The Reaction of Corn and Soybean Futures Markets to USDA Crop Progress and Condition Information

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Abstract

The objective of this study is to investigate the reactions of corn and soybean futures markets to crop progress and condition information of USDA's Crop Progress (CP) reports in an event study methodology over the period 1986 to 2012. Results show, first, significant differences in close-to-open return variability on report release trading days and pre- and postreport days, and second, market prices tend to react rapidly to new crop condition information in the indicated direction by changes in crop condition. Strongest market reactions for reports containing both crop progress and condition information could be found for summer months of July and August when weather conditions (precipitation and temperature) are most critical for the crop. Furthermore, the results show that the reactions of CP reports have increased over time. Overall, price reaction analyses in this study suggest that USDA's CP reports have substantial informational value.

Key Words: condition, corn, market reaction, progress, soybeans

JEL Classifications: G14, Q11, Q13

Introduction

Each week over the growing season (April through November), the Agricultural Statistics Board of the U.S. Department of Agriculture (USDA) releases its Crop Progress (CP) report. The report contains weekly estimates of crop progress and condition of selected crops in major producing states. Those estimates represent direct assessments of the overall status of a crop on a weekly basis throughout the growing season. They provide information for projecting crop yields and, hence, crop supplies in the coming harvest. Combined with demand expectations, they lead to crop price expectations.

A large body of empirical research has examined the value and impact of public information in agricultural markets. Studies have mostly been focused on the impact of USDA reports such as corn and soybean production forecasts, harvest forecasts and, in particular, World Agricultural Supply and Demand Estimates (WASDE) reports on corn and soybean prices (e.g., Fortenbery and Sumner, 1993; Garcia et al., 1997; Isengildina-Massa et al., 2008) or hogs and pigs, cattle on feed, and cold storage reports on cattle and hog prices (e.g., Colling and Irwin, 1990; Grunewald, McNulty, and Biere, 1993; Isengildina, Irwin, and Good, 2006). The majority of studies has found significant market impacts to the release of USDA reports, indicating that public information released by USDA generates economic welfare benefits (Falk and Orazem, 1985).

However, while crop condition data for corn and soybeans are widely used by market analysts, very little academic research has been focused on crop progress and condition information. Only a few academic studies have formally investigated the use of crop condition information, e.g., in modeling crop yields (Fackler and Norwood, 1999; Kruse and Smith, 1994). There is, in fact, no academic analysis available on the informational value and market impact of CP reports. Given the importance of crop progress and condition information on expected crop yield and the lack of previous research, a detailed examination of the reaction of corn and soybean futures markets to crop progress and condition information is needed.

Therefore, the objective of this study is to investigate price reactions in the futures markets in response to the release of corn and soybeans progress and condition information in an event study methodology. Aggregate U.S. crop progress and condition data for corn and soybeans for 1986 through 2012 are available on the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service Quick Stats website. Daily returns of new-crop corn (December) and soybean (November) futures contracts are used.

This paper is structured as follows. The concept of event study methodologies and market efficiency is briefly outlined in the following section. Then, crop progress and condition data are explained in more detail, and futures markets returns and related issues for event studies are discussed. Next, to examine reactions on the corn and soybean markets to crop progress and condition information, an announcement analysis on the return variability on report release trading days and pre- and postreport days is conducted, and changes in crop condition information is tested for rational price impacts. Finally, this paper is summarized and conclusions are presented.

This study contributes new evidence regarding the informational value of USDA crop progress and condition information. The use of alternative statistical tests as a check on the robustness and consistency of results across different methodologies, a relatively long sample period of 27 years, and variable market conditions over the sample provide conclusive evidence about the market impact of CP reports in corn and soybean futures markets.

Event Study Methodology and Market Efficiency

Event study analyses are based on the notion that if prices react to the announcement of information ("the event") in an efficient market, then the information is valuable to market participants (Campbell, Lo, and MacKinlay, 1997). New crop progress and condition information will change supply perceptions of market participants, and changed expectations will be reflected in a movement in the market price. Since the direction in which the expectations are changed is a priori unknown, the movements in market prices can either be positive or negative. While an average of market price movements is perhaps zero, the variability of price returns around the release of new important announcements should be greater than the "normal" variability on days without announcements

(Sumner and Mueller, 1989; Isengildina-Massa et al., 2008). Therefore, USDA reports are valuable to the market if the variability of price returns around the release of reports is significantly greater than the variability on days without report releases.

This reasoning in event studies assumes that markets are less than strong-form efficient. In strong-form market efficiency (Fama, 1970) futures prices reflect all information, public and private. Markets should be able to fully anticipate not only market information contained in news announcements, but also all private ("insider") information possessed by market participants. The variability of price returns around releases of announcements would be the same as on days without any announcements. However, previous studies on market efficiency mostly reject that markets, including agricultural futures markets, are strong-form efficient (e.g., Fama, 1991; Zulauf and Irwin, 1998). Thus, the event study methodology in this paper assumes that agricultural futures markets are less than strong-form efficient.

Under at least semi-strong-form efficiency, prices should adjust to publicly available new information very rapidly and in an unbiased way (Fama, 1970). This implies that, if the new information is valuable to market participants, the price adjustments to information contained in CP reports must be instantaneous in the indicated direction after the release of the report. As CP reports are released after the end of the daily trading session, price adjustments of corn and soybean futures should be reflected best by close-to-open returns.

To examine the reaction of crop progress and condition information on the corn and soybean markets, two lines of event study methods are used. First, an announcement effect analysis similar to, e.g., Isengildina-Massa et al. (2008) and Sumner and Mueller (1989) is employed. Statistical tests are used to detect differences in close-to-open return variability on report release trading days and pre- and postreport days. If CP reports contain valuable information for market participants in an efficient market, then price movements on days following report releases must be larger than other days. In addition, CP reports are divided into two groups: one that includes crop progress and condition information; and one that is limited only to crop progress information (at the beginning and at the end of the growing season). Second, an market impact analysis similar to, e.g., Garcia et al. (1997) and Grunewald, McNulty and Biere (1993) is conducted. It is tested whether market prices react to new crop condition information in the indicated direction. In an (at least semi-strong) efficient market, prices should react quickly and in an unbiased way to new information entering the market. In both analyses, market reactions are tested for all announcement weeks jointly from early April through the end of November as well as for individual calendar months. Possible changes in the market reaction to CP reports due to changing supply/demand conditions and different U.S. agricultural policy regimes are analyzed by examining market impact in four different subsamples.

Crop Progress and Condition Data

CP reports contain weekly crop progress and condition information over the growing season that provides, e.g., a major input for yield projections such as given in WASDE reports. The CP report issued by the USDA lists cumulative planting, fruiting, and harvesting progress and crop condition of selected crops in major producing states. Reports are released at 4:00 p.m. EST each Monday, except for holidays, after the end of the daily trading session at the Chicago Board of Trade (CBOT). Crop progress and condition estimates are based on survey data collected from around 4,000 respondents. Based on standard definitions, respondents subjectively estimate the progress of crops through the stages of development, the progress of producer activities, and they provide subjective evaluations of crop conditions. Respondents are asked to report for the entire week ending on Sunday. County data are summarized to state levels, weighting each county's reported data by county acreage estimates. Finally, state level data are compiled into a national level summary by weighting each state by its acreage estimates. Data are reviewed for reasonableness and consistency in all stages. Progress data are expressed as percentage of the crop planted, silking, dough, dented, mature, and harvested for corn and planted, blooming, setting pods, dropping leaves, and harvested for soybeans. Condition data are expressed as percentage of the crop in excellent, good, fair, poor, and very poor condition. They should reflect the effects of all variables on the status of a crop, including planting date, temperature, precipitation, solar radiation, insect infestation, disease, etc. Thus, the reports are considered as to contain important information for market participants since they describe how well corn and soybeans are developing during the growing season.

The data analyzed in this study (the "events") include the release of all CP reports over the period 1986 through 2012 from early April through the end of November that contain corn or soybean progress or condition information. 940 reports containing corn and 890 reports containing soybean progress or condition information were released in the sample period. Reports are divided into two groups. The first group consists of reports that contain crop progress and condition information (554 and 486 reports for corn and soybeans, respectively). The second group consists of reports that are limited only to crop progress information at the beginning and at the end of the growing season (386 and 404 reports for corn and soybeans, respectively). Data are obtained from the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service Quick Stats website.

Futures Price Data

Daily returns of new-crop corn (December) and soybean (November) futures contracts are collected over the period 1986 through 2012. New-crop contracts are used since progress and condition information contained in CP reports are mainly new-crop information. Thus, it is reasonable to argue that the best measurement of price reactions of progress and condition information can be derived from new-crop contracts (December corn and November soybeans) for each report release.

Report release events are always on the first day of the week since they are released on Monday, or the following day if Monday is a holiday. Therefore, day-of-the-week effects in futures returns and their variability have to be taken into account (e.g., Isengildina, Irwin, and Good, 2006; Junkus, 1986; Yang and Brorsen, 1994). Specifically, weekend overnight effects may bias tests to detect differences in close-to-open return variability on report release trading days and pre- and postreport days. Previous studies (e.g., Ferris and Chance, 1987; Fleming, Kirby and Ostidek, 2006) have indicated that the variability of close-to-open returns over the weekend (Friday close to Monday open) tends to be higher than over other days of the week. Event studies on other reports (e.g., WASDE, cattle on feed, cold storage) have not had to consider weekend effects as they are released on a monthly or less frequent basis and not on a particular day of the week. Weekend effects may be distributed evenly over their report release events since reports are released on different days of the week. However, weekend returns will not be sampled evenly around CP report releases since reports are issued on Mondays, or the following day. Summary statistics for weekend and non-weekend close-to-open returns are given in Table 1 from April to November, 1986 through 2012, for the new-crop corn (December) and soybeans (November) futures contract, respectively. The variance of close-to-open returns is significantly greater and returns show a significant negative mean over the weekend. These effects will substantially bias results for market reactions to the release of CP reports. Thus, weekend returns are omitted from the data for the analyses in this paper.

Previous event studies on agricultural futures markets have discussed that the analysis of market reactions is complicated by limit moves (e.g., Colling and Irwin, 1990; Isengildina-Massa et al., 2008; Sumner and Mueller, 1989). Limit moves in futures markets restrict daily futures price movements, and thus may bias estimates of price reactions. Tests may underestimate the significance of announcement effects and price impacts. However, only a small portion of the trading days has limit moves.[1] Furthermore, McKenzie, Thomsen, and Dixon (2004) conducted Monte Carlo simulations to assess the inferential accuracy of event studies on daily futures returns in the presence of price limits. Their results show that price limits are unlikely to lead to a failure to detect price reactions when they actually exist. Thus, this indicates that price limits are not likely to bias market reaction tests substantially (Isengildina-Massa et al., 2008).

[1]The daily price limit for CBOT corn contracts was set to 10¢/bushel (expandable to 15¢/bu.) until January 1994, 12¢/bu. (expandable to 18¢/bu.) from January 1994 to September 2000, 20¢/bu. from September 2000 to April 2008, 30¢/bu. (expandable to 45¢/bu. and 70¢/bu.) from April 2008 to August 2011, and 40¢/bu. (expandable to 60¢/bu.) since that time. Out of a total of 3631 non-weekend price changes included in this study, corn futures were subject to limit moves 17 times on a close-to-open basis and 54 times on a close-to-close basis, or 0.5% and 1.5%, respectively. On CP report release days with reports containing corn progress or condition information, corn futures reached the limit only eight times on a close-to-open basis and 17 times on a close-to-close basis out of 940 release days, or 0.9% and 1.8%, respectively. For CBOT soybean contracts, daily price changes were limited to 30¢/bu. (expandable to 45¢/bu.) until September 2000, 50¢/bu. from September 2000 to April 2008, and 70¢/bu. (expandable to 105¢/bu. and 160¢/bu.) since that time. On the 3429 non-weekend price changes, soybean futures prices hit the limit nine times on a close-to-open basis and 25 times on a close-to-close basis, or 0.3% and 0.7%, respectively. On CP report release days with reports containing soybean progress or condition information, soybean futures reached the limit only two times on a close-to-open basis and seven times on a close-to-close basis out of 890 release days, or 0.2% and 0.8%, respectively.

Announcement Effect Analysis

In the announcement effect analysis conducted in this paper, statistical tests are used to detect differences in close-to-open return variability on report release trading days and pre- and postreport days. If CP reports contain valuable information for market participants in an efficient market, then price movements on days following report releases must be larger than other days.

Out of the non-weekend returns, data are selected for two trading days before the release of each CP report, the day of the release, and two trading days after the release of each CP report, or a total of five days for each release over the sample period. Close-to-open futures returns for a specific CP release are computed as

$$r_{t,i} = \ln\left(\frac{p^{o}_{t,i}}{p^{c}_{t-1,i}}\right) \times 100, \tag{1}$$

with $t = -2, \ldots, 0, \ldots, +2$, $p^{o}_{t,i}$ is the opening price of the new-crop corn (December) and soybeans (November) futures contract for trading day t and event i, $p^{c}_{t-1,i}$ is the closing price of the new-crop corn (December) and soybeans (November) futures contract for trading day $t-1$ and event i, and ln is the natural logarithm. Thus, two returns are computed before the CP release date, one return is computed for the report release date, and two returns are computed after the release. Hence, the total length of the event window is five trading days. A wider event window would frequently overlap with report release days in the following or previous week due to holidays.

Summary statistics for corn and soybeans close-to-open returns are given in Table 2. The returns used for the statistics include all report release day returns and pre- and postrelease day returns without weekends. The means of both the corn and soybeans returns are very small and insignificantly different from zero. On the other hand, the mean of the absolute returns is significantly different from zero, reflecting the variability in price movements. Significant skewness and kurtosis statistics indicate that return distributions are positively skewed and have fatter tails than a normal distribution. This is confirmed by Jarque-Bera tests since they strongly reject the null-hypothesis of normality in all cases. Non-normality is a well known distributional characteristic of commodity futures returns since they appear to be skewed and leptokurtotic (e.g., Yang and Brorsen, 1994). This indicates that assumptions of normality in subsequent tests will be violated. Thus, to test the null hypothesis that return variability for report days and pre-/postreport days is equal, nonparametric tests on absolute returns (i.e., Kruskal-Wallis χ^2-tests) that do not rely on the assumption of normality are used to control and confirm the results of parametric tests (i.e., two-tailed F-tests).

Table 3 shows statistical test results on the variability of report days and pre-/postreport days for the entire sample period, 1986 through 2012. Return variance on CP report release days is 1.49 times greater than pre-/postreport day variance for corn and 1.37 times greater for soybeans. The presented parametric and nonparametric test statistics show that the increase in return variability on report days is consistently significant for corn and soybeans at the 1% level.[2] These results indicate that new crop progress and condition information contained in USDA CP reports generally changes supply expectations of market participants, as they are reflected in greater movements in the futures market price.[3]

Furthermore, announcement effects are tested for two groups of reports: reports that include crop progress and condition information; and reports that are limited only to crop progress information. Results for the two groups in Table 3 show that return variance on report release days containing crop progress and condition information is 1.66 times greater than pre-/postreport day variance for corn and 1.58 times greater for soybeans. The increase in return variability on report days is significant at the 1% level. On the other hand, for reports containing only progress information, return variance on report release days is similar to pre-/postreport day variance for corn and soybeans. The null hypothesis that return variability for report days and pre-/postreport days is equal could not be rejected. This may imply that only condition information in CP reports

[2]Other parametric (Bartlett test, Levene test, and Brown-Forsythe test) and nonparametric tests on absolute returns (Mann-Whitney, chi-square) are applied to insure that results are not sensitive to test selection. These additional tests reject the null hypothesis that return variability for report days and pre-/postreport days is equal at the same level of significance. Moreover, the same results are obtained from all tests when comparing report day return variability to prereport, postreport, or combined pre- and postreport day return variability. To conserve space, these results are not presented. They are available from the author upon request.

[3]Note, however, that announcement effects of CP reports presented in this study are smaller in comparison to other less frequent USDA reports, e.g. WASDE reports (Isengildina-Massa et al., 2008).

has impacts on futures markets returns. Condition information represents direct assessments of the overall status of a crop throughout the growing season. It should reflect the effects of all variables on the condition of a crop, including planting date, temperature, precipitation, etc. Thus, presented results suggest that, in particular, changes in crop condition tend to change supply expectations of market participants, and condition information included in USDA' CP reports is valuable to market participants.

Announcement effects are additionally tested for individual calendar months, from April through November. Table 3 shows consistent evidence (both parametric and nonparametric tests are significant) of market reactions for both corn and soybean futures prices only in July and August. The largest relative impacts are evident for the months of July and August. Return variance on reports in July is 2.02 times greater than pre-/postreport variance for corn and for soybeans. Return variance on reports in August is 2.47 times greater than pre-/postreport variance for corn and 2.36 times greater for soybeans. The changes are not only greatest in relative but also in absolute values. In absolute terms, CP reports in July cause the largest absolute changes in return variance for corn (0.68) and soybean futures (0.58), followed by August with absolute changes in return variance for corn (0.48) and soybeans (0.35).

A study conducted by Tannura, Irwin and Good (2008) shows that crop yield variation is largely explained by precipitation and temperature (besides technological improvements) during the reproductive periods for corn and soybeans in the U.S. Corn Belt. They provide evidence that corn and soybean yields are overwhelmingly determined by summer (July and August) weather conditions. Thus, as crop condition information included in CP reports reflect changes in temperature and precipitation, market reactions are strongest during July and August. In addition, return variance on report release days is consistently significant only for corn in May. This is perhaps because the very first condition information in a year tends to be included in CP reports in May, which may result in a greater change of market participant's expectations.

Finally, announcement effects are analyzed in subsamples. Previous event studies on agricultural futures markets (e.g., Garcia et al., 1997; Isengildina-Massa et al., 2008) have discussed that market reactions to USDA reports may vary over time due to changing market conditions and different U.S. agricultural policy regimes. To examine possible changes in market reactions to information contained in CP reports, the entire sample is divided into four subsamples (1986–1989, 1990–1995, 1996–2001, and 2002–2012). The sample split follows the reasoning of Isengildina-Massa et al. (2008). The first subsample is characterized by large year-to-year carryover of government owned stocks of grains and, consequently, low uncertainty with respect to future market conditions. In the other three subsample periods, year-to-year carryover of government owned stocks of grains was either low or nonexistent and, therefore, the uncertainty of future market conditions is higher. The third and forth subsamples are also characterized by increased market orientation of farm programs due to the 1996 and 2002 Farm Bills. Theoretically, crop progress and condition information should be more valuable to market participants (i.e., greater market reactions) when uncertainty about future market conditions is higher (Falk and Orazem, 1985).

Results for the four subsample periods are presented in Table 4. Most important, for the first and second subsample, results suggest that return variance on report release days is generally similar to pre-/postreport day variance for corn and soybeans since the null hypothesis that return variability is equal could not be rejected. For the third and forth subsample, however, results are consistent with the results for the entire sample. Consistently significant results are obtained for all CP reports and reports containing condition and progress information for corn and soybeans while only mixed evidence is found for reports containing only crop progress information (with the exception of corn in the forth sample period).[4] This indicates that market participants did not significantly change their future market perceptions based on information in CP reports in the first and second subsample period while crop progress and condition information is significantly valuable to market participants in the third and forth subsample. Thus, this suggests that crop progress and condition information contained in USDA's CP reports are more valuable to market participants (i.e., greater

[4]Announcement effects are also tested for individual calendar months over the four subsample periods. Results on individual calendar months lead to the same conclusion as for the entire sample and for all report release dates in the subsample periods: Announcement effects are consistently significant in July and August, but only in the third and fourth sample period. To conserve space, these results are not presented and are available from the author upon request.

market reactions) when uncertainty about future market conditions is higher.

Market Impact Analysis

The market impact analysis on the informational value and price reaction to CP reports tests whether market prices react to new crop condition information in the indicated direction by changes in crop condition. In an (at least semi-strong) efficient market, prices should react quickly and in an unbiased way to new information entering the market.

Previous studies (e.g., Colling and Irwin,1990; Garcia et al., 1997; Grunewald, McNulty and Biere, 1993) distinguished between unanticipated and anticipated/expected components of information. Prices will react only to the unanticipated, or "news" component of the information, and thus, they investigated how unanticipated components influenced commodity futures prices. In their framework, unanticipated information is defined as the difference between private information and information contained in USDA reports. In the case of condition data, unanticipated information would be defined as the difference between private condition estimates and condition data contained in CP reports of corn and soybeans. In the previous studies, they used industry estimates, surveys and forecasts as proxies for private information. The USDA reports under their investigation are released on a monthly or less frequent basis, and industry estimates and forecasts are available. However, CP reports are released weekly over the growing season, and pre-report estimates are unavailable for corn and soybean crop condition. Hence, it is assumed that the crop condition contained in CP reports of the previous week serves as a proxy for available private and anticipated information, and the unanticipated component of crop condition is encompassed by the change of conditions in the CP report from the previous week to the next.

In an initial analysis, crop condition information is classified into "bullish", "bearish", and "neutral" price signals. In general, the relationship between corn and soybean futures prices and (unanticipated) changes in condition data should be negative. That means, if a report shows that conditions are lower than in the previous report, then prices should rise after the release of the report, and vice versa. Condition data are expressed as percentage of the crop in excellent, good, fair, poor, and very poor condition. As a proxy for overall condition, the sum of the percentages of the crop in excellent and good condition is compared on a weekly basis with condition decreases considered as "bullish", increases considered as "bearish", and constant conditions as "neutral" price signals. Furthermore, prices should adjust rapidly after the release of reports containing new market information. Price returns for the three groups of signals are analyzed on report release and postreport trading days. Price impacts should only occur instantly after the release of the report, with no impacts around the postreport trading days.

Table 5 presents the return means for the three categories of price signals for close-to-open and open-to-close returns on the report trading day ($t = 0$), and close-to-close returns on the following two postreport trading days ($t = 1$ and $t = 2$), respectively. That means, the possibility of predictable price patterns up to two days after the reports is also examined. Again, a wider event window would frequently overlap with report release days in the following week due to holidays. To control and confirm the results of parametric tests (T-tests), nonparametric tests (Wilcoxon-test) that do not rely on the assumption of normality are employed. Results indicate a significant and consistent pattern for corn and soybean futures returns. "Bullish" price signals lead to significantly positive price reactions and "bearish" price signals are followed by significantly negative price reactions only for the close-to-open report trading day. On the other hand, "neutral" signals do not cause any significant price reaction. Thus, these results suggest that prices react quickly and in the indicated direction to condition information included in CP reports.

Furthermore, the null hypothesis that there are no price impacts to unanticipated information is tested by specifying the regressions

$$\ln(p^{o}_{t,i}) - \ln(p^{c}_{t,i}) = \beta_0 + \beta_1[\ln(GX_i) - \ln(GX_{i-1})] + \varepsilon_{t,i}, \quad (2)$$

where the dependent variable $(\ln(p^{o}_{t,i}) - \ln(p^{c}_{t,i}))$ is the close-to-open return on the report trading day ($t = 0$) and event i, the independent variable $(\ln(GX_i) - \ln(GX_{i-1}))$ is the difference between the sum of the percentages of the crop in excellent and good condition for event i and the previous week $i-1$, and $\varepsilon_{t,i}$ is the error term. Again, the possibility of predictable price patterns up to two days after the reports is examined. That is, open-to-close returns on the report trading day ($t=0$) and close-to-close returns on the following two postreport trading days ($t=1$ and $t=2$) are considered as well. The null hypothesis of H_0: $\beta_1 = 0$ is tested. Condition data are transformed via natural logarithms; hence, the analysis is performed on a percentage basis. In addition, the potential for heteroscedasticity is considered, and tests for heteroscedasticity are performed for regression models. However, evidence of a serious heteroscedasticity problem is not found.

The results of the OLS estimation for corn and soybeans futures returns are presented in Table 6 for the entire sample period and the four subsamples. Results generally indicate that corn and soybean markets respond significantly and rapidly to changes in conditions. The signs of the coefficients are consistent with expectations, with crop conditions higher (lower) leading to decreases (increases) in prices after the release of the report. For the entire sample period, coefficient estimates are significant only for the close-to-open return on the report trading day. Significant results could not be found for the open-to-close return of the report trading day or the close-to-close returns on the following two postreport trading days. Hence, this supports that prices adjust rapidly in the indicated direction after the release of reports.

Similar as in the announcement effect analysis, for the first and second subsample, results do not generally suggest that corn and soybeans prices react to changes in condition data after the release of reports. For the third and forth subsample, however, coefficient estimates are significant as in the entire sample. It suggests that market participants did not significantly change their future market perceptions based on condition information in CP reports in the first and second subsample period while they significantly react to crop condition information in the third and forth subsample. This supports the evidence found in the announcement report analysis that information contained in CP reports are more valuable to market participants (i.e., greater market reactions) when uncertainty about future market conditions is higher (in the third and forth subsample period). In addition, price impact regressions are also tested for individual calendar months. Again, results on individual calendar months lead to similar conclusions as for the announcement effect analysis: Price impacts are strongest in summer (July and August) when weather conditions (precipitation and temperature) are critical for the crop.[5]

There are two further notable patterns of price reaction to crop condition changes in subsample periods presented in Table 6. For corn in the first subsample, there is a significant reaction indicated by the close-to-open return on the second postreport day. And, for soybeans in the forth subsample, the relatively large change in the magnitude of coefficients from the close-to-open to the following open-to-close return on the report release day suggests that overreaction may be present. However, due to the existence of price limits and execution costs, these results do not necessarily imply that a profitable trading strategy could be developed to exploit these price patterns in the respective subsample periods.

Summary and Conclusions

Crop Progress (CP) reports provide important information for projecting crop yields and, hence, crop supplies in the coming harvest. The purpose of this study was to investigate price reactions in the futures markets in response to the release of corn and soybeans progress and condition information in an event study methodology. Aggregate U.S. crop progress and condition data for corn and soybeans and daily returns of new-crop contracts (December corn and November soybeans), 1986 through 2012, were used. First, an announcement effect analysis with parametric and nonparametric statistical tests was conducted to detect differences in close-to-open return variability on report release trading days and pre- and postreport days, and second, a market impact analysis on price impacts to CP reports tested whether market prices react rapidly to new crop condition information in the indicated direction by changes in crop condition.

Empirical results presented in this study suggest that CP reports provide valuable information to corn and soybean futures markets. First, return variance on CP report release days is significantly greater than pre-/postreport day variance for corn and soybeans. This indicates that new crop progress and condition information changes supply perceptions of market participants, as changed

[5] To conserve space, these results are not presented and are available from the author upon request.

expectations are reflected in greater movement in the market price. Second, only CP reports containing both progress and condition information lead to announcement effects in the variance. This implies that, in particular, condition information in CP reports has major impacts on futures markets returns. Condition information represents direct assessments of the overall status of a crop throughout the growing season and should reflect the effects of all variables on the condition of a crop. However, this does not necessarily imply that crop progress information is without value since it is impossible to fully disentangle the separate impacts of progress and condition information due to the combined nature of CP reports. Third, results of the market impact analysis strongly suggest that prices react quickly and in the indicated direction to changes in condition information included in CP reports. Generally, price impact estimates are found only for the close-to-open return on the report trading day. Furthermore, strongest market reactions in the announcement effect and market impact analyses could be found for summer months of July and August. Corn and soybean yields are overwhelmingly determined by summer (July and August) weather conditions. As crop condition information included in CP reports reflect changes in temperature and precipitation, market reactions are strongest during July and August. Finally, the overall market reactions to CP reports have increased over time. From 1996 through 2012, results strongly suggest that corn and soybeans prices react to CP reports. From 1986 through 1995, however, results do not generally suggest market reactions. This indicates that crop progress and condition information contained in CP reports are more valuable to market participants (i.e., greater market reactions) when uncertainty about future market conditions is higher (1996 through 2012).

Overall, price impact analyses in this paper suggest that USDA's CP reports have substantial informational value. Thus, this study contributes new evidence regarding the value of USDA crop progress and condition information. Future research may investigate the use of condition data in improving crop yield forecasts throughout the growing season (Fackler and Norwood, 1999; Kruse and Smith, 1994), in particular over the summer months when weather conditions (precipitation and temperature) are critical for the crop.

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Table 1. Weekday Statistics for Corn and Soybean Close-to-Open Returns, April to November, 1986 – 2012

	Corn		Soybeans	
	Non-weekend	Weekend	Non-weekend	Weekend
Mean	0.00	-0.12**	0.01	-0.10**
Median	0.00	-0.13	-0.02	-0.10
Variance	0.38	1.24	0.30	1.13
F-test	3.29**		3.77**	
Data points	3631	941	3429	881

Note: Returns (r) are computed as the difference in the natural logarithm of price multiplied by 100. New-crop futures contracts (December corn and November soybeans) are used. Single (*) and double (**) asterisks denote significance at the 5% and 1% levels, respectively.

Table 2. Summary Statistics for Corn and Soybean Non-Weekend Close-to-Open Returns, April to November, 1986 – 2012

	Corn		Soybeans	
	r	$\|r\|$	r	$\|r\|$
Mean	0.00	0.35**	0.01	0.29**
Median	0.00	0.20	0.00	0.16
Variance	0.37	0.25	0.28	0.20
Skewness	1.11**	3.91**	1.09**	4.95**
Kurtosis	14.67**	22.14**	24.25**	36.62**
Jarque-Bera	42986**	107722**	108830**	264275**

Note: Returns (r) are computed as the difference in the natural logarithm of price multiplied by 100. Data are selected for two trading days before the release of each CP report, the day of the release, and two trading days after the release of each CP report, or a total of five days for each release over the sample period. Number of observations is 4700 for corn and 4418 for soybeans. Tests on the skewness and kurtosis are D'Agostino and Anscombe-Glynn tests for normal samples, respectively. New-crop futures contracts (December corn and November soybeans) are used. Single (*) and double (**) asterisks denote significance at the 5% and 1% levels, respectively.

Table 3. Futures Return Volatility Test Results for Crop Progress Reports for Corn and Soybeans, Non-Weekend Close-to-Open Returns, April to November, 1986–2012

	Corn						Soybeans					
Reports	N	Report Day Variance	Pre-/ Postreport Day Variance	Diff. in Report and Pre-/ Postreport Variance	F-Stat.	Kruskal-Wallis χ^2-Stat.	N	Report Day Variance	Pre-/ Postreport Day Variance	Diff. in Report and Pre-/ Postreport Variance	F-Stat.	Kruskal-Wallis χ^2-Stat.
All	940	0.51	0.34	0.17	1.49**	22.96**	890	0.36	0.26	0.10	1.37**	16.60**
Condition & Progress	554	0.67	0.40	0.26	1.66**	22.32**	486	0.53	0.33	0.19	1.58**	32.66**
Progress	386	0.27	0.25	0.03	1.12	3.13	404	0.16	0.17	-0.01	0.95	0.10
April	114	0.22	0.18	0.04	1.23	7.19*	114	0.07	0.05	0.02	1.35*	0.68
May	116	0.49	0.30	0.19	1.64**	13.78**	116	0.25	0.18	0.07	1.40*	0.37
June	120	0.63	0.52	0.10	1.20	3.08	120	0.28	0.47	-0.20	0.58**	0.80
July	119	1.35	0.67	0.68	2.02**	15.68**	119	1.16	0.57	0.58	2.02**	14.06**
August	120	0.81	0.33	0.48	2.47**	10.67**	120	0.61	0.26	0.35	2.36**	21.45**
September	115	0.18	0.20	-0.03	0.87	0.88	115	0.16	0.12	0.03	1.27	8.16**
October	120	0.20	0.22	-0.03	0.89	2.55	120	0.10	0.13	-0.04	0.72*	1.38
November	116	0.09	0.29	-0.20	0.32**	1.28	66	0.12	0.33	-0.21	0.37**	0.02

Note: Returns are computed as the difference in the natural logarithm of price multiplied by 100. N denotes the number of reports included in the sample. New-crop futures contracts (December corn and November soybeans) are used. Single (*) and double (**) asterisks denote significance at the 5% and 1% levels, respectively.

Table 4. Futures Return Volatility Test Results for Crop Progress Reports for Corn and Soybeans, Non-Weekend Close-to-Open Returns, April to November, 1986–1989, 1990–1995, 1996–2001, 2002–2012

	Corn						Soybeans					
Reports	N	Report Day Variance	Pre-/Postreport Day Variance	Diff. in Report and Pre-/Postreport Variance	F-Stat.	Kruskal-Wallis χ^2-Stat.	N	Report Day Variance	Pre-/Postreport Day Variance	Diff. in Report and Pre-/Postreport Variance	F-Stat.	Kruskal-Wallis χ^2-Stat.
1986–1989												
All	139	1.19	0.84	0.35	1.41*	0.02	133	0.87	0.79	0.08	1.10	0.24
Condition & Progress	74	1.85	1.14	0.71	1.62*	0.21	65	1.41	1.19	0.22	1.18	0.13
Progress	65	0.45	0.42	0.03	1.06	0.31	68	0.36	0.36	-0.00	0.99	0.07
1990–1995												
All	209	0.52	0.49	0.03	1.06	1.07	200	0.59	0.48	0.10	1.21	0.56
Condition & Progress	120	0.59	0.56	0.03	1.05	0.09	105	0.86	0.56	0.29	1.52**	0.00
Progress	89	0.42	0.40	0.02	1.05	2.21	95	0.29	0.37	-0.08	0.79	0.58
1996–2001												
All	209	0.58	0.29	0.29	1.97**	5.28*	199	0.22	0.06	0.17	3.83**	17.34**
Condition & Progress	117	0.82	0.33	0.49	2.51**	9.26**	106	0.37	0.08	0.29	4.62**	34.64**
Progress	92	0.20	0.25	-0.04	0.82	0.01	93	0.05	0.03	0.01	1.40*	0.25
2002–2012												
All	383	0.21	0.10	0.11	2.10**	46.75**	358	0.12	0.06	0.07	2.17**	18.35**
Condition & Progress	243	0.26	0.13	0.13	2.05**	32.23**	210	0.17	0.07	0.10	2.55 **	26.70**
Progress	140	0.13	0.06	0.07	2.34**	14.29**	148	0.06	0.04	0.02	1.42*	0.25

Note: Returns are computed as the difference in the natural logarithm of price multiplied by 100. N denotes the number of reports included in the sample. New-crop futures contracts (December corn and November soybeans) are used. Single (*) and double (**) asterisks denote significance at the 5% and 1% levels, respectively.

Table 5. Futures Price Impacts to Crop Condition Price Signals for Corn and Soybeans, Non-Weekend Postreport Returns, April to November, 1986–2012

	Bullish Price Signal			Bearish Price Signal			Neutral Price Signal		
	Mean	T-Stat.	Wilcoxon W-Stat.	Mean	T-Stat.	Wilcoxon W-Stat.	Mean	T-Stat.	Wilcoxon W-Stat.
Corn returns									
N		206			201			120	
close-to-open $t = 0$	0.30	4.71**	12064**	-0.13	-2.15*	5842**	0.01	0.27	2404
open-to-close $t = 0$	-0.03	-0.31	9005	-0.06	-0.59	8433	-0.10	-0.60	3109
close-to-close $t = 1$	0.18	1.60	11234	-0.13	-1.11	8752	0.17	0.95	3554
close-to-close $t = 2$	-0.22	-1.74	6243	-0.12	-0.94	6370	0.05	0.27	2680
Soybeans returns									
N		204			160			95	
close-to-open $t = 0$	0.17	2.97**	12237**	-0.12	-1.99*	3682**	0.06	1.15	2294
open-to-close $t = 0$	-0.18	-1.61	9754	0.06	0.65	6343	-0.24	-1.57	1876
close-to-close $t = 1$	0.10	0.98	11202	-0.00	-0.04	6295	0.08	0.45	2435
close-to-close $t = 2$	-0.18	-1.58	6854	0.15	1.29	5093	-0.15	-0.76	1605

Note: Returns are computed as the difference in the natural logarithm of price multiplied by 100. N denotes the number of reports included in the sample. New-crop futures contracts (December corn and November soybeans) are used. Single (*) and double (**) asterisks denote significance at the 5% and 1% levels, respectively.

Table 6. Regression Estimates of Futures Price Impacts to Crop Condition Changes for Corn and Soybeans, Non-Weekend Postreport Returns, April to November, 1986–1989, 1990–1995, 1996–2001, 2002–2012

close-to-open $t = 0$		open-to-close $t = 0$		close-to-close $t = 1$		close-to-close $t = 2$	
$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_0$	$\hat{\beta}_1$
			Corn, 1986–2012				
0.05	-3.89**	-0.06	0.48	0.05	-1.81	-0.13	-1.21
(0.03)	(0.54)	(0.07)	(1.09)	(0.07)	(1.16)	(0.08)	(1.21)
			Corn, 1986–1989				
0.03	-3.27*	-0.06	0.57	0.03	-0.68	0.01	-4.58**
(0.16)	(1.38)	(0.16)	(1.33)	(0.20)	(1.70)	(0.20)	(1.65)
			Corn, 1990–1995				
0.06	-2.04	0.02	-0.22	-0.17	-2.34	-0.13	-0.55
(0.07)	(1.09)	(0.07)	(1.13)	(0.12)	(1.83)	(0.11)	(1.65)
			Corn, 1996–2001				
0.19*	-10.15**	-0.02	-0.20	-0.15	-5.70	-0.09	4.75
(0.08)	(2.00)	(0.13)	(3.39)	(0.13)	(3.37)	(0.15)	(3.74)
			Corn, 2002–2012				
-0.04	-4.90**	-0.11	1.05	0.25	-1.59	-0.16	3.13
(0.03)	(0.63)	(0.14)	(2.83)	(0.13)	(2.78)	(0.14)	(3.03)
			Soybeans, 1986–2012				
0.02	-2.84**	-0.09	1.79	0.05	-1.41	-0.06	0.25
(0.03)	(0.60)	(0.07)	(1.22)	(0.07)	(1.25)	(0.08)	(1.38)
			Soybeans, 1986–1989				
0.03	-2.54	-0.10	0.34	-0.01	-0.08	0.02	-2.38
(0.15)	(1.57)	(0.16)	(1.61)	(0.21)	(2.15)	(0.21)	(2.03)
			Soybeans, 1990–1995				
0.04	0.07	0.02	-0.28	-0.16	-0.41	-0.09	-2.44
(0.10)	(1.52)	(0.07)	(1.15)	(0.13)	(2.05)	(0.13)	(2.11)
			Soybeans, 1996–2001				
0.06	-7.45**	0.00	-0.94	0.01	-4.10	-0.12	7.21
(0.06)	(1.46)	(0.15)	(3.87)	(0.14)	(3.69)	(0.17)	(4.32)
			Soybeans, 2002–2012				
-0.05	-5.13**	-0.14	8.25*	0.16	-3.36	0.04	6.10
(0.03)	(0.68)	(0.13)	(3.19)	(0.12)	(2.93)	(0.13)	(3.33)

Note: Coefficient estimates are multiplied by 100. Standard errors are reported in parentheses. Regressions are checked for heteroskedasticity, and no corrections are considered necessary. New-crop futures contracts (December corn and November soybeans) are used. Single (*) and double (**) asterisks denote significance at the 5% and 1% levels, respectively.