and evaluation processes (Council on Food, Agricultural and Resource Economics, 2013). U.S. Department of Agriculture (USDA) reports have been the predominant source of public information in crop and livestock markets. A large body of literature (e.g., Sumner and Mueller, 1989; Fortenbery and Summer, 1993; Grunewald, McNulty, and Biere, 1993; Garcia et al., 1997; Isengildina, Irwin, and Good, 2006; McKenzie, 2008; Karali, 2012) shows that these reports generally contain substantial informational value. The bulk of the studies in this literature test for informational value using a traditional event study approach, comparing price volatility on report release and nonreport days. If market prices are more volatile on report release days, this indicates that the information impacts market prices (e.g., Campbell, Lo, and MacKinlay, 1997).

A recent study by Isengildina-Massa et al. (2016) finds that the market impact of USDA inventory reports in livestock markets decreased substantially in the last 15 years, while the impact of inventory and production reports in crop markets generally increased during the same period. The authors of the study argue that the decrease in market impact in livestock markets was likely not due to the emergence of new information sources such as satellite imagery and precision agriculture. Instead, the authors argue that livestock markets underwent substantial structural changes starting in the 1990s due to increased vertical integration in the supply chain; this was likely the primary driver of changes in livestock market reaction to USDA inventory reports.

The U.S. livestock sector has in fact been particularly affected by the movement toward greater consolidation. The four-firm concentration ratio (CR4), which measures the four largest firms' share in total slaughter, increased from 36% in 1980 to 85% in 2012 for steers and heifers and from

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Review coordinated by Dragan Miljkovic.

34% to 64% for hogs (MacDonald, 2017).[1]. One of the outcomes of highly concentrated markets is lower variability and higher predictability of supply, as vertically coordinated companies have more control over planning production in their operations. In this environment, USDA reports of livestock inventories would presumably be less valuable.

While the logic of the market concentration explanation for declining price reaction to USDA livestock reports is compelling, this does not necessarily imply that the informational value of these reports has disappeared completely. It is possible that markets continue to react to the information contained in the reports but that the reaction cannot be identified with the relatively simple price volatility tests used in much of the literature, including the Isengildina-Massa et al. (2016) study. The value of USDA information can be estimated more precisely by directly measuring informational content using "market surprise," which is the difference between USDA estimates and private analysts' expectations. As long as data on market expectations for USDA reports are available, this approach allows a better identification of new information contained in the reports and the response of market price to USDA reports (e.g., Colling and Irwin, 1990; Grunewald, McNulty, and Biere, 1993; Garcia et al., 1997).

In light of this discussion, the current study evaluates changes in the market impact of USDA inventory reports in livestock markets using both price volatility and market surprise tests. We focus on the impact of *Cattle on Feed* and *Hogs and Pigs* reports, which have historically played a key role in livestock markets and have been widely watched by market participants.[2] The sample period is 1977–2016 for cattle and 1982–2016 for hogs. The market response to release of these reports is estimated in two ways: using (i) the ratio of futures return variance on report versus nonreport days and (ii) a generalized autoregressive conditional heteroskedasticity (GARCH) model of the relationship between futures returns and market surprises. Further, we compare market response across pre- and post-2000 subperiods and estimate 10-year rolling GARCH models for a more detailed comparison in order to assess our hypothesis that the value of USDA information has decreased over time as markets have become more vertically integrated and concentrated.

Using traditional price volatility tests, we find that the market impact of USDA *Cattle on Feed* and *Hogs and Pigs* reports largely disappeared after 2000. In contrast, using market surprise tests, we find no evidence that the impact of *Cattle on Feed* information changed significantly after 2000. The evidence is mixed for *Hogs and Pigs* reports using market surprise tests, with market inventory information increasing in value and breeding inventory decreasing. The contrasting results across market impact tests can be explained by the fact that price reaction per unit of market surprise generally did not change; rather, the magnitude of market surprises decreased. The end result is that increased market concentration in cattle and hog markets may have led to smaller market surprises and smaller futures price reactions.

Data

We use daily data for nearby futures contracts of live cattle and lean hogs, both of which are traded at the Chicago Mercantile Exchange (CME). To match the availability of private analysts' forecasts, we collect futures data starting in 1977 for live cattle and 1982 for lean hogs. The hog series uses live hog futures prices through November 1996 and lean hog futures prices from December 1996 onward. Nearby series are constructed by rolling over to the second closest to expiration contract

[1] Further, while there were 145 steer and heifer slaughtering plants in 1975–1976, with the five largest plants having a 14.8% share in total slaughter, there were only 36 plants in 2006–2007, with the 14 largest plants having a 70.2% share (Ward, 2010). Similarly, 235,000 hog farms maintained 67% of total hog inventories and 87% of hogs were sold via spot markets in 1993, in 2009–2010, there were 63,000 farms with a 43% share of hog inventories and only 8% of hogs were sold through spot markets (Lawrence, 2010)

[2] The surveys by Pruitt et al. (2012, 2013), for instance, show that while livestock extension agents ranked *Cattle on Feed* as the second and *Hogs and Pigs* as the eighth most useful report, market analysts and/or agribusiness professionals regarded *Cattle on Feed* as valuable and *Hogs and Pigs* as more valuable.

once that next contract has a trade volume exceeding the nearest delivery contract. Due to relatively low trading volume, we eliminate the May contract for lean hogs.

Futures contracts are subject to daily price limits from the previous day's settlement price, and they therefore mask the true price reaction by making the free market equilibrium price no longer observable.[3] Livestock futures contracts, especially lean hogs, experienced several trading days that were subject to a limit hit in the past. Therefore, to measure the true price reaction to market surprises, we compute the price difference from the day preceding the report release (if it was not subject to a limit hit) to the first nonlimit move day (if the report day was subject to a limit hit).

Cattle on Feed reports are published monthly by the National Agricultural Statistics Service (NASS) agency of the USDA and contain data on the total number of cattle and calves on feed, placements, marketings, and other disappearances. These reported categories are closely related, as on-feed inventory numbers are stocks at a particular point in time, placements are additions to these stocks, and marketings and other disappearances are reductions in these stocks. Therefore, the difference between the on-feed numbers from the beginning of one month to the next reflects the on-feed inventory from the previous month, plus placements, less marketings and other disappearances (Mark and Small, 2007). The reports are typically released at 3:00 pm EST on the third Friday of the month and contain data as of the beginning of the month.[4] The information in these reports is based on the survey of feedlots in major cattle-feeding states in the United States,[5] representing about 98% of total U.S. production.[6]

Hogs and Pigs reports are also prepared by NASS and released quarterly. The two main inventory categories are breeding herd and market hogs. The reports are typically released at 3:00 pm EST on Friday near the end of March, June, September, and December and present inventory data as of the first day of the month and the previous and future quarters.[7] Inventory estimates in these reports are for the major hog-producing states,[8] which account for about 95% of total U.S. production. The reports also aggregate the remaining states to generate the U.S. total, thereby providing the most comprehensive publicly available estimates of current and future hog supplies (Small, Waterbury, and Mark, 2007).

Industry analysts' estimates, which are usually released a few days before the USDA reports, have traditionally been used as a proxy for market expectations of government reports (e.g., Colling and Irwin, 1990; Grunewald, McNulty, and Biere, 1993; Garcia et al., 1997; Egelkraut et al., 2003; Frank, Garcia, and Irwin, 2008). Private analysts' expectations for *Cattle on Feed* reports, available starting in 1977, are obtained from Knight Ridder Wire Service and Bridge Wire Service for 1977–2000 and from Oster Dow Jones and Dow Jones for 2000–2016. The expectations are reported as the average trade estimate of cattle on feed, placements, and marketings for the current quarter as a percentage of the comparable month a year ago. Private analysts' expectations of *Hogs and Pigs* reports, available from 1982, are obtained from various sources: Futures World News for 1982–1991, Knight Ridder Wire Service for 1992–2000, Reuters (Bridge) and Dow Jones Newswire for 2000–2004 and December 2006, Dow Jones Newswire for 2005–2013, and Urner Barry for 2015–2016.

[3] The price limit for live cattle futures during our study period was $1.50/cwt until 2004 and increased to $3.00/cwt after 2014. The limit for lean hogs was $1.50/cwt until 1995, $2.00/cwt during 1995–2006, and increased to $3.00/cwt thereafter.

[4] There were two exceptions due to USDA's release schedule before the holidays. The *Cattle on Feed* report for December 2005 was released at 1:00 pm EST, and the May 2015 and December 2016 reports were released at 12:00 pm EST.

[5] The USDA's definition of feedlots included in the survey has changed over time. The dataset is composed of inventory levels in all feedlots in seven states through December 1994, the feedlots in seven states with at least 1,000 head of cattle from January 1995 to October 1998, and 1,000+ capacity U.S. feedlots thereafter.

[6] For more information, see Mark and Small (2007).

[7] The December 2011 *Hogs and Pigs* report was released at 1:00 pm EST, and the March and December 2016 reports were released at 12:00 pm EST due to the USDA's release schedule before the holidays. The release schedule of *Hogs and Pigs* report changed to monthly from January 2001 through September 2003, after which the quarterly schedule was resumed. We only include quarterly reports in our study.

[8] The USDA's definition of major states has changed over time, as some states have experienced a great expansion of hog production while others have become less important in the hog industry. The dataset is composed of 14 states through March 1982, 10 states from June 1982 to March 1996, 17 states from June 1996 to September 2009, and 16 states thereafter.

The expectations are reported as the average trade estimate of the breeding and marketing inventory for the current quarter as a percentage of the comparable quarter a year ago. For both reports, we multiply year-ago inventory levels by the analysts' expected percentage of year-ago figures. This provides us the market analysts' expectations in terms of the number of cattle and hogs, making them comparable to USDA figures.

Market Impact Tests

The first test of market impact we consider is the volatility response in livestock futures markets on report days versus nonreport days, which is the traditional event study approach. The main premise of the price volatility tests is that the USDA reports have value for the market if futures prices change significantly in response to report release, but they have no value if futures prices do not change (e.g., Campbell, Lo, and MacKinlay, 1997). We define $\Delta P_t = 100 \times (\ln P_t - \ln P_{t-1})$ as the percentage change in a futures contract's settlement price from day $t-1$ to day t and compute the variance of price changes on report and all nonreport days. The ratio of the variances is reported as an F-test in Table 1, and these tests demonstrate that live cattle futures reaction to *Cattle on Feed* reports was large and highly significant in 1977–1999, with price volatility on report release days 1.62 times greater than volatility on nonreport days. In contrast, price volatility on report release days for the 2000–2016 subperiod is only 1.08 times greater than volatility on nonreport days and statistically insignificant. Lean hog futures reaction to *Hogs and Pigs* reports is very large and highly significant over 1982–1999, with a report/nonreport volatility ratio of 2.74. During 2000–2016, the ratio fell to 1.34 and retained statistical significance, but only at the 10% level. These results are similar to those found in the Isengildina-Massa et al. (2016) study and suggest that the market impact of USDA *Cattle on Feed* and *Hogs and Pigs* reports largely disappeared after 2000.

The second test of market impact that we consider is based on the response of prices to the unanticipated component of new information measured in terms of market surprise (e.g., Colling and Irwin, 1990; Garcia et al., 1997). Hence, these tests measure the magnitude of price reaction per unit of market surprise. To allow for time-varying volatility observed in futures prices, we specify the following GARCH system:

$$
\begin{aligned}
\Delta P_t &= \mu + \sum_{k=1}^{K} \lambda^k Surprise_t^k + \gamma TrendDev_t + \sum_{p=1}^{P} \delta_p \Delta P_{t-p} + \varepsilon_t, \\
\varepsilon_t &= \sigma_t z_t, \\
\sigma_t^2 &= \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2,
\end{aligned}
\tag{1}
$$

where ΔP_t is once again the percentage change in a futures contract's settlement price from day $t-1$ to day t, ε_t is the regression error term, and z_t is a standard normal random variable. The variable $Surprise_t^k$ is defined as the percentage difference between the USDA's ($q_t^{k,U}$) and private analysts' forecasts ($q_t^{k,P}$) for category k in a report on day t,

$$
Surprise_t^k = 100 \times \left(\ln q_t^{k,U} - \ln q_t^{k,P} \right), \tag{2}
$$

and takes the value of 0 on nonreport days.[9] Thus, the coefficients λ^k measure the price reaction per unit of market surprise (%). The variable $TrendDev_t$ represents percentage deviation of the USDA's estimate ($q_t^{k,U}$) from a quadratic trend in inventories before 2000 and a linear trend after 2000.[10] The lagged values of the dependent variable in the conditional mean equation are included to account for serial correlation in the daily futures price changes.

[9] The market surprise variable takes its corresponding value on the exact announcement day for reports released before or during trading hours and on the following trading day for reports released after trading hours.

[10] Trend is estimated for each report month separately. In-sample deviations from trend are calculated as the difference between the USDA's figure in a given report and the forecast for that month obtained from the trend models.

Table 1. Livestock Futures Returns on Report-Release and Nonreport Days

		All Days			Report Days			Nonreport Days			Variance Ratio	
	Period	**Mean**	**Std. Dev.**	***N***	**Mean**	**Std. Dev.**	***N***	**Mean**	**Std. Dev.**	***N***	***F*-test**	***p*-value**
Cattle	1977–2016	0.01	0.97	10,087	-0.01	1.15	480	0.01	0.96	9,607	1.41	0.00***
	1977–1999	0.02	0.99	5,808	-0.13	1.24	276	0.03	0.98	5,532	1.62	0.00***
	2000–2016	0.00	0.95	4,279	0.14	0.98	204	0.00	0.95	4,075	1.08	0.43
Hogs	1982–2016	0.00	1.46	8,828	0.23	2.05	140	-0.01	1.45	8,688	2.01	0.00***
	1982–1999	0.02	1.43	4,549	0.29	2.33	72	0.01	1.41	4,477	2.74	0.00***
	2000–2016	-0.02	1.49	4,279	0.16	1.72	68	-0.03	1.48	4,211	1.34	0.07*

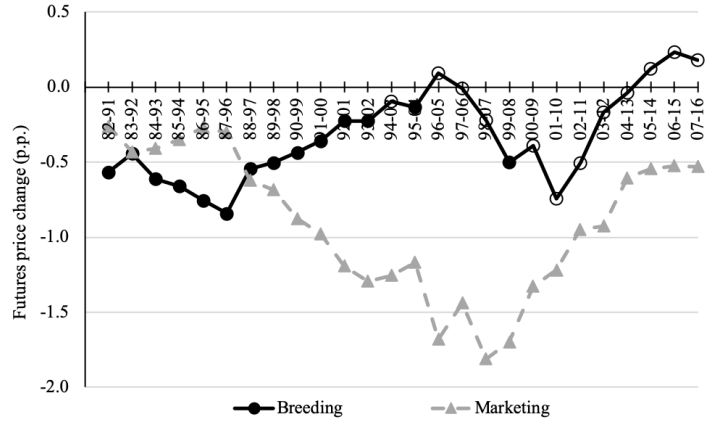
Notes: The null hypothesis of the *F*-test is the unity of the return variance ratio (report vs. nonreport days). Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Table 2. Price Reaction Test of the Informational Value of Cattle on Feed Reports in Live Cattle Futures Market ($N = 10,087$)

	1	2	
	Coefficient (Std. Err.)	**Coefficient (Std. Err.)**	**Equality Test χ^2 (p-value)**
Mean Equation			
On Feed	0.011		
	(0.058)		
$\text{On Feed}_{\text{Pre-2000}}$		0.018	
		(0.065)	
$\text{On Feed}_{\text{Post-2000}}$		−0.210	1.72
		(0.161)	[0.19]
Placed	−0.042***		
	(0.014)		
$\text{Placed}_{\text{Pre-2000}}$		−0.032**	
		(0.017)	
$\text{Placed}_{\text{Post-2000}}$		−0.036	0.01
		(0.030)	[0.93]
Marketed	0.102***		
	(0.016)		
$\text{Marketed}_{\text{Pre-2000}}$		0.096***	
		(0.018)	
$\text{Marketed}_{\text{Post-2000}}$		0.102**	0.01
		(0.049)	[0.91]
Trend Deviation	0.003	0.003	
	(0.007)	(0.007)	
Constant	0.019**	0.018**	
	(0.009)	(0.009)	
Variance Equation			
ARCH	0.043***	0.043***	
	(0.003)	(0.003)	
GARCH	0.951***	0.951***	
	(0.003)	(0.003)	
Constant	0.005***	0.005***	
	(0.001)	(0.001)	
Log-likelihood	−13,246.94	−13,242.03	
AIC	26,519.88	26,516.06	
BIC	26,613.73	26,631.56	

Notes: Results are obtained from AR(5)-GARCH(1,1) estimation. Full sample period is 1977–2016. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

(a) Cattle



(b) Hogs

Figure 1. Livestock Futures Price Reactions to per Unit Surprises in USDA Reports over Time

To assess changes in reaction to market surprises in USDA livestock reports, we performed Chow structural break tests by regressing the futures return series on an intercept, each of the surprise variables, and trend deviation variable, allowing all surprise coefficients to vary across pre- and post-2000 possible regimes. Based on the results confirming a break in 2000,[11] we interact all the surprise variables in the conditional mean equation in system (1), using subperiod dummy variables to examine differences in price reaction to market surprises across subperiods. In addition, changes in price reaction over time are demonstrated by estimating the GARCH system (1) with a 10-year rolling window by dropping the earliest calendar year and adding the newest one as we move forward in time.

Table 2 reports full sample results for live cattle. Column 1 presents the estimates obtained by using the full sample period and column 2 shows the results obtained by interacting surprise variables with the pre- and post-2000 period dummy variables.[12] The results indicate a negative reaction to placement surprises, a positive reaction to marketing surprises, and no significant reaction to on-feed surprises. Since cattle on-feed values illustrate the levels of supply available at a point in time

[11] The χ^2 statistics are 9.30 with a p-value of 0.03 for cattle and 6.38 with a p-value of 0.04 for hogs.

[12] The length of autoregressive lags, p, is set to 5 for both commodities in all estimations. Their parameter estimates, δ_p, are not included in the tables to save space but are available from the authors.

and placements reflect additions to cattle supply (Mark and Small, 2007), all else equal, positive surprises in both categories will result in lower prices. Cattle marketings, on the other hand, reflect reductions in supply, and positive surprises therefore result in higher prices.

Our findings show that market surprises associated with cattle inventories on feed do not cause a significant price reaction, both for the full sample as well as subsamples. The magnitude of estimated coefficient for cattle placements surprise is small (−0.042) and statistically significant for the entire sample but insignificant in the post-2000 subperiod.[13] The only information in *Cattle on Feed* reports that causes consistent price reaction is associated with the amount of cattle marketed. Full sample results indicate that when the USDA's cattle marketing estimates are 1% higher than expected, live cattle prices increase by about 0.102 percentage points, with the same magnitude of reaction occurring in the post-2000 subperiod and a slightly smaller reaction of 0.096 percentage points during the earlier subperiod. This observation is confirmed by the Wald test reported in the last column of Table 2, which examines statistical differences in the estimates across subperiods and shows lack of significant differences in market reaction to marketed surprise.

Figure 1(a) shows price reaction estimates for live cattle from rolling GARCH regressions.[14] The plot demonstrates that the magnitude of cattle price reaction to on-feed surprise increased dramatically during 1997–2007 and 2003–2013. Even though the coefficient estimated for the 2000–2016 subperiod in Table 2 suggests that a 1% increase in on-feed surprise results in an 0.210-percentage-point drop in live cattle futures prices, the estimate is statistically insignificant. Cattle price reaction to placed and marketed surprises appear stable over time, with a very small reaction to placed surprises and a larger reaction to marketed surprises, consistent with subperiod analysis.

Full sample results for hogs in Table 3 suggest that increases in both breeding and marketing herd surprise by 1% result in an average decrease of 0.495 percentage points in hog futures prices. Small, Waterbury, and Mark (2007, p. 2) discuss that

> an increase in market hog inventory would indicate future increases in hog slaughter and pork supplies. This would cause prices to decrease, everything else held constant.... Market analysts can use the information in the report related to breeding herd inventory and average litter size to make long-term price forecasts based on expected expansions and contractions in pork production.

Thus, a larger-than-expected inventory level (positive surprise) in either category would cause hog prices to drop. The subperiod results indicate that the market reaction to breeding inventory surprise is significant only in the earlier part of the sample (1982–2000). The Wald test result in the last column of the table shows that the price responses to breeding inventory surprises in the first and second subperiods are statistically different from each other, supporting the pattern found in Figure 1(b). The subperiod findings for market hog surprises, on the other hand, show statistically larger price response in magnitude after 2000. For a 1% increase in marketing hog surprise, lean hog futures prices decrease by 0.421 percentage points before 2000 and by 0.754 percentage points after 2000. Figure 1(b) suggests that market reaction to market hog inventory surprise increased through 2007, reaching −1.810 percentage points over 1998–2007, and decreased thereafter. The market reaction to hog breeding herd surprise exhibits a mirror-image to that of market hog surprise through 2005. However, the reaction diminished starting with the 1995–2005 subperiod, except for 1999–2008.

In sum, the results of the market impact tests present an interesting contrast. On one hand, using traditional price volatility tests we find, similar to Isengildina-Massa et al. (2016), that the market impact of USDA *Cattle on Feed* and *Hogs and Pigs* reports largely disappeared after 2000. On the other hand, using market surprise tests we find no evidence that the impact of *Cattle on Feed* information changed significantly after 2000. The evidence is mixed for *Hogs and Pigs* reports using market surprise tests, with market inventory information increasing in value and breeding inventory

[13] However, the Wald test result suggests that there is no significant difference between the pre- and post-2000 subperiods.

[14] Coefficient estimates that are statistically significant at the 10% level are plotted with a filled marker symbol and insignificant estimates are indicated with an open marker.

Table 3. Price Reaction Test of the Informational Value of Hogs and Pigs Reports in Lean Hogs Futures Market ($N = 8,828$)

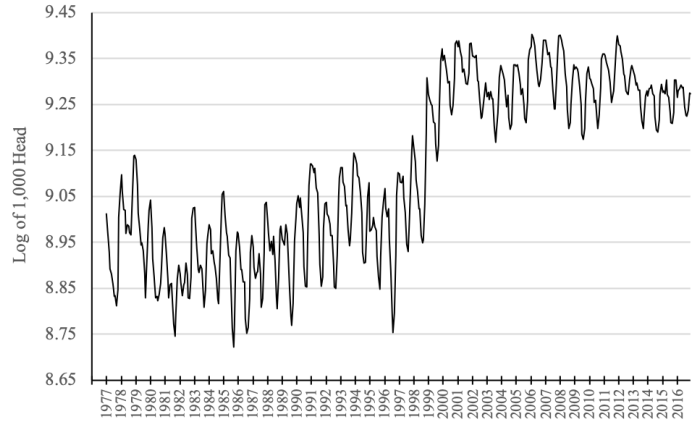
	1	2	
	Coefficient (Std. Err.)	Coefficient (Std. Err.)	Equality Test χ^2 (p-value)
Mean Equation			
Breeding	−0.495***		
	(0.048)		
$\text{Breeding}_{\text{Pre-2000}}$		−0.561***	
		(0.048)	
$\text{Breeding}_{\text{Post-2000}}$		−0.060	5.68**
		(0.206)	[0.02]
Marketing	−0.495***		
	(0.054)		
$\text{Marketing}_{\text{Pre-2000}}$		−0.421***	
		(0.057)	
$\text{Marketing}_{\text{Post-2000}}$		−0.754***	3.09*
		(0.182)	[0.08]
Trend Deviation	−0.011	−0.008	
	(0.034)	(0.035)	
Constant	0.005	0.005	
	(0.015)	(0.015)	
Variance Equation			
ARCH	0.043***	0.042***	
	(0.003)	(0.003)	
GARCH	0.945***	0.945***	
	(0.005)	(0.005)	
Constant	0.025***	0.025***	
	(0.004)	(0.004)	
Log likelihood	−15,287.10	−15,284.17	
AIC	30,598.20	30,596.34	
BIC	30,683.23	30,695.54	

Notes: Results are obtained from AR(5)-GARCH(1,1) estimation. Full sample period is 1982–2016. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

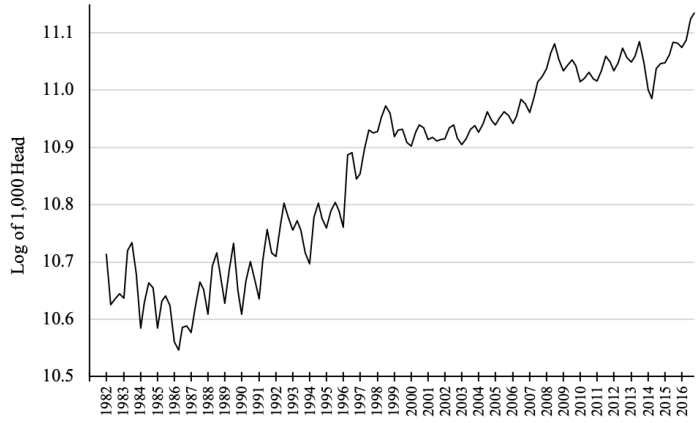
decreasing. These results confirm that market surprise tests are more powerful in detecting market impact than traditional price volatility tests, which is sensible because market surprise tests use more information.

Reconciling the Market Impact Test Results

We know from the results in the previous section that post-2000, (i) price volatility on release days for *Cattle on Feed* and *Hogs and Pigs* reports was generally not significantly different from nonreport days; and (ii) live cattle and lean hog futures prices continued to react to the surprise component in the two reports. The first clue to resolving this seeming contradiction is



(a) Cattle Inventories



(b) Hog Inventories

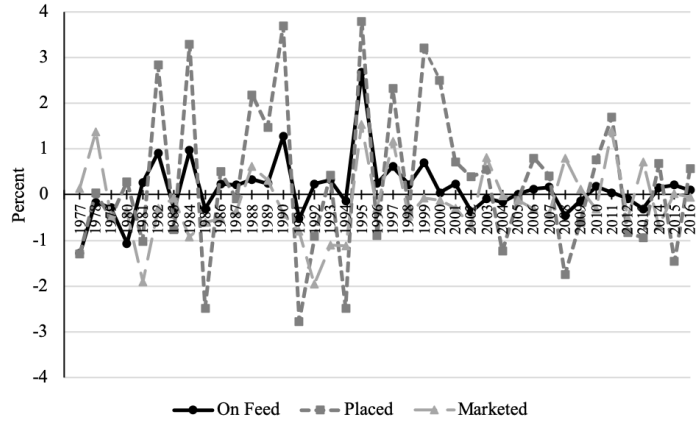
Figure 2. Livestock Inventories over Time

found in Figure 2, which highlights the sharp decrease in volatility of cattle and hog inventories starting around 2000, immediately following the spike in market concentration in these industries.[15] The mean and standard deviation of cattle inventories (in logs) are 8.97 and 0.12 before 2000, respectively, and 9.30 and 0.06 after 2000. For hog inventories (in logs), the mean and standard deviation are 10.73 and 0.11, respectively, before 2000 and 11.00 and 0.06 after 2000. For both cattle and hogs, the equality of means and variances across subperiods is strongly rejected with the *t*-test with Welch adjustment and with the Brown–Forsythe *F*-test, respectively, indicating larger and less variable inventories in the post-2000 period.[16] This decrease in supply variability coincides with the decrease in price volatility following the release of USDA *Cattle on Feed* and *Hogs and Pigs* reports.

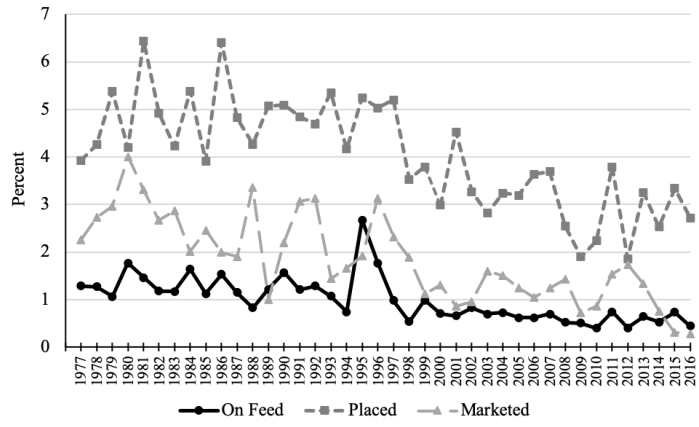
We now turn to the behavior of the market surprises for the USDA reports. Figures 3 and 4 illustrate the patterns in average surprises and average absolute surprises for cattle and hogs,

[15] Cattle inventories refer to the number of cattle on feed, and hog inventories refer to the total number of breeding and marketing hogs.

[16] Welch's (1947) adjustment of the *t*-test relaxes the assumption of equal variances across samples and can be used to compare means of subperiods with unequal variances. The Brown–Forsythe test is based on the analysis of variance (ANOVA) of the absolute median differences; it is a modification of Levene's *F*-test which evaluates absolute mean differences in ANOVA and has been shown to perform better in terms of robustness and power in previous studies (e.g., Neter et al., 1996).



(a) Surprise

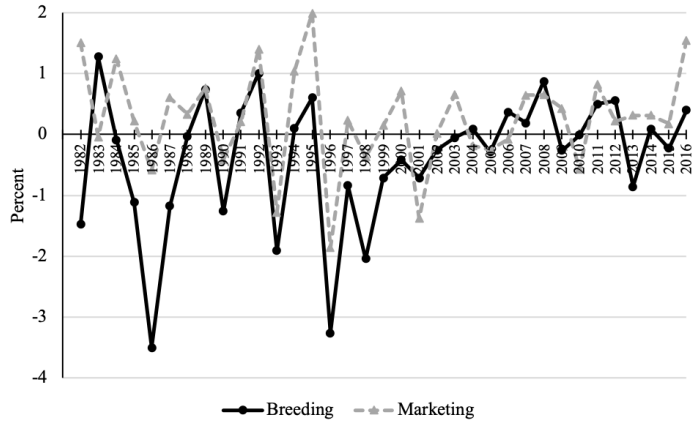


(b) Absolute Surprise

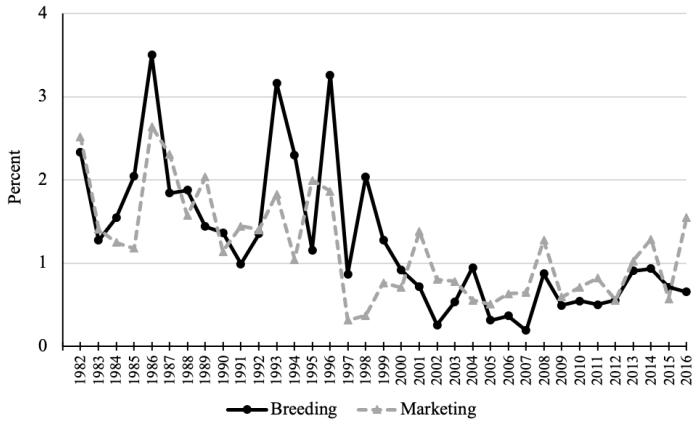
Figure 3. Average Annual Market Surprises in *Cattle on Feed* Reports

respectively. Figure 3 shows that cattle placements estimates had the largest surprises throughout the study period, while the magnitudes of surprise for cattle marketed and on-feed estimates were much smaller. It appears that average surprises approached 0 in the 2000s, following structural changes that took place in the cattle market. This pattern is also captured in absolute surprises, which tend to decrease in magnitude in the 2000s across all three categories. Similar patterns are observed for hogs (Figure 4), with the magnitude of surprises diminishing in the 2000s. Differently from cattle, there appears to be a tendency to overestimate breeding inventory estimates in the earlier part of the sample, which seems to have been subsequently corrected.

To assess changes in the magnitude of market surprise and its variability over time, Table 4 reports differences in average absolute surprises and differences in their variances across subperiods using the *t*-test with Welch adjustment and the Brown–Forsythe test, respectively. Consistent with the patterns observed in Figures 3 and 4, the means and variances for the two subsamples are significantly different for each surprise category, dropping 0.66–1.79 percentage points across various categories from the earlier to the later part of the sample. The average magnitude of cattle on-feed surprises declined by 0.66 percentage points, from 1.28% to 0.62%. A larger decrease is observed in the magnitude of cattle marketed surprises, a 1.25-percentage-point decrease, from 2.35% to 1.10%. Cattle placement surprises decreased in magnitude by an even larger amount—1.79 percentage points—from 4.82% to 3.03%. In hogs, breeding surprises decreased by 1.26 percentage



(a) Surprise



(b) Absolute Surprise

Figure 4. Average Annual Market Surprises in *Hogs and Pigs* Reports

points, from 1.87% before 2000 to 0.61% post-2000. The decrease in hog marketing surprises, from 1.50% to 0.85%, is more modest at 0.66 percentage points. These findings indicate that the information shocks from the USDA *Cattle on Feed* and *Hogs and Pigs* reports decreased after 2000.

These results allow us to reconcile the seemingly contradictory market impact test results, with price volatility on report release days decreasing after 2000 and live cattle and lean hog futures markets continuing to react to the release of reports. The key is that price reaction per unit of market surprise generally did not change; rather, the magnitude of market surprises decreased as analysts were able to better anticipate USDA information. The end result is that surprises and price reactions became smaller after 2000, coinciding with a period of increased market concentration in cattle and hogs.

Summary and Conclusions

This study evaluated changes in the market impact of USDA inventory reports in livestock markets using both price volatility and market surprise tests. We focus on the impact of *Cattle on Feed* and *Hogs and Pigs* reports, which have historically played a key role in livestock markets and have been widely watched by market participants. The sample period is 1977–2016 for cattle and 1982–2016 for hogs. Using traditional price volatility tests, we find that the market impact of USDA *Cattle on*

Table 4. Tests for Equality of Absolute Surprises between Pre-2000 and Post-2000 Subperiods

		Full Sample	Pre-2000	Post-2000	Equality Test	*p*-value
Cattle						
On-feed	Mean	0.98	1.28	0.62	8.65	0.00***
	Std. dev.	0.92	1.06	0.52	41.07	0.00***
	N	454	250	204		
Placed	Mean	4.02	4.82	3.03	6.04	0.00***
	Std. dev.	3.39	3.84	2.42	20.61	0.00***
	N	454	250	204		
Marketed	Mean	1.79	2.35	1.10	9.11	0.00***
	Std. dev.	1.66	1.87	1.01	67.53	0.00***
	N	454	250	204		
Hogs						
Breeding	Mean	1.26	1.87	0.61	6.33	0.00***
	Std. dev.	1.35	1.61	0.47	28.20	0.00***
	N	140	72	68		
Marketing	Mean	1.18	1.50	0.85	4.05	0.00***
	Std. dev.	1.03	1.25	0.56	22.47	0.00***
	N	140	72	68		

Notes: Equality tests are conducted for the absolute value of variables to measure the differences in magnitude between subperiods. The equality of means is tested by the *t*-test with Welch adjustment allowing for unequal variances across subperiods. The equality of variances is tested by the Brown–Forsythe *F*-test. Full sample period is 1977–2016 for cattle and 1982–2016 for hogs. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level.

Feed and *Hogs and Pigs* reports largely disappeared after 2000. In contrast, using market surprise tests, we find no evidence that the impact of *Cattle on Feed* information changed significantly after 2000. The evidence using market surprise tests is mixed for *Hogs and Pigs* reports, with market inventory information increasing in value and breeding inventory decreasing. These results confirm that market surprise tests are more powerful in detecting market impact than traditional price volatility tests, which is sensible because market surprise tests use more information.

We conducted additional analyses to determine why price volatility on report release days decreased after 2000 despite the fact that live cattle and lean hog futures markets continued to react to information contained in the reports. The key is that price reaction per unit of market surprise generally did not change; rather, the magnitude of market surprises decreased. We posit that market analysts were better able to anticipate USDA information in more concentrated and less variable cattle and hog markets (in terms of inventories). The end result was that increased market concentration in cattle and hogs led to smaller market surprises and smaller futures price reactions.

What conclusion should be reached regarding the informational value of USDA *Cattle on Feed* and *Hogs and Pigs* reports in concentrated livestock markets? The decline in price volatility reaction to report releases indicates that the reports do not move the cattle and hog markets as much after 2000 as before, which implies a clear decline of informational value. However, more powerful tests provide evidence that the reports continue to impact market prices. In fact, there has been limited change in the impact of the reports per unit of market surprise. The bottom line is that the overall impact of the USDA inventory reports in cattle and hog markets is smaller but nonetheless still significant.

[First submitted October 2018; accepted for publication November 2018.]

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