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IMPACT OF CROP CONDITION REPORTS ON NATIONAL AND LOCAL WHEAT MARKETS

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Abstract. The U.S. Department of Agriculture (USDA) releases crop condition reports detailing crop progress and growing conditions for various crops including corn, soybeans, and winter wheat. Previous research has investigated market impacts from various USDA reports, but crop condition reports have received little attention. This article investigates the impact of crop condition reports on winter wheat prices at the national level and for a local market. We employ both parametric and nonparametric tests. Results suggest that crop condition reports for winter wheat do not generally affect market prices. This contrasts with results found in corn and soybean markets.

Keywords. Crop conditions, event study, futures markets, public information, Savage scores

JEL Classifications: Q02, Q13, G13, G14, C14

1. Introduction

There have been several studies over the past few decades examining the impact of information on commodity market prices. Much of the work has focused on whether the releases of public reports (U.S. Department of Agriculture [USDA] crop reports, for example) provide new information to the market. If prices respond to a report release, then it is argued that public investment in the reports has value. These are generally referred to as event studies.

This article looks at the information and market responses associated with the crop condition reports released by the National Agricultural Statistics Service (NASS) of the USDA. We examine report impacts both before and after the general increase in commodity prices in late 2007 (our sample runs from April 1986 through June 2014). We employ both parametric and nonparametric tests

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to investigate the impact of the weekly crop condition reports on national wheat futures prices and on white wheat basis for a cash market in the Pacific Northwest. This provides local producers with a better understanding of the risks they may face prior to a report release and can help them determine whether basis protection makes sense going into a report.

Earlier studies often focused on whether producers face "abnormal" price risk prior to a report release and, in some cases (Fortenbery and Sumner, 1993), described futures or flat cash price strategies one might consider to mitigate that risk. However, if the price and basis risks are not symmetric, then producers may want to consider strategies that lock in a basis level even when futures prices are not attractive or that do not lock in the basis level even when futures prices are attractive. This requires a more complete understanding of the local impacts of new information and whether they may differ systematically from measures of the national impact.

Similar to previous work, this study evaluates whether price and/or basis changes on days when the crop condition reports are released differ significantly from price and/or basis changes on days with no release. However, before testing for price impacts we first measure the extent to which the crop condition reports actually provide useful information. We do this by measuring whether weekly condition reports provide insight into final wheat yields. If the reports do not inform on final yields, then we would expect the market to ignore the reports because they do not provide new information. If, however, the reports do provide insight into final yields, then we would expect the market to respond to the reports unless the information was already known to market participants. This is discussed in more detail subsequently.

The article proceeds with a short discussion of the theory surrounding event studies, followed by a description of the unique contributions offered by this study. We then describe the data and methodology and present a discussion of the specific results. Results are presented in the order of crop condition yield estimates, final annual production estimates, national price impact results, and then a discussion of the local basis impacts. Finally, interpretations of results are discussed in the conclusion section.

2. Event Studies and the Theoretical Foundation

The general theory surrounding event studies relates to market efficiency. In general, a market is considered semistrong efficient if prices completely incorporate all public information related to the supply/demand conditions of the asset being priced (Fama, 1970).

If a futures market is semistrong efficient, then it should not be possible for an analyst to use public information to consistently produce superior forecasts of some future price compared to the current futures market price for that same delivery period. In other words, the current futures market price should be at

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least as accurate in predicting the price at contract expiration as any model an analyst might develop based on public information. In addition, if a report is released that contains new market information, then efficient markets should adjust to reflect the new information.

Falk and Orazem (1984) explicitly outlined the theoretical foundation for futures market responses to government crop forecasts under the assumption of semistrong efficiency. They developed a model that allows for different impacts associated with information generated by private sources and information coming from the release of government reports. They argued that the government has a comparative advantage in the development of both production forecasts and crop condition reports, and as such, we should expect any new information contained in reports related to those topics to have an influence in futures market price changes.

Using the assumption of market efficiency as a foundation, more recent event studies have used futures prices to test whether various reports contain new and important market information. If futures markets are efficient, one can test for the informational content of new reports by examining whether futures market prices change as a result of the new information being released and provide empirical verification of the Falk and Orazem model in various contexts.

Much of the previous work in grains has focused on USDA crop production reports and/or the *World Agricultural Supply and Demand Estimates* (WASDE) released by USDA (e.g., Colling and Irwin, 1990; Fortenbery and Sumner, 1993; Garcia et al., 1997; Milonas, 1987; Sumner and Mueller, 1989). These USDA reports are of interest because of the costs associated with generating them and the efforts taken to ensure that the information contained in them is not available to anyone until the reports are publically released. Their information is generated through both extensive surveys (in the case of the crop production reports) and detailed statistical analysis. Further, USDA analysts are sequestered in a room with no outside contact while the reports are generated and kept there until the official release time.

Sumner and Mueller (1989) investigated the effect of USDA harvest forecasts contained in WASDE on corn and soybean futures prices using parametric test statistics and the nonparametric Savage scores test. Nonparametric tests are useful for analyzing futures prices because they do not require the assumption of a normal distribution. By nature, the distribution of prices is truncated at zero, which suggests the use of a nonparametric test to account for violations of normality. Such a test is likely more appropriate than a test based on a regression technique that assumes normality. Using both techniques, Sumner and Mueller found that following USDA corn and soybean report releases, futures prices for both corn and soybeans had higher mean price changes and larger variances compared with days when a report was not released.

Fortenbery and Sumner (1993) then investigated whether the impacts of WASDE harvest forecast announcements changed following the introduction of options for corn and soybean futures. They also implemented the Savage scores and the Kruskal-Wallis and Van der Waerden nonparametric tests. They did not utilize any parametric tests in their analysis. Results were consistent across the three tests, and Fortenbery and Sumner found diminished futures price effects from USDA report releases after the advent of options trading for the corn and soybean markets. They hypothesized that traders may take option positions to protect against futures price risk prior to the reports and dampen some of the postreport futures trading that drove earlier price effects.

Robenstein and Thurman's (1996) work represents the opposite extreme in terms of information delivery. They were interested in the potential market impacts of health news reported through the popular press. Thus, they were not testing the impact of "new" information but rather the reporting of information to a broader audience that was already known by some. They used a regression technique first pioneered by Fama et al. (1969) to investigate whether negative health news related to consumption of red meat affected live cattle, feeder cattle, pork belly, and live hog futures contracts. They tested for changes in market returns to red meat futures positions following press reports focused on the relationship between red meat consumption and cholesterol. Although they did not find any effects from negative health news, they did suggest that futures contracts and their pricing may not be the appropriate place to look for changes in consumer demand. The type of model that Robenstein and Thurman used is less attractive for the work here because of the frequency of report releases during the period of study. A market returns model requires first estimating the expected rate of return, in this case average price, over a period of time up to, but not including, the time of the event. Because crop condition reports are released weekly, the estimation window before each event is too brief for valid estimation of such parameters, making it difficult to disentangle postevent effects from preevent effects on a week-to-week basis (MacKinlay, 1997).

Lehecka's (2014) research is most similar to the event studied here. He examined the response in corn and soybean futures markets to the weekly releases of USDA crop condition reports—the same reports studied in this article. These reports are quite different from the USDA production and WASDE reports in a couple of ways. First, although there is a standard release time, there is not a concerted effort to keep the report information secret prior to release. Second, these reports represent the subjective evaluations of producers and others (for example, county extension agents) concerning local crop conditions. There are no formal surveys, and no attempt is made to validate individuals' subjective evaluations of current crop conditions. Individual assessments are simply aggregated to arrive at the report's released data. Despite this, Lehecka claims that these are some of the most requested reports from NASS during the growing season.

Lehecka used both parametric and nonparametric tests, including the Kruskal-Wallis test, to determine if crop condition reports affect market prices. He found a significant impact on market price variance on report days, with price variances increasing following report releases. His study period ran from 1986 to 2012 and overlaps with the sample period used in this article.

Missing from the literature to date are local measures of report impacts, and these might be important. The USDA crop production report, for example, details production prospects on individual production units, yet previous analyses of report impacts have focused on national average prices. Similarly, the crop condition reports provide both state-level and national results. Thus, even when impacts are found, it is possible that results understate the actual value of the information if there are differences in local impacts across regions. For example, if production prospects increase in one area relative to earlier expectations (a price negative result) but decrease in another (a price positive result), impacts may at least partially offset each other in the calculation of national average prices, and the actual "news" would be undervalued when looking at national average price reactions.

3. Objectives and Data

The objective of this article is to examine the effect of weekly USDA crop condition reports on both the national and a local market for winter wheat. As such, we extend Lehecka's (2014) work along two fronts: first, we examine the impacts on markets for winter wheat, and second, we investigate the extent to which local market impacts might vary from national impacts.

In order to determine whether the crop condition reports provide relevant market information, we first measure whether they provide insight into final harvest yields. Once this is determined, we conduct tests for market price impacts on the days the reports are released. We do this by employing a portfolio of tests including tests used by Sumner and Mueller (1989), Fortenbery and Sumner (1993), and Lehecka (2014).

Data for the USDA weekly crop condition reports were collected from April 1986 through June 2014. April through June reports are used to account for changes in crop conditions through the winter wheat growing season. Data are collected for the six largest winter wheat–producing states. The six states include Washington, Colorado, Kansas, Montana, Oklahoma, and Texas.[1] Importantly, winter wheat crop conditions are not distinguishable between hard red, hard white, soft red, and soft white winter wheat. However, it is known that each of the six largest winter wheat–growing states primarily grows hard red winter wheat, except for the state of Washington, which primarily grows soft white winter wheat.

Contracts for hard red winter wheat futures are traded on the Kansas City futures exchange. Soft white winter wheat is not traded in the futures market but

1 Determined by percent total of U.S. winter wheat production from 2003 to 2014.

is generally priced based on the soft red winter wheat futures price at the Chicago Mercantile Exchange. Thus, both Chicago and Kansas City futures market data are considered to measure impacts. We focus on the July contracts for both wheat varieties because these are considered the "new" crop contracts; that is, July is the first futures contract delivery month explicitly pricing the upcoming harvest. The futures prices come from the Commodity Research Bureau database and are composed of daily prices from April 1986 through June 2014.

In this analysis, we consider one local cash market: Odessa, Washington. This is because of the difficulty of collecting a consistent time series of local cash market transaction prices for other locations. Cash prices for Odessa come from CashGrainBids.com. Although we have complete data for Odessa, CashGrainBids.com was not able to furnish complete data for most other Washington markets. Unfortunately, we were not able to collect a cash series that exactly matches the futures price time series. The cash data span 1999 through 2011.

The final yearly yields of winter wheat production in bushels per acre were gathered from USDA-NASS for all six states along with the national average yield of winter wheat over the time period 1986–2014. These represent the yields potentially being "predicted" by the crop condition estimates.

Only the conditions reported for the growing/harvest season from April to June were used in estimation.[2] Because the length of the growing and harvest seasons may vary by 3 to 4 weeks year to year, and by state, we use the first 13 weeks of the postemergence growing season beginning with the first report released in April (or late March). This results in a consistent number of reports used for each state's growing year. In addition, we remove price changes from weekends as the amount of information being brought to the market from Friday to Monday may bias the variance of the nonreport-bearing weekdays. This is consistent with Lehecka (2014), among others.[3]

We initially separate the data into two periods. The first is selected to include the earliest data collected for each market (April 1986) through 2007. This period captures the market before the effects of the Great Recession and before the general increase in commodity price levels, and it corresponds to the gap observed in Figure 1.

The second period begins with the start of 2008 and runs through 2014. It captures each market from the start of the Great Recession forward and reflects higher average commodity prices compared with the earlier period. The intuition is that as more uncertainty is introduced in the economy, USDA reports may

2 In a few cases, the first report used was in the last week of March.

3 We also remove Mondays when they happen to be holidays. When that happens, the crop conditions are released on Tuesday, and that becomes our event day for estimation purposes.

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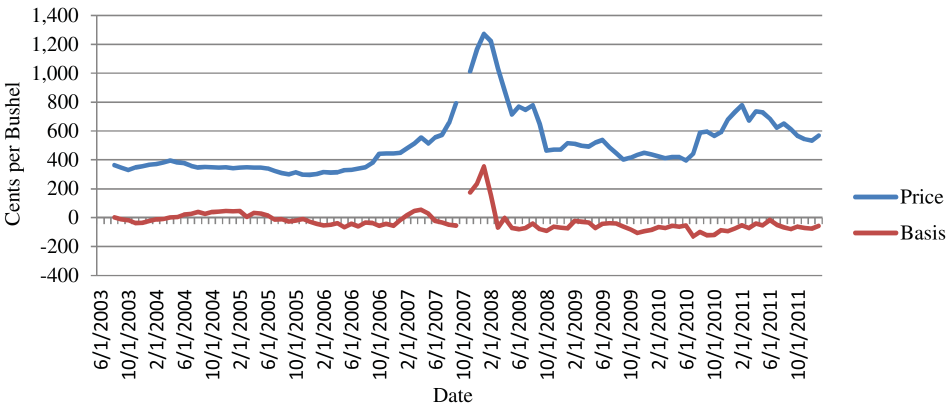

Figure 1. Odessa Monthly White Wheat Basis, 2003–2011 (data for October 2007 were unavailable)

convey more information to the market and we should expect to see greater effects from reported crop information. This is consistent with Lehecka (2014).[4]

4. Methods

The empirical analysis involves two stages. First, the efficacy of the condition reports' ability to predict final per acre yields is estimated to determine if the reports provide market information. Second, tests are conducted to determine if futures and local prices respond to the release of the reports. It is theorized that if the crop condition reports provide useful predictions of national average yield that lead to an unanticipated revision in wheat production estimates, then we should observe futures market prices reacting to the new information. Further, if local yields are accurately predicted, we might observe local price responses that do not necessarily mirror those observed nationally. This hypothesis follows from the possibility that condition report effects in different markets could be "averaged out" in the national market and would not reflect the local value of reports. Conversely, if the reports do not contain useful yield information, and the markets, either local or national, react, it might indicate some inefficiency in short-run market price formation.

The analyses employed in this article, all told, are as follows: an index of crop conditions is constructed to parsimoniously estimate final yield/acre (by state and total United States) for each week of report releases. These yield estimates are then used to estimate final production totals by state and for the United

4 We also looked at the sensitivity of the results to this break. Specifically, we extended the first period through 2009 and shortened the second period to 2010 through 2014. In addition, we estimated results treating the entire time series (1986–2014) as a single sample. The quality of the results is invariant to these specifications. Results are available from the authors.

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States—all as a simple check of information potentially contained within crop condition reports. Next, analyses are performed similar to previous studies to determine if the futures markets and the local market considered react to releases of the reports.

For parsimony in estimating yield values from crop conditions, we construct an index of weekly crop conditions:[5]

$$CCIndex = (\%\ Acreage\ Excellent) \times 1 + (\%\ Good) \times 0.75 + (\%\ Fair) \times 0.5 + (\%\ Poor) \times 0.25 + (\%\ Very\ Poor) \times 0. \quad (1)$$

The index is calculated separately for each state each week, and the index ranges from [0, 100]. An index value of 100 corresponds to 100% of the surveyed crop being reported in excellent condition, and a value of 0 indicates 100% of the crop is in very poor condition.

Next, we regress each week's index against that year's final yield per acre. Thus, there are 13 yield regressions for each state, 1 for each of the 13 weekly conditions reports. In addition, a national index of crop conditions is regressed against the U.S. winter wheat yield by week. Regressions are estimated using ordinary least squares and take the form:

$$Yield_{st} = \alpha_{si} + \beta_{si} \times CCIndex_{sti} + \varepsilon_{si}, \quad (2)$$

where $CCIndex$ is the crop condition index, s denotes the state (including an aggregate U.S. equation), t denotes the year, i denotes the week, and ε represents an error term. We initially estimate equation (2) for the period 1986 through 2010 and then generate out-of-sample forecasts for subsequent years to ensure the models are in fact generating reasonable forecasts of future yields.

Using the estimated yields for the six states and the United States, we can make a prediction of total winter wheat production based on the number of acres planted in each state and nationally. We consider two formulations to estimate production, using estimated yield and planted acres. The first is as follows:

$$\hat{y}_{sti} = \left(\hat{\alpha}_{si} + \hat{\beta}_{si} \times CCIndex_{sti}\right) \times (planted\ acres)_{st}, \quad (3)$$

where $\hat{y}_{sti}$ is the estimated final production for state s in year t based on week i's crop condition index; $\hat{\alpha}_{si}$ and $\hat{\beta}_{si}$ are the yield estimate constant and coefficient

5 There are other ways one might use the crop condition information in constructing measures of information. For example, Irwin, Good, and Tannura (2009) simply add the percent of crop rated excellent to the percent rated good and use that as an explanatory variable in a model explaining corn and soybean yields. One disadvantage of this approach relative to our index is that yield expectations are not affected by movement between the good and excellent categories or between the fair, poor, and very poor categories. Lehecka (2014) also only uses information from the good and excellent categories in measuring price responses to changes in conditions. Similar to Irwin et al., he does not consider price responses from changes in the bottom three categories (fair, poor, or very poor) or changes in the relative percentages between excellent and good.

for state s in week i of the growing season; $CCIndex_{sti}$ is the crop condition index of week i for state s in year t; and $(planted\ acres)_{st}$ is the number of acres planted in year t for state s.

In the second formulation, we weight the number of acres planted by the ratio of acres harvested over acres planted from the previous year:

$$\hat{y}_{sti} = \left(\hat{\alpha}_{si} + \hat{\beta}_{si} \times CCIndex_{sti}\right) \times (planted\ acres)_{st} \times (harvest\ ratio)_{st-1}, \quad (4)$$

where $(harvest\ ratio)_{st-1}$ is the number of acres harvested divided by the number of acres planted for state s in the previous year, $t-1$.

Similar to earlier work, we employ both parametric and nonparametric tests to look for price impacts associated with releases of the crop condition reports. The parametric tests include F-tests for equivalence of variance and t-tests for equivalence of means. However, because the data used in testing for report effects are calculated as absolute price changes, they follow a distribution close to that of an exponential distribution. This violates the assumption of normality on which the parametric tests are based. To account for this, we also employ the Savage scores test (also used by Sumner and Mueller [1989]), which is based on order statistics from an exponential distribution. In addition, the Kruskal-Wallis nonparametric statistic is included as a check for robustness (this test was also employed by both Fortenbery and Sumner [1993] and Lehecka [2014]).[6] This allows us to compare our results with those generated by Lehecka for national corn and soybean markets

Recall that we are focused on July futures contracts in measuring national price effects. Because the crop condition reports are released on Monday afternoons after the day session of the futures markets has closed, we calculate absolute price changes as follows:

$$ABS\,(P_t - P_{t-1}), \quad (5)$$

where P_t is the day session opening price and P_{t-1} is the market settlement price at the end of the previous day session. This assumes that the markets will adjust fully from the reports, released at 4 p.m. (EST), between market close and open.[7]

6 The Savage scores test and the Kruskal-Wallis test are rank tests and are based on linear rank statistics. They are nonparametric tests that measure whether individual samples are from the same population. The null hypothesis is that the samples considered are from the same population. Thus, a significant test statistic indicates that the samples considered originate from different distributions. Details on both the test statistic specifications and their relative power can be found in Hajek (1969).

7 There have been significant changes to futures market trading hours over our sample period. Specifically, futures now trade in an overnight session. However, futures traders are still marked-to-market (meaning they settle profits and losses) daily based on closing prices of the day session. Further, these are the reference prices that are generally used by cash merchandisers to set cash price offerings for the next day. This is also the sample frame considered by Lehecka (2014).

Price changes are then compared based on whether they occurred on days of a report release or on a nonreport day, excluding weekends. We first test for equivalence of variance between the two groups for both Chicago and Kansas City winter wheat futures, and then equivalence of means.

To measure local price impacts from crop condition reports, we analyze changes in basis levels following a report release. Basis is measured as cash minus the nearby futures price. Because our local market is represented by a white wheat–producing area, the basis is white wheat cash price minus soft red wheat futures. If crop condition reports provide local information relative to production potential that differs from national average yield expectations, then a change in basis should be expected (i.e., local prices should change relative to national prices to reflect the change in local crop conditions).

We measure local winter wheat price and basis data from June 1999 to December 2011 for Odessa, Washington.[8] The absolute change in daily basis is recorded as follows:

$$ABS\,(Basis_t - Basis_{t-1})\,. \tag{6}$$

5. Results

5.1. State and National Yield Predictions Using Crop Conditions

Results from the 13 different weekly yield models from equation (2) are presented in Table 1 (R^2 values for each regression are reported in Table A1 in the online supplementary appendix). This table presents the coefficients for the aggregate United States and each state's condition estimates regressed on final yield by week from 1986 to 2010.

It is apparent that as the season advances the condition reports do a better job of predicting the final crop yield. In Washington, for example, the 13th crop progress report predicts 59% of the final annual yield variation, whereas in week 1 it only predicts 17%. This is illustrated in Figure 2. The change in the coefficients of the estimates in Table 1 demonstrates that the crop condition index coefficient increases, as does the R^2 (Table A1 in the online supplementary appendix) as we progress through the growing season.

Using these regressions, we forecast the final yields out-of-sample for 2011–2014 at each weekly horizon. We then compute the root-mean-square error (RMSE) for each set of predictions using the realized final yield values for each state (these are reported in Table A2 by state and week, and graphically presented in Figure A1 in the online supplementary appendix). Yield prediction errors tend to be relatively stable over the course of the growing season, with some states marginally improving and other state yield predictions worsening over the season.

8 We are not able to obtain daily transaction prices prior to June 1999.

Table 1. Yield Estimation Coefficients, 1986–2010

	Washington			Colorado		
Week	Beta 1	*P*	Constant	Beta 1	*P*	Constant
1	0.18	0.04	49.76	0.28	0.01	15.33
2	0.17	0.06	50.41	0.27	0.01	15.84
3	0.17	0.09	50.59	0.25	0.01	16.93
4	0.24	0.04	46.08	0.30	0.00	13.68
5	0.33	0.01	39.80	0.34	0.00	10.89
6	0.40	0.01	34.44	0.33	0.00	12.46
7	0.50	0.00	28.18	0.34	0.00	12.17
8	0.54	0.00	25.58	0.36	0.00	11.01
9	0.47	0.00	30.76	0.35	0.00	11.68
10	0.42	0.00	34.14	0.36	0.00	11.38
11	0.40	0.00	34.87	0.36	0.00	11.42
12	0.41	0.00	34.33	0.37	0.00	10.79
13	0.51	0.00	28.11	0.40	0.00	8.77
	Kansas			Montana		
Week	Beta 1	*P*	Constant	Beta 1	*P*	Constant
1	0.18	0.05	25.81	0.09	0.55	30.72
2	0.19	0.04	25.51	0.16	0.24	26.07
3	0.20	0.02	25.08	0.15	0.27	26.65
4	0.24	0.01	22.97	0.16	0.18	26.38
5	0.25	0.00	22.70	0.17	0.16	26.00
6	0.24	0.00	23.48	0.20	0.07	24.15
7	0.23	0.00	24.34	0.18	0.09	25.39
8	0.23	0.01	24.26	0.23	0.02	22.01
9	0.21	0.01	25.67	0.21	0.02	23.64
10	0.22	0.01	24.98	0.25	0.00	21.17
11	0.26	0.00	23.20	0.27	0.00	19.64
12	0.28	0.00	21.89	0.30	0.00	17.69
13	0.36	0.00	17.94	0.34	0.00	15.18
	Oklahoma			Texas		
Week	Beta 1	*P*	Constant	Beta 1	*P*	Constant
1	0.21	0.01	17.32	0.18	0.00	20.45
2	0.23	0.00	16.23	0.19	0.00	19.74
3	0.23	0.00	16.29	0.19	0.00	20.03
4	0.21	0.00	17.43	0.20	0.00	19.81
5	0.22	0.00	17.78	0.20	0.00	19.70
6	0.23	0.00	16.93	0.20	0.00	19.92
7	0.25	0.00	15.92	0.22	0.00	19.10
8	0.26	0.00	15.51	0.21	0.00	19.45
9	0.27	0.00	15.22	0.20	0.00	19.86
10	0.30	0.00	13.01	0.21	0.00	19.55
11	0.33	0.00	11.76	0.21	0.00	19.45
12	0.32	0.00	12.58	0.22	0.00	18.59
13	0.32	0.00	12.19	0.24	0.00	17.98

Table 1. Continued

	United States		
Week	Beta 1	*P*	Constant
1	0.08	0.26	36.64
2	0.10	0.14	35.03
3	0.10	0.16	35.50
4	0.08	0.26	36.36
5	0.10	0.17	35.49
6	0.08	0.25	36.85
7	0.12	0.13	34.34
8	0.07	0.31	37.17
9	0.07	0.33	37.31
10	0.11	0.20	35.43
11	0.12	0.16	34.81
12	0.11	0.17	35.13
13	0.15	0.08	32.37

Note: For 2008, no state reported growing conditions past 12 weeks.

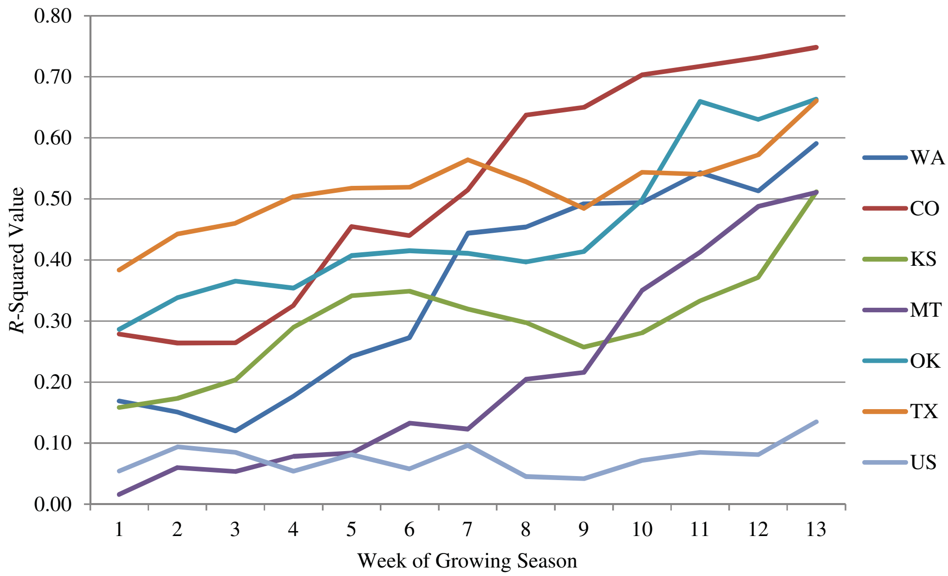

Figure 2. Percentage of Final Yield Variation Predicted, 1986–2010

The yield model results provide a reasonable expectation that crop condition reports provide information relative to final realized yields. Further, although prediction error may not improve dramatically over the season, the error as a percentage of final yield (root-mean-square percentage error [RMSPE]) is in the range of 8%–14% for all states and the United States, with the notable exception of Colorado (Table A3 and Figure A2 in the online supplementary appendix). As

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Table 2a. Production Prediction RMSEs in Bushels, Out-of-Sample Forecasts, 2011–2014

Week	Washington	Colorado	Kansas	Montana	Oklahoma	Texas	United States
1	11,211,841	15,224,920	47,903,849	6,337,246	56,295,676	90,345,883	207,500,000
2	11,495,907	16,033,412	45,528,478	6,113,252	53,292,513	87,170,968	195,000,000
3	11,110,183	14,903,505	44,026,555	5,715,030	51,582,286	89,126,332	199,500,000
4	10,293,773	15,607,991	37,960,940	5,729,062	50,950,993	85,756,600	204,700,000
5	10,895,155	17,461,906	32,856,747	5,289,623	51,035,667	83,957,164	194,600,000
6	10,965,051	16,450,196	29,983,076	4,917,322	46,300,439	82,288,107	200,000,000
7	10,799,389	16,984,741	31,227,621	5,488,443	43,153,030	80,136,198	178,400,000
8	11,839,655	16,484,357	32,227,029	5,361,511	40,657,841	81,802,691	202,400,000
9	11,126,902	15,241,240	35,981,576	3,975,739	40,021,531	81,942,676	203,500,000
10	10,327,367	14,367,432	34,006,518	3,254,119	35,300,602	79,627,585	188,400,000
11	11,715,393	12,853,822	30,668,059	4,596,715	35,213,513	82,403,293	184,700,000
12	12,269,085	12,612,186	28,601,352	3,066,645	36,437,463	79,763,275	188,200,000
13	**11,619,887**	**14,822,785**	**22,962,334**	**3,866,638**	35,402,511	78,974,089	**158,000,000**

Notes: Terms in bold indicate the model specification (between Tables 2a and 2b) that minimizes prediction error. RMSE, root-mean-square error.

such, we should expect efficient cash markets to respond to changes in local crop conditions if the changes represent new market information (i.e., the information was not anticipated prior to a report's release).

5.2. Production Estimates

Accurately predicting yields is likely important in predicting final production (yield times acres harvested), but the market is likely more focused on total production than yield. As a result, we test whether the yield forecasts provide significant insight into actual production. The RMSEs from out-of-sample production predictions for 2011–2014 are listed in Tables 2a and 2b for the first and second production specifications (equations 3 and 4), respectively. The final bold RMSE values in Tables 2a and 2b identify the specifications with the smallest forecast error for each state, highlighting the difference between the two specifications by state.

There is a distinct difference between the two specifications for the two southernmost states, Oklahoma and Texas. These states tend to harvest a lower percentage of their planted acres year over year, and this appears to factor into the prediction noticeably. The yield and production predictions do not do a particularly good job of predicting Colorado, Oklahoma, or Texas winter wheat production. The prediction errors generally decrease from week 1 to week 13 under the specification for each state that yielded the lowest final error. Noticeably, Kansas and Montana have the lowest production prediction errors.

Tables 2c and 2d contain the RMSPE of the production predictions to aid in interpreting the magnitude of the prediction errors. The week 13 estimates of total production are off by 4.41% for Montana, ranging up to almost 36%

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Table 2b. Production Prediction RMSEs with Acres Planted/Harvested Weighting, Out-of-Sample Forecasts, 2011–2014

Week	Washington	Colorado	Kansas	Montana	Oklahoma	Texas	United States
1	13,074,560	25,063,382	39,188,718	10,094,642	30,572,447	29,552,480	160,600,000
2	13,381,315	25,403,103	35,871,198	9,851,387	27,820,203	27,964,601	162,900,000
3	13,002,664	24,569,762	33,402,527	9,288,421	26,472,454	28,370,885	160,100,000
4	12,235,492	25,596,330	29,651,710	9,328,880	26,925,209	26,855,770	157,200,000
5	12,842,768	27,163,584	28,913,209	8,891,311	26,461,423	26,073,980	160,100,000
6	12,908,276	26,138,861	27,910,347	8,185,494	24,145,556	25,965,516	159,600,000
7	12,774,624	26,227,520	31,272,137	8,811,054	22,305,248	25,447,208	168,300,000
8	13,785,459	26,205,516	35,175,761	8,046,677	21,358,730	24,970,720	159,400,000
9	13,114,155	25,451,818	37,252,416	7,306,148	21,599,314	25,751,591	160,900,000
10	12,358,410	25,183,132	35,492,083	6,634,718	19,692,035	25,586,444	166,700,000
11	13,696,626	24,292,083	34,019,113	8,025,396	18,292,096	24,812,978	166,500,000
12	14,219,156	24,531,775	33,374,465	6,892,903	18,983,425	23,976,489	164,400,000
13	13,498,782	26,209,812	34,577,808	7,140,657	**19,085,686**	**23,418,634**	181,400,000

Notes: Terms in bold indicate the model specification (between Tables 2a and 2b) that minimizes prediction error. RMSE, root-mean-square error.

Table 2c. Yield Production RMSPEs by Week of Growing Season, Out-of-Sample Forecasts, 2011–2014

Week	Washington	Colorado	Kansas	Montana	Oklahoma	Texas	United States
1	9.00%	22.04%	19.73%	7.48%	94.30%	150.29%	14.34%
2	9.30%	23.38%	18.93%	7.23%	88.76%	144.08%	13.46%
3	8.90%	22.49%	18.45%	6.85%	85.49%	146.94%	13.76%
4	8.30%	19.91%	16.05%	6.84%	84.01%	141.27%	14.12%
5	8.80%	20.69%	13.82%	6.28%	83.96%	138.46%	13.41%
6	8.90%	20.17%	12.57%	5.90%	75.00%	135.97%	13.79%
7	9.20%	22.35%	12.82%	6.56%	68.97%	132.24%	12.29%
8	10.20%	20.31%	12.72%	6.44%	64.73%	134.36%	13.96%
9	9.50%	19.79%	14.11%	4.78%	63.98%	135.71%	14.05%
10	8.80%	16.67%	13.45%	3.91%	55.03%	132.51%	13.01%
11	10.00%	15.03%	12.11%	5.56%	52.96%	135.20%	12.75%
12	10.50%	13.19%	11.19%	3.66%	55.94%	130.55%	12.99%
13	**10.20%**	**16.27%**	**8.39%**	**4.41%**	54.01%	128.75%	**10.91%**

Notes: Terms in bold indicate the model specification (between Tables 2c and 2d) that minimizes prediction error. RMSPE, root-mean-square percentage error.

for the state of Texas on average over the 4 years predicted. Though we may not employ the most robust specification for predicting total state production of winter wheat, these calculations again suggest that crop condition reports are providing information that market prices should react to if the information was unanticipated.

Table 2d. Yield Production RMSPEs with Harvest Ratio Weighting, Out-of-Sample Forecasts, 2011–2014

Week	Washington	Colorado	Kansas	Montana	Oklahoma	Texas	United States
1	10.53%	28.47%	13.48%	11.77%	38.04%	48.41%	10.11%
2	10.83%	29.22%	12.52%	11.51%	34.19%	44.81%	10.34%
3	10.52%	28.29%	11.88%	10.93%	32.03%	45.95%	10.15%
4	9.95%	27.94%	10.21%	10.96%	31.45%	42.85%	9.94%
5	10.44%	29.14%	9.20%	10.41%	31.25%	41.52%	10.19%
6	10.53%	27.93%	8.53%	9.65%	26.05%	41.14%	10.11%
7	10.90%	28.67%	9.33%	10.38%	22.50%	39.58%	10.80%
8	11.85%	28.01%	10.14%	9.62%	20.25%	39.63%	10.08%
9	11.15%	27.53%	10.89%	8.64%	20.08%	40.57%	10.15%
10	10.51%	26.67%	10.33%	7.79%	15.77%	39.11%	10.60%
11	11.64%	25.45%	9.69%	9.49%	14.21%	39.02%	10.62%
12	12.14%	25.86%	9.33%	8.03%	15.61%	36.97%	10.47%
13	11.81%	28.33%	9.52%	8.15%	**14.98%**	**35.84%**	11.70%

Notes: Terms in bold indicate the model specification (between Tables 2c and 2d) that minimizes prediction error. RMSPE, root-mean-square percentage error.

5.3. National Price Responses

Results of parametric and nonparametric tests for futures market impacts are reported in Tables 3a and 3b. Table 3a presents results associated with the close to open price spread, whereas Table 3b is for the close to close price spread.

The *F*-statistics in Table 3a are highly significant, implying the null hypothesis of equal variances should be rejected for both time periods considered. In contrast to Lehecka (2014), however, we actually find smaller price variances following a report release when compared with no report release.

Next, we test for equivalence of means, assuming unequal variances, and find that the means are unequal in both futures markets at the 5% level of significance, but only for the time period 2008–2014. As with variance, mean price changes are actually smaller following a report release. These results appear counterintuitive and inconsistent with previous commodity market event studies. However, results are robust whether the daily price changes are measured from market close to next day open or when measured as market close to next day close.

Because the daily price changes are measured in absolute terms, the data follow an exponential distribution. A more appropriate test for differences in these populations is the Savage scores test, which does not assume normality. The chi-square statistics from the Savage tests are reported in Tables 3a and 3b with their associated *P* values, and they reinforce that the two populations of price changes are indeed significantly different for the Kansas City wheat market in the 2008–2014 period under both price measurement specifications, as well

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Table 3a. Means, Variances, and Statistical Tests for Chicago and Kansas City, Close/Open Report Effects

	Chicago				Kansas City			
	1986–2007		2008–2014		1986–2007		2008–2014	
	Report Day	Nonreport Day	Report Day	Nonreport Day	Report Day	Nonreport Day	Report Day	Nonreport Day
Observations	103	564	60	362	103	564	60	362
Mean, $	0.009	0.009	0.012	0.025	0.016	0.015	0.013	0.024
Variance	0.0001	0.0004	0.0002	0.0092	0.0003	0.0004	0.0003	0.0047
F-statistic for unequal variance								
	2.984***		53.272***		1.469**		14.974***	
Parametric test statistic for report effects								
t-statistic	−0.45		2.464**		−0.76		2.551**	
Nonparametric test statistic for report effects								
χ^2 statistics								
Kruskal-Wallis	2.649	$P = 0.104$	0.273	$P = 0.601$	1.092	$P = 0.296$	3.197*	$P = 0.074$
Savage	1.854	$P = 0.173$	1.350	$P = 0.245$	1.362	$P = 0.243$	3.090*	$P = 0.079$

Note: Asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3b. Means, Variances, and Statistical Tests for Chicago and Kansas City, Close/Close Report Effects

	Chicago				Kansas City			
	1986–2007		2008–2014		1986–2007		2008–2014	
	Report Day	Nonreport Day	Report Day	Nonreport Day	Report Day	Nonreport Day	Report Day	Nonreport Day
Observations	103	564	60	362	103	564	60	362
Mean, $	0.041	0.043	0.102	0.144	0.045	0.041	0.095	0.133
Variance	0.0016	0.0020	0.0081	0.0236	0.0020	0.0016	0.0061	0.0179
F-statistic for unequal variance								
	1.286		2.904***		0.812		2.9309***	
Parametric test statistic for report effects								
t-statistic	0.4		3.001***		-0.79		3.138***	
Nonparametric test statistic for report effects								
χ^2 statistics								
Kruskal-Wallis	0.082	$P = 0.775$	3.537*	$P = 0.060$	0.048	$P = 0.826$	3.504*	$P = 0.061$
Savage	0.121	$P = 0.728$	4.092**	$P = 0.043$	0.675	$P = 0.411$	4.300**	$P = 0.038$

Note: Asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

as for the Chicago market in the 2008–2014 period under the close–close price measurement.[9]

These results lead to three possibilities. First, perhaps the appropriate event window is misspecified. However, the window definitions are consistent with previous studies.

Second, rather than provide new market information, the condition reports may simply confirm what market participants already know. If traders and/or private-sector analysts accurately predict the information contained in the condition reports, then prices will have already reacted to the "new" market information, suggesting the reports only confirm existing market information, and thus no price effect is realized. However, this does not explain why price responses are actually smaller on report versus nonreport days unless uncertainty about yields generates price uncertainty leading up to a report, but then the report generally confirms expectations and the volatility diminishes. It is more likely that there are other events that dominate trade early in the trading week, especially in those early weeks when the yield forecasts are less accurate. For example, the wheat market is heavily focused on exports, and the sample period incorporates the fourth quarter of the marketing year where export pace is critical to meeting market expectations relative to ending stocks. Export inspections for the previous week are released on Tuesday. Perhaps the market is waiting for that information before deciding on a direction or price change for the trading week.[10]

Another possibility is that week-to-week changes in U.S. yield expectations for wheat are not as important in overall price discovery as they are for corn and soybeans because of differences in market structure. Corn and soybeans are relatively homogenous products of a single class. In other words, corn produced anywhere can be used to satisfy the demand for almost any corn use, and soybeans are similar. This is not true for wheat. The crop conditions reported for winter wheat are aggregated across several classes (hard red, soft red, soft white, hard white, etc.), and each has unique characteristics and uses. As such, average yield expectation across all varieties may mask any variation in specific production expectations for individual classes. Perhaps aggregate production information is not as important as specific class information in price discovery

9 This is confirmed with the Kruskal-Wallis test, also reported in Tables 3a and 3b.

10 We did test whether Tuesday price activity was significantly different from activity Wednesday through Friday. We did not include Monday in the analysis, because we already confirmed it had lower average price changes and variance; thus including it with the rest of the week would have reduced the weekly averages and biased the results in favor of a Tuesday effect. In general, we did not find a significant difference between either close to open or close to close price behavior on Tuesday relative to the rest of the week (results are available from the authors). However, other potentially important trade data are released on other days (weekly shipments are released on Thursday), so measuring the extent to which trade activity dominates price discovery relative to changes in yield expectations may be more complicated than identifying and testing for a single event.

(we look at futures prices for specific classes, but the condition numbers are aggregated across a variety of classes).

Even more likely is that changes in U.S. wheat yield expectations are less important in price determination compared with corn and soybeans because U.S. production represents a much smaller percentage of global supply, and the futures markets are really trying to discover equilibrium prices for the world market. According to the September 2016 WASDE (USDA, 2016), U.S. wheat accounted for less than 8.5% of global production in the 2016/2017 marketing year, and this was up almost 1% from the previous year. Further, global wheat production occurs in most parts of the world, meaning global production risk is well diversified geographically (for 2016/2017, the largest producer, the European Union, still represented less than 20% of global production). In contrast, the September 2016 WASDE indicated that the United States represented 38% of global corn production and 33% of global soybean production in 2016/2017. In addition, most production of both crops is concentrated in the Western Hemisphere, meaning there is less geographic diversification of production risk. As the United States experiences weekly changes in crop prospects for corn and soybeans, the global supply implications are much greater than is the case for wheat, and as such, we should not be surprised to find larger price impacts in their respective futures markets.

Exactly what it is that results in less price movement between the Monday and Tuesday prices for wheat compared with other adjacent trading days is not clear from this analysis, but it is apparent that the crop condition reports on average do not appear to be important in the overall price discovery process for wheat even though they do seem to provide insight into final U.S. wheat yields.

A final possibility is that there are changes in local market price behavior following a report, but with the broad geographic dispersion of U.S. wheat production, local market changes offset each other when looking at national impacts. In 2012, for example, Southern wheat-producing states experienced drought stress whereas many Pacific Northwest producers experienced excellent yields. If these offset each other, then futures prices may not react, but local prices in each individual market might. This possibility is examined subsequently.

5.4. Local Market Event Study

Table 4 presents the parametric and nonparametric test results for a local market. The Savage scores test rejects the null hypothesis of zero difference between daily basis changes after a report release versus no report release beyond the 20% level of significance for the 2008–2011 period but fails to reject the null hypothesis for the 1999–2007 period. Though not statistically significant, the descriptive statistics again suggest that the price changes after a report release are smaller than those changes when there is no release. In Table 5, it is evident that the mean absolute monthly basis changes are larger in the 2008–2011 period than in the 1999–2007 period. The variance of the monthly basis changes is higher in the

Table 4. Means, Variances, and Statistical Tests for Odessa Report Effects

	2003–2007		2008–2011	
	Report Day	Nonreport Day	Report Day	Nonreport Day
Observations	39	275	47	278
Mean, $	0.045	0.056	0.092	0.115
Variance	0.0009	0.0067	0.0104	0.0155
F-statistic for unequal variance				
	7.6240***		1.4936*	
Parametric test statistic for report effects				
t-statistic	1.6627*		1.3831	
Nonparametric test statistic for report effects				
χ^2 statistics				
Kruskal-Wallis	0.055	$P = 0.814$	2.072	$P = 0.150$
Savage	0.366	$P = 0.545$	1.649	$P = 0.199$

Note: Asterisks (*, **, and ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5. Statistics for Odessa Daily Price Change by Month, 1999–2007

	1999–2007				
	March	April	May	June	July
Observations	70	57	57	70	60
Mean	0.07	0.05	0.04	0.06	0.06
Standard error	0.02	0.01	0.00	0.01	0.01
Variance	0.018	0.002	0.001	0.004	0.002
	2008–2011				
	March	April	May	June	July
Observations	70	65	59	70	61
Mean	0.14	0.13	0.09	0.11	0.09
Standard error	0.02	0.02	0.01	0.01	0.01
Variance	0.027	0.020	0.010	0.010	0.004

2008–2011 period as well. This is similar to what we observed for the Chicago and Kansas City futures markets, though again not statistically significant.

Based on the Odessa results, it appears that local prices react in a similar way to national prices following the release of crop condition reports, although with less statistical significance. The lack of significance in the report effects for the Odessa market might be because of the fact that, in general, Washington's crop conditions have lower variance than those of the other five main winter wheat–producing states, as evident from Table 6. This suggests that the information contained in crop condition reports for Washington might in general be less impactful, as the conditions change less year over year across every week than in states that represent much of the rest of winter wheat production. To more fully

Table 6. Index Variances by Week from 1986 to 2014

Week	Washington	Colorado	Kansas	Montana	Oklahoma	Texas	United States
1	172	171	194	83	213	214	148
2	176	178	196	90	223	226	143
3	148	194	205	91	236	220	145
4	116	182	216	121	278	237	128
5	82	185	241	117	299	235	139
6	63	190	267	130	291	247	167
7	67	188	274	149	267	236	119
8	60	199	254	149	257	237	146
9	82	208	268	188	247	244	142
10	105	227	253	211	242	253	115
11	121	222	226	211	255	244	112
12	112	229	217	206	263	235	115
13	91	212	206	180	259	250	99

investigate local impacts, cash prices for geographically disparate regions need to be collected. This effort is currently underway.

Nonetheless, because the crop condition reports do provide insight into final yields yet prices do not seem to react to their release, it appears that either market participants are accurately predicting the yield implications of the reports prior to their release dates or U.S. yield variation is less important in wheat than in corn and soybean markets. As a result, the reports do not appear to be providing new information important to price formation.

6. Conclusions

Crop condition reports are shown to provide useful information in predicting crop yields for various individual winter wheat markets. However, price effects from these reports on both the Chicago and Kansas City futures markets is minimal, even after accounting for the effects of weekends and a possible structural change in the market following the advent of the Great Recession. We find that crop condition report effects in the period marked by high levels of uncertainty in the economy, 2008–2014, are significant for the Kansas City futures market under both close–open and close–close price change measurements using both parametric and nonparametric tests. Similarly, the parametric techniques suggest significance for the Chicago market under both price measurement methods for the 2008–2014 period, as well as effects according to the nonparametric statistics under the close–close measurement in the same period. However, the statistics show there to be less variance on days when a report is released than on nonreport release days. There could be several ways to interpret this. One possibility is that the market is very good at anticipating the information contained in the reports, and thus the reports are simply confirming expectations. It may also be that other information—for example, export activity—is more important in price discovery during the spring months.

Another possibility is that price effects are muted because the United States does not dominate world production or trade in wheat to the extent it does in corn and soybeans. Thus, changes in U.S. wheat production prospects are less important in identifying and pricing global production risk. Further, geographic dispersion of global wheat production may lead to less concern about changes in production prospects in any specific county, at least below some threshold level.

For the local market, Odessa, Washington, we observe higher levels of variance and mean absolute daily changes in basis levels in the period beginning with the Great Recession compared with the period before. We do not find, though, that either parametric or nonparametric techniques detect significant effects from report releases (they are present according to the Savage statistic at the 20% level in the 2008–2011 period). The lack of significance in the Odessa market may partially be because of the fact that Washington has less variance in crop conditions reported week by week over the growing season compared with the other major winter wheat–growing states.

Future work includes developing a more comprehensive world wheat pricing model that looks at the relative importance of U.S. versus non-U.S. market information in wheat price formation. We also plan to expand the cash markets considered, both by class and geography. In addition, we are conducting a market impact analysis examining whether the wheat market reacts in the expected direction to crop condition reports, even if price changes are not different than on nonreport days. It would also be of interest to evaluate market impacts for individual states when the conditions reported in a particular state are bearish or bullish relative to those of the other major growing regions, and to look at price responses when changes in a condition index from one period to the next exceeds some significant threshold.

Supplementary Material

To view supplementary material for this article, please visit https://doi.org/1010.1017/aae.2016.31.

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