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The Effects of USDA Reports in Futures and Options Markets

T. Randall Fortenbery and Daniel A. Sumner*

The USDA releases its estimates of supply and demand conditions in domestic and international markets each month in regularly scheduled and widely publicized announcements. In recent years the release of the World Agricultural Supply and Demand Estimates (WASDE) have coincided with the domestic crop production estimates for major commodities. The announcements are widely considered to be among the most important sources of information affecting trade in farm commodities.

Recent research by Sumner and Mueller examined the informational content of the domestic production reports, and their impact on futures prices for the period 1961 through 1982.[1] They used the absolute differences between price changes following release of a report and price changes on non-report trading days as a measure of market participants' reactions and found that the USDA reports did provide news to the market.

Since 1982 there have been several changes in the commodities trading industry, in communications technology, and in USDA reporting. Some of these changes may have implications relative to the informational content of USDA reports. In the fall of 1984, options on futures contracts began trading. The advent of options provided traders with increased opportunities for managing the price risk of a cash and/or futures position in particular commodities. If a grain trader or producer can hedge exposure to adverse consequences resulting from new information by using options markets, the role of production and supply forecasts in determining pricing behavior may have changed. Also, the U.S. share of world soybean and corn trade has changed in recent years, with the U.S. generally becoming a less dominant market participant. Over this same period U.S. crop production reports have coincided with the release of the WASDE reports. This may have implications for the relative importance of domestic crop reports versus world supply and demand reports.

Improvements in communications technology may have implications for the accuracy with which private analysts anticipate the information contained in forthcoming reports. Some private reporting firms now conduct producer surveys on a regular basis, and thus may have access to much the same type information collected by USDA. All these events suggest that the role of USDA reports in guiding traders to price discovery may have changed in recent years.

Objectives

The purpose of this analysis is to evaluate the effects of USDA Crop Production Reports and USDA World Agricultural Supply and Demand Reports in light of substantial changes in both domestic and world grain markets. More

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specifically, we explore market reactions to USDA reports over the recent historical period in which both futures and options on corn and soybeans have been actively traded, as well as trading periods before options on agricultural futures were available.

Our empirical procedure is to compare futures price and option premium movements on release dates to their movements on non-release dates. The specific futures and options contracts considered are the January soybean and the December corn contacts. These were selected to roughly coincide with the U.S. harvest and to allow consideration of the impact of production reports on a single contract over complete crop years. The data consists of daily observations, and includes the settlement futures price, options premiums for all traded strike prices of both puts and calls, and a zero-one dummy variable for report dates.

Empirical Approach

The impact of USDA reports on futures and options markets was tested two ways. The first consisted of measuring the absolute differences between price changes following a report release and the differences on non-report trading days. If the USDA reports provide news to the market, then we would expect the mean absolute price change (or option premium change) to be greater following the release of a report relative to non-report days. This methodology is similar to that of Sumner and Mueller. The second test of report news employed regression analysis. This allowed an explicit measure of magnitude related to a report's news. As discussed more fully below, the regression models essentially involve regressing the absolute price changes on a dummy variable for report release dates and other explanatory variables.

The empirical analysis utilized the movements of closing prices for soybean and corn contracts traded at the Chicago Board of Trade. Daily data for all trading days from January 1968 through December 1989 for corn futures, January 1969 through December 1989 for soybean futures, and January 1985 through December 1988 for options were collected.[2] Analyses were conducted using all available data, using only data for the report day and four trading days before and after the report day, and using only three option strike prices for each trading day; one in, one out, and one nearest to the money. In general, the quality of the results was invariant with respect to the number of non-report days included, and with regard to the number of strikes for each option.

For the period 1969 through 1984, the only crop reports directly relevant to corn and soybeans are those released July through November, and the January annual update. Thus, the early data period only considered the impact of reports for the months July through November. Beginning in 1985, WASDE reports were released in conjunction with domestic crop reports. The WASDE reports contain information germane to international corn and soybean markets each month. Thus, beginning in 1985 all months were considered in the empirical analysis. In addition, results were disaggregated by month to examine the impact of WASDE reports (i.e. January through June releases) relative to months when relevant domestic reports are also released.

Two measures of price change were used. Both are based on the absolute difference between daily closing prices (or options premiums). For report days, the relevant prices are the closing price the day the report is released and the closing price the following trading day. The USDA releases reports after the close of futures trading. In addition, they employ considerable effort to insure that information contained in the reports is not leaked until it is officially released. If a report is released on October 10, the relevant measure of market reaction is the absolute difference between the closing price on October 10 and the closing price on October 11. Differences between prices on all other trading days represent non-report price movements.

The measures of price change included a relative price change variable and a nominal price change variable. The relative price change variable was used to account for differences in price levels over the data period. This was not as important a consideration during the relatively short trading period for options. However, results are invariant with respect to the measure of price change employed, and thus results are reported for the relative price change variable. This variable is defined as:

$$ABS[\Delta P/P_{t-1}] = ABS[(P_t - P_{t-1})/(P_{t-1})]$$

where ABS refers to absolute value, and p represents either futures prices or options premiums.

Means Tests for Report Effects

Descriptive statistics were initially tabulated for the relative price changes of futures and options for each commodity. The results suggested that mean price changes for both options and futures were generally not significantly different from zero. Also, consistent with the findings of Sumner and Mueller, we found no evidence of serial correlation between day to day price movements. This suggests that the statistical tests used below are appropriate.

To test for differences in mean price changes between report and non-report trading days, a series of t-tests were employed. The usual formulation of the t-statistic is:

$$t = (\bar{x}_1 - \bar{x}_2)/\sqrt{s^2(1/n_1 + 1/n_2)}$$

where $\bar{x}_1$ and $\bar{x}_2$ are the means from two independent samples, n_1 and n_2 are the number of observations from each sample, and s^2 is the pooled variance. The pooled variance is calculated as:

$$s^2 = [(n_1-1)s_1^2 + (n_2-1)s_2^2]/(n_1+n_2-2)$$

where s_1^2 and s_2^2 are the variances of the two groups. This specification of the t-test assumes that the population variances of the two groups are equal.

If the variances of the two groups are not equal, the t-test is specified as:

$$t = (\overline{x_1} - \overline{x_2}) / \sqrt{s_1^2/n_1 + s_2^2/n_2}$$

with degrees of freedom approximated by:

$$DF = \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{s_1^2/n_1)^2/n_1-1) + (s_2^2/n_2)^2/(n_2-1)}$$

where all variables are as previously defined.

To test the assumption of equal variances a two-tailed F-test was conducted. This test is specified as:

$$F = (\text{larger of } s_1^2, s_2^2)/(\text{smaller of } s_1^2, s_2^2)$$

Several combinations of t-tests were conducted to determine if the mean changes in futures prices and options premiums are significantly different immediately following the release of a report versus non-report days. For options, the tests were initially conducted combining all strike prices for a given commodity and option. For example, the mean percentage change in the options premiums for all soybean puts on non-report days was compared with the mean percentage premium change on report days. The tests were also conducted by month. This allowed a comparison of effects for times when only the WASDE was relevant versus times when both WASDE and domestic reports related to corn and soybeans. In addition, the tests were conducted by strike price, and by strike price and month. The tests by strike price were not particularly informative because many strikes had only four or five report day observations resulting in few degrees of freedom.[3] With all these tests, a folded F test was conducted to test the appropriateness of the assumption of equal variances for report versus non-report days. In general, the hypothesis of equal variances was supported. In those instances when it was not, the t-tests were adjusted to account for the assumption of unequal variances.

T-tests were also conducted eliminating all options in which there was no trading volume. The rationale was that options with strikes furthest from the futures would be the ones with little or no volume, and being so far in or out of the money might not reveal a report effect even if one existed for the market in general. Thus, using the non-traded options might bias the results in favor of the null hypothesis of no report effect. However, a lack of trading volume may have implications for the informational content of a report, and as such, eliminating no volume options from the set of observations may not be appropriate. The quality of the results turns out to be invariant with respect to keeping or deleting no volume options.

T-tests were also conducted using only option strike prices nearest the futures, and including only the four trading days before and after the report trade day. These include an at-the-money option (or the one closest to the futures price), the nearest out-of-the-money option, and the nearest in-the-money option. The rational behind three strikes is that they are the most actively traded options, and are likely the most sensitive to information which impacts the futures price since their intrinsic values could change in sign as a result of a futures price change. We restricted the sample to four days before and after the reports to account for the possibility that trading activity is suppressed in anticipation of a report, and then increases after the report is released. Our results suggest that trading activity just before a report release is not systematically different from other trading days. The test detected no difference in results associated with using all non-report trading days as opposed to only those days immediately before and after a report release.

Table 1 provides t- and f- statistics for this last group of observations. Table 2 provides the same statistics by month. The analysis suggests that, in general, there was no news impact from USDA reports on options markets over the data period considered. However, there are some exceptions identified in Table 3. For example, the mean premium change for soybean call options in June following release of a report is significantly different at the five percent level than premium changes four days before and four days after the report release. Note that the premium change following a report, however, is actually smaller than the premium change on non-report days. For soybean puts, four exceptions exist. February and June reflect a difference in mean premium changes on report and non-report days at the five percent level of significance, and May and July show a significant difference at the one percent level. Note that two of the months show the premium change following a report to be larger than the other trading days, and two show the report change to be smaller than non-report changes. The premium effects in the corn market are similar to those for soybeans.

Based on the t-tests, we find no significant price effect resulting from report releases in corn and soybean options markets. This evidence suggests no new information was provided by either WASDE or domestic production reports for the period 1985 to 1988. This is in contrast to the findings of Sumner and Mueller for futures markets.

Monthly evidence of the impact of USDA reports in corn and soybean futures markets is given in Tables 3 and 4. Table 3 presents t-tests for the data period 1968 through 1989. The months considered are July through November since no other reports were directly relevant to corn and soybean markets for the period prior to 1985. Note that these results are consistent with those of Sumner and Mueller for 1961 through 1982. In every case, for both commodities, the absolute price change following a report is greater than non-report days. In addition, the mean price changes between report and non-report trading days are statistically significant at the five percent level for all months and commodities considered. Note further that price changes are larger following a report than on non-report days.

Table 4 presents t-tests for futures by month for that subset of the data period in which options have traded. Note that these results differ from those reported above and from those of Sumner and Mueller. In general, mean price changes for both corn and soybeans are no different following release of a report than on non-report days.

In addition to the results listed, t-tests were conducted for the sub-periods 1969-1982, 1982-1989, and 1982-1985. The first subset represents the data period which overlaps between our sample and the sample of Sumner and Mueller. For this sub-sample, our results are similar in quality to those in the first half of Table 3, and consistent with Sumner and Mueller. The second period, 1982-1989, represents the most recent futures trading history not included in Sumner and Mueller. In this period, mean price changes following reports were essentially no different than non-report dates.

The last period, 1982-1985, represents the period after Sumner and Mueller and before agricultural options were available. The t-tests for this period suggest that USDA reports for July through November were providing news to futures markets. There was no evidence of news for report dates which only apply to WASDE reports.

The t-tests provide evidence that futures markets reacted to the release of USDA domestic production reports prior to 1985. The conclusion drawn is that the domestic production reports did in fact provide news to the markets. Since 1985, however, both futures and options markets appear to be less affected by USDA reports than in earlier years. This is true for both WASDE and domestic production reports. The t-tests suggest no differential impact in price discovery in options or futures markets following a report release as compared to other trading days.

Regression Tests for Report Effects

The results presented in the previous section may suggest that USDA reports are no longer an important source of supply and demand news for corn and soybean markets. However, a definitive conclusion is premature. In order to more fully understand the t-test results, we introduce and test the following hypotheses using regression analysis.

Hypothesis 1. Private analysts have gotten better at anticipating the information in upcoming USDA reports. Advances in communication and forecasting technology have provided better access to the same sort of data and surveys used by USDA in compiling reports, and private analysts now accurately anticipate the information in forthcoming USDA reports.

Hypothesis 2. Prices for much of the 1985-1989 sample period were at or near the loan rate, and world markets experienced large surpluses of corn and soybeans. There may have been news in USDA reports, but economic conditions in the relevant markets were such that the news released had no impact on price levels which were already supported above market clearing levels.

Hypothesis 3. The U.S. share of world corn and soybean markets has fallen considerably over the sample period, thus domestic production reports have become less important. They may still contain news, but the news relates to a reduced market share and is not weighted as heavily by the market. This still would not explain the lack of response to WASDE by market participants.

Hypothesis 4. USDA reports still provide news to the market, but the news cannot be measured directly by price changes because traders use options markets to hedge futures positions against the adverse consequences of news.

In order to test the above hypotheses several regression tests were employed. To test hypothesis 1, private analysts have become better forecasters, the absolute futures price change variable was regressed on a linear trend variable, the dummy variable for report days, and an interaction term between the trend variable and the report day variable:

$$\Delta P = \alpha + \beta_1 SIG + \beta_2 TREND + \beta_3 INER$$

where ΔP is the absolute relative price change variable, SIG is the zero/one dummy variable for report dates, TREND is a linear trend variable, and INER is an interaction term between the trend and report day variables. The results of this test are presented in Table 5. For both corn and soybeans, the report date variable is statistically significant at the one percent level and of the expected sign. Neither equation, however, shows the linear trend variable to be statistically significant at the one or five percent levels, however. For soybeans the interaction term is also insignificant, suggesting no improvement in private analysts' forecasts of USDA report information for soybeans over the sample period. For corn, however, the interaction term is significant. The negative sign on the interaction term suggests that market participants may have become better at anticipating report news. However, the size of the coefficient is extremely small relative to the size of the price change variable. The implication is its actual impact on the price change variable is negligible. While this provides some evidence that corn market participants have become better at anticipating the information forthcoming in USDA reports over time, the evidence is at best weak. This coupled with the soybean results suggest it is unlikely private analysts have replaced USDA as a primary source of supply and demand information in commodity markets.

The test for hypothesis 2, prices for much of the 1985-1989 period were supported above market clearing levels and thus insensitive to report news, was conducted with the following regression equation:

$$\Delta P = \alpha + \beta_1 SIG + \beta_2 PRICE/LOAN + \beta_3 INER$$

where ΔP and SIG are as before, PRICE/LOAN is the price to U.S. loan rate ratio,[4] and INER is again in interaction term. The results of this test are also in Table 5. Note that the interaction term between the price to loan rate ratio and the report date is statistically significant at the five percent level in the soybean equation. In addition, the sign on the variable is positive. This suggests that the changes in soybean futures prices are sensitive to the relationship between price levels and U.S. support prices.

For corn, the price to loan rate ratio is significant but the interaction between the ratio variable and the report day variable is only significant at the ten percent level. While the evidence for corn is not so strong as for soybeans, there is still reason to believe that price levels in the middle 1980's dampened the effects of USDA reports on market prices. An examination of the ratio variable for corn reveals that prices were at or below loan rates for the sample months in 1982, and from 1985 through 1987. Except for 1982, the same is generally true for soybeans. This provides some evidence that USDA reports could have provided news to markets, but prices were already supported above market clearing levels, and as a result the news had no measurable price effect.

Hypothesis 3, the impact of a reduced U.S. share of corn and soybean trade, was explored using the model:

$$\Delta P = \alpha + \beta_1 SIG + \beta_2 \frac{US\ EXP}{W\ EXP} + \beta_3 INER$$

where all variables are as previously defined, and US EXP/W EXP is the ratio of U.S. to world exports for each commodity. These results are in Table 5.

Note that for corn the interaction term between U.S. market share and report dates is statistically insignificant. This suggests that changes in U.S. market share have not impacted on the importance of domestic supply and demand information in futures market price discovery for corn.

For soybeans there is evidence of a trade effect. The negative sign on the interaction term suggests that as the U.S. share of world soybean trade falls, domestic crop production reports are associated with larger futures price changes. This evidence is contrary to the evidence suggested by the t-tests.

The final hypothesis, option trading has impacted on the measurable reactions of futures traders to USDA reports, was tested with the model:

$$\Delta P = \alpha + \beta_1 SIG + \beta_2 OPT + \beta_3 INER$$

where all variables are as before and OPT is a zero/one dummy variable. It is zero for trading days before options were traded, and one for trading days after the introduction of options. The results from this test are also in Table 5. For both corn and soybeans, the interaction terms between options trading and USDA reports are statistically significant. The results suggest that options trading has influenced the way futures markets react to USDA reports. The negative sign on the interaction variable suggests that the introduction of agricultural options has resulted in price changes which are smaller following a report release than in previous trading periods. This is consistent with the t-test results, and suggests that traders may be using options markets to mitigate the impacts of adverse news on a futures position. These results do not address the specific options strategies employed by traders, but of the four hypotheses considered, the fourth provides the most significant and consistent results across the two commodities.

Conclusion

The empirical results presented above suggest a change in the way USDA reports are digested by market participants. Specifically, from 1985 through 1989 report releases were found not to result in abnormally large price movements. This is in contrast to the result of both this study and others for periods prior to 1985. Based solely on t-tests, one might conclude that USDA reports no longer provide news to markets; participants have become sufficiently skilled to anticipate the information forthcoming, and thus no market reaction is detected. Based on regression tests, however, it appears that this conclusions is unfounded.

The regression tests specifically tested four hypotheses relative to the impact of USDA reports. The evidence in support of hypothesis one, private analysts have become better forecasters, is at best weak and inconsistent across commodities. For soybeans, we find no support for this hypothesis. For corn, we find the relevant interaction variable to be statistically significant, but the magnitude of the coefficient is so small relative to the dependent variable as to render its impact essentially negligible.

Tests of the second hypothesis, effects of the price to loan rate ratio, are more consistent and generally support the hypothesis. The price to loan rate ratio is an important component of price change for soybeans. Evidence of an effect also exists for corn. The positive sign on the price to loan rate interaction terms are as expected; the smaller the price to loan rate ratio the smaller the price change effect of a USDA report.

Hypothesis three, effects of U.S. trade share, is not supported for corn. Market reactions to domestic crop reports appear to be insensitive to historical changes in the U.S. relative share of corn trade. Evidence of a trade effect does exist for soybeans. In general, we would expect a larger effect in soybean markets as opposed to corn. The U.S. share of soybean trade through the 1980's has slipped from a high in excess of 60 percent to below 50 percent. While there has been some variation in the U.S. share of corn trade,, the current U.S. share is very near its decade high. The U.S. share of corn trade has not experienced as steady a decline as the U.S. soybean trade share.

The last test, the impact of options on market reactions to reports, provides the clearest evidence of a report effect for both markets. The results presented here suggest that the introduction of options has been an important factor in determining how market participants react to USDA reports. Furthermore, the regression tests suggest that it would be unfounded to endorse the hypothesis that USDA reports no longer provide news to the market. It is more likely that reports provide news but the news impact can no longer be measured by a simple price change variable.

Suggestions for Further Research

In light of the results above, several areas of research seem warranted. First, if futures traders use options to offset risk exposure to report news, then a report effect might more appropriately be measured by looking at futures price volatility on report versus non-report trading days, rather than

price changes. Also, further evidence of an option effect might be found by comparing options trade volume on report versus non-report days. Is there an increase in options volume just before a report is released? This might be expected if futures traders do in fact seek protection in options markets.

Second, we have not attempted to explain how traders use options to offset the futures price risk. Investigation into how traders use options would not only provide more insight to the question at hand, but also provide help in understanding the general relationship between options and futures markets.

Lastly, this study makes no attempt to address relative benefits and costs of public reporting. Given current budget considerations, this may be an important area of research.

Endnotes

1. Their work was preceded by several others who were interested in informational aspects of public reports. These include Choi, Gorham, Hoffman, Miller, and Pearson and Houck. The results from this body of literature have been mixed.

2. Options on soybeans started trading in November, 1984. Corn options began trading in February, 1985. A calendar year data period was chosen for simplicity. We a currently updating the options results to include 1989. These results, however, are not yet complete.

3. In general the degrees of freedom for options are misleading. Many of the option strikes are not independent since they are based on the same expiration date and futures price. For soybeans there were 44 report dates, and for corn 43. This implies the number of independent means for the t- and f- statistics was substantially less than the degrees of freedom reported in Table 1.

4. From 1984 on the loan rate was adjusted to reflect reductions imposed by the Gramm-Rudman deficit reduction act.

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