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Abstract

The purpose of this report is to improve understanding of USDA crop forecasting methods, performance and market impact. A review of USDA's forecasting procedures and methodology confirmed the objectivity and consistency of the forecasting process over time. Month-to-month changes in corn and soybean production forecasts from 1970 through 2005 indicated little difference in magnitude and direction of monthly changes over time. USDA production forecast errors were largest in August and smaller in subsequent forecasts. There appeared to be no trend in the size or direction of forecast errors over time. On average, USDA corn production forecasts were more accurate than private market forecasts over 1970-2005, with the exception of August forecasts since the mid-1980s. The forecasting comparisons for soybeans were somewhat sensitive to the measure of forecast accuracy considered. One measure showed that private market forecasts were more accurate than USDA forecasts for August regardless of the time period considered. Another measure showed just the opposite. As the growing season progresses the difference in the results across the two measures of forecast accuracy diminished, with USDA forecast errors in soybeans about equal to or smaller than private market errors. USDA corn production forecasts had the largest impact on corn futures prices in August and recent price reactions have been somewhat larger than historical reactions. Similar to corn, USDA soybean production forecasts had the largest impact on soybean futures prices in August with recent price reactions appearing somewhat larger than in the past. Overall, the analysis suggests that over the long-run the USDA performs reasonably well in generating crop production forecasts for corn and soybeans.

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Introduction

There appears to be continuing misunderstanding of US Department of Agriculture (USDA) motives, methods and procedures used to arrive at production forecasts for US corn and soybean crops. This was vividly illustrated by comments from producers, commodity analysts and farm market advisory services following the release of the August 2003 forecasts. For example, we received the following e-mail inquiry from a farmer after the release of these forecasts:

> "I have a question concerning the August and the September crop production reports. A friend told me that the numbers that came out in the August report, which were lower than many predicted, were utilizing a weather forecast for a hotter and drier 30 day outlook, as of August 1 (the forecast would have been for the month of August). He said that the USDA was trying to use a new system, which would take into account the weather forecast, along with the usual crop conditions and yield checks. I was under the assumption that the August crop report took field surveys as of August 1, and then assumed average weather for the rest of the growing season. If my friend was correct, then this could potentially mean that the dropping crop conditions have already been factored in, and that the September report may only have a slight revision downward."

Market analysts, as represented below, also echoed these concerns:

> "There has been considerable dismay in the industry as to USDA's August corn and soybean estimates. Most do not see them as real objective analysis…We think that NASS just missed it by being too conservative with an immature corn and soy crop."

These comments nicely illustrate the importance placed on USDA crop forecasts by market participants and the potential for misunderstanding of the methods used to produce the forecasts. Some in the agricultural community apparently even believe that the USDA manipulates crop forecasts to fulfill some mystical objectives that are contrary to the best interest of farmers. There is clearly a need for a better understanding of all aspects of the USDA crop production forecasting process.

The objectives of this report are to 1) provide an overview of the forecasting process for corn and soybean production used by the USDA, 2) present monthly production forecasts for the 1970 through 2005 corn and soybean crops, 3) examine relationships in the monthly changes in production forecasts, 4) examine errors in the USDA forecasts, 5) compare USDA forecasts to private market forecasts and 6) examine the price response to USDA forecasts and the relationship of the responses to report "surprises." This information should improve understanding of USDA crop forecasting methods, performance and market impact.

USDA Forecasting Process

The USDA uses a highly sophisticated and well-documented procedure to generate its crop production forecasts.[1] All phases of the process are conducted by the National Agricultural Statistics Service (NASS), an agency within the USDA. For corn and soybeans, production forecasts are released in August, September, October, and November.[2] Final estimates are published in January.

The USDA generates crop production forecasts based on estimates of planted and harvested acreage and two types of yield indications, a farmer-reported survey and objective measurements. The acreage figures are obtained from the June Agricultural Survey, conducted during the first two weeks of June and reported at the end of June. The June Survey is based on a large farm operator list frame and a separate and independent area frame survey. These acreage estimates are used in subsequent production forecasts until there is evidence (survey or other) to alter the acreage estimates.[3] The farmer and objective yield “probability” surveys use the same sampling, survey and estimation procedures from year-to-year. This allows yield and production forecasts to be compared over time.

The farmer-reported yield survey is conducted for states with significant corn and soybean production. In 2005, 33 states were surveyed for corn and 29 for soybeans. Farmers included in the yield survey are randomly selected from the list frame (essentially a list of names, addresses and phone numbers) of individuals that responded to the June Agricultural Survey. This assures that farmers included in the yield surveys are growing the crop of interest. Farmers are asked monthly (August through November) for a subjective prediction of their final corn and soybean yields. While the list frame changes across years, reflecting changing farming arrangements, the same individuals are surveyed each month for a particular crop year.

Farmer-reported yield surveys are conducted primarily by Computer Assisted Telephone Interviewing (CATI), but some data are collected by mail and by face-to-face interviews. The USDA has determined that farmers tend to make conservative (low) yield predictions, especially early in the season, so the survey results for each month are compared to survey results at the same time during the past 10 years and the final average yields for those years. Thus, the final farmer-reported yield for a given month is adjusted to reflect that fact that farmers consistently are conservative over time.

The objective yield survey for corn and soybeans typically has been conducted only for the seven most important production states, but that number was expanded to 10 states for corn and 11 states for soybeans beginning in 2004. These "speculative" states generate about 70 percent of US production for each of the crops. The objective yield survey is based on an area-

[1] The main sources for this section are NASS/SMB (1998), Egelkraut et al. (2003), Allen (2003, 2005), Isengildena, Irwin, and Good (2006), and Prusacki (2006).

[2] The USDA also published corn and soybean production forecasts for July until the mid-1980s.

[3] The USDA announced on September 29, 2003 that it will begin using the Farm Service Agency’s (FSA) certified acreage information for the October crop report. Previously, this information was not available until the end of the year, and thus, could only be incorporated into January estimates.

frame sampling design, where fields are randomly selected from the total land area used in production of a given crop. Mirroring the procedure for the farmer-reported yield survey, fields for the objective yield survey are randomly selected from the larger number surveyed in USDA's June Agricultural Survey. Note that sample fields are selected with a probability proportional to their size.

Objective yields are obtained from two independently located plots in each randomly selected field. Physical counts and measurements of the number of plants and production per plant are conducted. Yield per acre is generated for the field after standardizing for row widths, moisture content and harvest loss. Objective yield indications are derived from models based on observations over the last five years for the corresponding months compared with end of season yields. Separate monthly models are constructed by maturity stage so forecast adjustments are automatically made for early or late maturing crops.

It is important to note that accuracy of the objective yield indications can change through the growing and harvest seasons. Early in the season, the yield indications are influenced by assumed relationships between plant counts and fruit numbers, and an assumed fruit weight adjusted for moisture content and harvest loss. As the season progresses, fruit counts become known. At the end of the season, plots are harvested, and yields are calculated based on actual grain weights and harvest losses. Historically, an interview was conducted with the farm operator immediately after harvest to determine acres actually harvested and the yield realized in the sample field. This follow up interview was discontinued in 2002.

As noted earlier, yield forecasts are developed monthly from August through November. The data on both yield surveys are collected during the last week of the month previous to the survey month and the first few days of the survey month, generally from the 25th of the previous month through the 3rd of the survey month. Yield forecasts then reflect crop conditions at the beginning of the survey month. The crop production forecasts are based on the assumption of normal growing conditions for the remainder of the season as reflected by historical records. The USDA does not incorporate any weather forecasts or factor in crop conditions as reflected by weekly crop progress reports.

The farmer and objective yield indications are combined in a multistage process employing statistical and judgmental techniques. Before the actual "lock-up" that precedes the release of a crop report, all available acreage data and farmer-reported yield indications for non-speculative states are reviewed. One part of this review is comparison of yield recommendations for a given state with adjoining states to see if they demonstrate consistency, based on the weather that has already occurred. If there is a need to discuss recommendations with a state office, this can be done but no information is exchanged about yield indications for other states. By the time lock-up occurs, harvested acreage for all states and yields for non-speculative states have been set.

The lock-up for USDA crop reports occurs the night before a report is released. The recommendations and comments for speculative states are transmitted as encrypted data files which are locked in a safe until the lock-up area is secured. For these states, yield indications are available from both the farmer-reported survey and the objective yield survey. During lock-up, the Agricultural Statistics Board reviews all the indications, and in consultation with commodity statisticians, determines production forecasts for speculative states. Regional production forecasts are then determined. The final step is the generation of national production forecasts. The process used to determine final production estimates is described by Gardner (1992) this way:

> "A NASS board in Washington then assesses all the indicators of yield, including the estimates of a month earlier. This is not done using a pre-specified formula---in which case a computer could replace the NASS board---but through a consensus of the Board members based on their experience and the full information before them. (p. 1068)

After the Agricultural Statistics Board moves to another crop, a commodity statistician, and usually one other Board member, completes the review of individual state indications, recommendations, and analyses and adjusts final state figures if necessary. For a complete description of the production forecasting process, see "The Yield Forecasting Program of NASS", *SMB Staff Report Number SMB 98-01*, USDA, NASS, Statistical Methods Branch, July 1998.

USDA Forecast Performance

Corn and soybean production forecasts provided by the USDA for the 36-year period covering 1970-2005 are presented in Figures 1 and 2. Production forecasts are shown for August, September, October and November of each year. As noted in the previous section, a July forecast was made until the mid-1980s, but is not considered here in order to have a consistent set of forecasts for the entire period. USDA crop production estimates released in January of the year after harvest generally are considered to be "final" estimates. While January estimates may be subsequently revised based on stocks reports or agricultural census data, such changes tend to be rather small.[4]

Changes in the monthly production forecasts relative to the previous month's forecast are presented in Figures 3 and 4 for corn and soybeans, respectively.[5] Before proceeding further, it is important to emphasize that the term "change in forecast" is not meant to imply that the USDA revises monthly forecasts. As discussed in the previous section, the USDA makes the best possible interpretation of production potential each month based upon available information. In other words, the USDA makes a "fresh" or "new" forecast each month.

Returning to Figures 3 and 4, the change in forecasts is presented in percentage terms, rather than in bushels, in order to standardize for increasing crop size over time. A positive change represents a larger forecast in the current month relative to the previous month and vice versa. The September change for both corn and soybeans was very large in 1983, as well as the October change for corn and soybeans in 2004. There appears to be little difference in the

[4] The official track record of USDA crop production forecasts can be found in the publication at: http://usda.mannlib.cornell.edu/data-sets/crops/96120/.

[5] Please see the appendix to this report for all computational formulas.

magnitude of monthly changes over time, with the possible exception of September changes in corn that appear to be smaller in recent years and October changes in soybeans that may be larger in recent years. In addition, there appears to be no change in the pattern or direction of monthly changes over time. It is not surprising that the size of forecast changes tends to diminish across the forecasting cycle (e.g., September corn changes versus January corn changes) with improving information on crop production.

An interesting question is whether the changes in the production forecasts from month-to-month are driven by changes in harvested acreage forecasts, yield per acre forecasts, or some combination of the two. Figures 5 and 7 show that harvested acreage forecasts for corn and soybeans often do not change from month-to-month and when they do change the magnitude is relatively small, with the exception of some January estimates for both corn and soybeans and the October 2005 soybean estimate.[6] Examination of the yield changes in Figures 6 and 8 clearly shows that changes in yield forecasts are the major driver of changes in total production forecasts for corn and soybeans (Figures 3 and 4), with the possible exception of January.[7] The magnitude of the relationship is indicated by the correlation coefficient (r). A correlation coefficient of +1 indicates a perfect positive correlation in monthly forecast changes and a coefficient of 0 indicates no correlation in monthly changes (A coefficient of -1 indicates perfectly negative correlation.) The average correlation between the change in production forecasts and change in yield forecasts across all four announcement months (September through January) is 0.90 in corn and 0.97 in soybeans. By comparison, the average correlation between the change in production forecasts and change in harvested acreage forecasts across all four announcement months is 0.50 in corn and 0.26 in soybeans. While both harvested acreage forecast changes and yield forecast changes contribute to explaining the changes in production forecasts, the dominance of yield changes makes sense. The reason is that harvested acreage can be forecast quite accurately in most years based on the June Agricultural Survey estimate of planted acreage, while in contrast, a substantial amount of new information on corn and soybean yields is revealed nearly every year from August through January.

Figures 9 and 10 illustrate the relationship between changes in monthly production forecasts. The figures address the question of whether the size and direction of change in October forecasts, for example, is correlated to the size and direction of change in September forecasts. The results indicate that there is a positive relationship in the monthly changes for both corn and soybeans. Correlations in corn are moderate for October versus September and January versus November changes and high for November versus October changes. The average correlation across all three comparisons for corn is 0.52, which indicates substantial “smoothing” of changes in corn production forecasts. Relationships are more limited in soybeans, where the highest correlation is 0.49 (November versus October changes). The average correlation across all three comparisons for soybeans is 0.34, suggesting less smoothing of soybean production forecasts across months. Isengildina, Irwin, and Good (2006) conduct a thorough analysis of the relationship between production forecast changes in both corn and soybeans and report that the

[6] The large change in the October 2005 harvested acreage estimate for soybeans likely reflects the availability of FSA acreage data in October instead of January. See footnote 3 for details.

[7] Note the difference in scale between Figures 5 and 7 and Figures 6 and 8.

correlations generally are statistically significant. They also estimate the potential gain in forecast accuracy by adjusting for smoothing in USDA corn and soybean production forecasts. The improvement in forecast accuracy across the forecasting cycle averages 10 percent in corn and 2 percent in soybeans, indicating that information about smoothing potentially could be used to make non-trivial improvements in the accuracy of USDA corn and soybean production forecasts. Isengildina, Irwin, and Good discuss several possible explanations for observed smoothing of changes in the production forecasts. Given the potential implications of smoothing on forecast accuracy, additional research is needed to better understand the nature of observed smoothing.

An important issue related to smoothing is how USDA forecast revisions are interpreted and used by market participants. If market participants are unaware of or misunderstand the nature of the revision process, incorrect resource allocation decisions may be made that lead to economic welfare losses. If instead market participants are aware of the smoothing process and account for it in forming expectations, economic welfare losses may be negligible or non-existent (Orazem and Falk, 1989). Figures 11 and 12 present the monthly changes in USDA corn and soybean production forecasts and the changes expected by private market analysts. For the period 1970 through 2000, the expected private market changes are represented by an average of the changes in production forecasts by Conrad Leslie and Sparks Companies, Inc. (now Informa Economics, Inc.) Forecasts from these two firms are selected because they generally were considered to be the most influential and were widely-reported in the popular press during this period. The two firms used different procedures and sources for estimating crop size (Egelkraut et al., 2003). In addition, the history of forecasts by these two firms is available for an extended period of time. For the period 2001 through 2005, the expected private market changes are represented by an average of the changes in the production forecasts from Sparks Companies, Inc. (now Informa Economics, Inc.) and the changes in the “average trade guess” as reported by Oster/Dow Jones (ODJ). The change was made because Conrad Leslie discontinued his service after 2000. Note that Sparks forecasts are not included in the ODJ averages. Figures 11 and 12 suggest that the private sector generally anticipates the direction and the magnitude of changes in monthly USDA corn and soybean production forecasts. This indicates private analysts are able to anticipate and incorporate at least part of the “smoothness” in USDA changes into their own forecasts.

Additional evidence on the ability of the private sector to anticipate changes in USDA corn and soybean production forecasts is presented in Figures 13 and 14, where the relationship between the actual change in USDA production forecasts and the revision expected by the private sector is estimated. If the private sector “rationally” anticipates USDA forecast changes the intercept and slope of each regression should equal zero and one, respectively. When this condition is met the revision expected by the private market, on average, equals the actual revision announced by the USDA. In all cases the estimated intercept is quite close to zero, consistent with rationality. Estimated slopes are near one and consistent with rationality in three cases: September corn, November corn, and October soybeans. The slope for October corn revisions is well above one, indicating the private sector consistently under-estimates the size of USDA revisions in this case. The estimated slopes for September and November soybean revisions are well below one, indicating the private sector consistently over-estimates the size of USDA revisions in these cases. In sum, the evidence is mixed regarding the ability of the private sector to fully anticipate changes in USDA production forecasts. Further research is needed to determine the statistical and economic significance of the observed deviations from “rational expectations” on the part of private market analysts.

The analysis to this point indicates that the pattern of changes in USDA corn and soybean production forecasts has been relatively stable over time and that the private sector partially to fully anticipates the changes. However, there is still the question of the accuracy of monthly USDA forecasts. Following previous studies (e.g., Garcia et al., 1997; Egelkraut et al., 2003), the accuracy of the August, September, October and November forecasts is measured against the January estimate. The percentage errors in each of the monthly forecasts are presented in Figures 15 and 16 for the 1970 through 2005 corn and soybean crops, respectively. Not surprisingly, errors generally are largest in August and become smaller in subsequent forecasts, reflecting improving information on actual crop size. In every case, the average forecast error is near zero, indicating USDA forecasts do not tend to be too high or too low on average. There also does not appear to be any discernable trend in the size of forecast errors through the years. Finally, it is interesting to note that, on average, the magnitude of percentage forecast errors for corn and soybeans in the same month is about equal.

Corn and soybean forecast errors for the USDA and private market are compared in Figures 17 and 18, respectively. The figures suggest that USDA and private forecast errors are about the same magnitude, especially so for soybeans. However, there are times when the forecast errors diverge sharply. It turns out that there are some important trends in the relative forecasting accuracy of the USDA and private market over this period, but it can be difficult to see just looking at the figures. The trends are more easily discernable in Tables 1 and 2, which present mean absolute percentage errors (MAPE) and root mean squared percentage errors (RMSPE). In general terms, MAPE and RMSPE are computed as follows:

$$MAPE = \frac{1}{N}\sum_{j=1}^{N}\left|\frac{A_j - F_j}{A_j}\cdot 100\right| \qquad RMSPE = \sqrt{\frac{1}{N}\sum_{j=1}^{N}\left(\frac{A_j - F_j}{A_j}\cdot 100\right)^2}$$

where A_j is the actual value, F_j is the forecast value and N is the number of observations. Both calculations treat negative and positive forecast errors the same. In other words, the direction of error does not matter, only the distance from the final value. However, MAPE averages absolute errors and RMSPE averages squared errors. This difference in the treatment of errors, absolute vs. squared, provides evidence on the sensitivity of comparisons to the type of forecast accuracy measure considered.[8]

[8] See Egelkraut et al. (2003) for a thorough analysis of USDA forecast accuracy in both corn and soybeans. Their investigation is based on several measures of forecast accuracy, including the MAPE and RMSPE measures considered here. They also conduct statistical tests of differences in forecast accuracy and examine in detail the question of structural change in relative forecast accuracy.

The error measures are reported in Tables 1 and 2 for the entire 1970-2005 period, three sub-periods, 1970-1984 and 1985-2005, and the last five years, 2001-2005.[9] In corn, the relative forecasting accuracy of the USDA was superior in every case for both forecast measures, except August over 1985-2005. USDA forecasts in corn also improved more quickly than the private market as the growing season progressed. The one trouble spot for the USDA in corn was August forecast accuracy since the mid-1980s. Since that time, private market forecasts have been more accurate. This reflects improvement in August private sector forecast accuracy relative to the USDA over the last three decades. However, for the most recent period, 2001-2005, the USDA forecast in corn was once again more accurate than the private forecast in August.

The relative forecasting comparisons for soybeans are somewhat sensitive to the measure of forecast accuracy considered. This is most evident for August soybean production forecasts. The MAPE results (Table 1) indicate that private market forecasts were more accurate than USDA forecasts for August, regardless of the time period considered. For example, private market forecasts of August soybean production since the mid-1980s have been more accurate by an average of 0.6 percentage points in absolute terms. In contrast, the RMSPE results (Table 2) suggest just the opposite conclusion; that private market forecasts were less accurate than USDA forecasts for August, regardless of the time period considered. The explanation for this difference in results is that the average absolute size of USDA errors exceeded the average absolute size of private market errors, but the USDA made fewer large errors than the private market in forecasting soybean production in August. Large forecast errors have relatively more impact on accuracy measures based on squared errors, such as RMSPE.[10] As the growing season progresses the difference in the results across the two measures of forecast accuracy diminish. In general, USDA forecasting accuracy is about equal to or smaller than the private market for September, October and November soybean production forecasts.

Overall, the analysis presented in this section suggests the USDA performs reasonably well in generating crop production forecasts for corn and soybeans. There is nonetheless room for improvement. Commenting on similar forecast accuracy results, Egelkraut et al. (2003), offer this suggestion:

> "The improved performance by the private agencies for August for both crops during the most recent years, and the ability of the private agencies to generate

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[9] The 1984/1985 breakpoint is suggested by empirical results found in Fortenbery and Sumner (1993), Garcia et al. (1997) and Egelkraut et al. (2003). An additional reason for considering this breakpoint is the revision to NASS crop condition ratings that occurred in 1986 (Allen, 2005). Survey methods used in each state were standardized and nationally aggregated crop condition ratings were first published on a regular basis at this time.

[10] It is impossible to reach a definitive conclusion about which set of results is correct. The different measures of accuracy reflect different assumptions about the way forecast errors are processed by individual users. Absolute errors correspond to a linear loss function with respect to forecast errors. Squared errors correspond to a quadratic loss function with respect to forecast errors. A quadratic loss function penalizes large errors more than small errors compared to a linear loss function. Granger and Newbold (1986, pp. 277-278) argue that a quadratic loss function is superior for three reasons. First, it is not an unreasonable assumption. Second, it is mathematically more tractable than any other alternative. Third, it parallels the loss function embedded in ordinary least squared regression, which is used to estimate many forecasting models. Section 9.3 of the Granger and Newbold book contains a nice discussion about various loss functions and their application to forecast evaluation.

> relatively accurate forecasts in soybeans suggest that it might be useful for USDA to investigate expanding the scope of their subjective yield analysis to incorporate a wider range of market and industry participants. Such a strategy, if proved effective, might lead to improved crop production forecasts." (p. 94)

As a final point, it is interesting to consider the results of other studies that compare the forecasting accuracy of public agencies and private firms. Just and Rausser (1981) compare internal USDA agricultural price forecasts to price forecasts from four private firms (and futures markets) over December 1976-December 1978. They report that, on average, USDA forecasts of wheat, corn, soybean, soybean meal, soybean oil, cotton, hog and cattle prices are less accurate than comparable forecasts from each of the four private firms. Batchelor (2001) studies the accuracy and information content of economic forecasts for G7 countries made in the 1990s by the International Monetary Fund (IMF) and Organization for Economic Cooperation and Development (OECD). He compares the IMF and OECD forecasts to the average forecasts of private sector economists published by *Consensus Economics*. With few exceptions, the private sector forecasts are more accurate than the IMF and OECD forecasts. Juhn and Lungani (2002) examine IMF forecasts for a broader set of countries and find that the IMF forecasts do not add to the explanatory power provided by private sector forecasts. While the number of comparable studies is limited, the available evidence suggests that the relative performance of the USDA in forecasting corn and soybean production compares quite favorably to its own performance in forecasting agricultural prices and to that of other public agencies in forecasting macroeconomic variables.

Market Impact of USDA Forecasts

Theoretically, the price impact of USDA corn and soybean production forecasts should be determined by how well the market anticipates the forecasts. If the market perfectly anticipates USDA production forecasts, then, under the theory of efficient markets, prices will not change. If the market does not perfectly anticipate the forecasts, prices will change in relation to the degree that the market is "surprised" by the new information. To compute surprises, a measure of market expectations is needed. Once again, private market forecasts are represented by an average of Conrad Leslie and Sparks Companies, Inc. (now Informa Economics, Inc.) forecasts from 1970-2000 and an average of Sparks Companies, Inc. forecasts and ODJ averages for 2001-2005.[11] Figures 19 and 20 show the percentage difference between monthly USDA production forecasts and the monthly private market forecasts.[12] This difference is an estimate of the market surprise for each crop report. A positive surprise number is considered "bearish" because the USDA forecast is larger than the market expectation. Likewise, a negative surprise number is considered "bullish" because the USDA forecast is smaller than the market expectation. Earlier it was shown that the private sector anticipates

[11] Private firms typically released their forecasts to customers five to seven days prior to the release of USDA crop reports. This should allow the market adequate time to digest the information and incorporate it into prices before USDA crop reports are released.

[12] Market surprises are not presented for January crop reports due to limited availability of data on private market expectations for this month.

much of the information in crop reports (see Figures 11 and 12). However, this does not mean the private sector anticipates the information entirely, as is dramatically illustrated in Figures 19 and 20. Market surprises tend to be largest in August and smallest in November for both corn and soybeans. This makes sense as there is more uncertainty about crop conditions earlier in the growing season. There does not appear to be any obvious trends in market surprises across crop years, with the possible exception of an increasing magnitude of market surprises associated with October soybean forecasts.

The price impact of corn and soybean production forecasts is presented in Figures 21 and 22, respectively. Price impact is indicated by the reaction of December corn futures and November soybean futures (as measured by the first non-limit opening or closing price) immediately after the release of the USDA production forecasts.[13] For corn, the largest reaction in December futures occurs following the August report. Interestingly, recent price reactions have been somewhat larger than historical reactions, except for 1973. Reactions in corn have been relatively small in September, larger in October, and small in November, with a dramatic exception in 1993. The pattern of price reactions in soybeans is quite similar to corn. The largest reaction in November futures occurs following the August report and recent price reactions have been somewhat larger than in the past. Reactions in soybeans have been relatively small in September, with the exception of 2003, larger in October, and small in November, again with a dramatic exception in 1993.[14]

Figures 23 and 24 illustrate the relationship between price reactions in the futures market and the calculated surprises in the USDA forecasts. As expected, there is a negative relationship between the direction of the surprise and the direction of price reaction for both corn and soybeans. In other words, bullish reports (negative surprises) tend to lead to price increases and bearish reports (positive surprises) tend to lead to price decreases. The relationships are somewhat stronger for corn than soybeans, with the variation of surprises for the USDA production forecasts explaining 42 to 57 percent of the variation in the immediate change of corn futures prices and 23 to 35 percent of the variation of the immediate change in soybean futures prices (as indicated by R^2 statistics).[15] The strongest relationship is found in November for corn

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[13] Data on the cash price reaction to the release of USDA crop production forecasts for a number of commodities, including corn and soybeans, can be found in the publication at: http://www.usda.gov/nass/pubs/prrcan05.pdf.

[14] From 1970-1984, only USDA corn and soybean production forecasts were announced on report release dates, and therefore, the price impact shown in Figures 21 and 22 over this time period can be attributed solely to the USDA production forecasts. From 1985 onwards, USDA corn and soybean production reports were released simultaneously with World Agricultural Supply and Demand Estimate (WASDE) reports. This means price reaction over 1985-2005 may be attributed to the information contained in both the corn and soybean production forecasts and WASDE estimates. While it is impossible to disentangle the differential impact of the production forecasts and WASDE estimates with available data, the consistency of the price reactions over the entire 1970-2005 time period suggests the bulk of the price impact over 1985-2005 should be credited to the USDA corn and soybean production forecasts. For further discussion of this issue see Isengildina et al. (2005).

[15] It may be possible to improve upon the regression models presented in Figures 23 and 24. Garcia et al. (1997) recommend pooling observations across all forecast months and including market surprises for both crops in the regression models (e.g., corn price reaction based on both corn and soybean market surprises). Pooling may aggregate the information contained in the individual months more efficiently so that the price response can be more clearly discerned. Including both surprises in each model is based on the argument that cross-price effects are

and October for soybeans. The slopes of the estimated lines vary by forecast month but equal, on average, about -1.1 for corn and -0.80 for soybeans. This means a one-percentage point bearish (bullish) surprise leads, on average, to about a one-percentage point decrease (increase) in corn futures prices and a 0.8 percentage point decrease (increase) in soybean futures prices.[16] The relatively wide scatter of price reactions for a given level of surprise indicates the approximate nature of these relationships.

Price impacts illustrated in this section provide strong evidence that market participants view USDA corn and soybean production forecasts as important new information. This further suggests that USDA forecasts improve economic welfare by moving prices closer to the "true" market equilibrium (Falk and Orazem, 1985). Having said this, it is important to point out that earlier forecast performance results in some cases appear to contradict the price impact results. The forecast performance results indicate that in absolute terms private market forecasts early in the season (August) for both crops have been more accurate than USDA forecasts since the mid-1980s. At the same time, corn and soybean futures prices continue to react to the release of these same USDA forecasts. There is some evidence that the price reaction in corn and soybeans actually has increased in recent years.

Falk and Orazem (1985) offer the most straightforward explanation for the puzzle. In their theoretical model, market participants rationally update crop production forecasts as new information becomes available on the potential size of the crop. When the USDA releases a new forecast of crop production market participants revise their forecasts in light of the new USDA forecast. However, market participants do not necessarily place a weight of 100 percent on the USDA forecast as they revise their previous production forecast. Market participants will instead form a weighted-average of their previous production forecast and the new USDA production forecast that minimizes the variance of forecast errors. The intuition is that a combination (portfolio) of the two forecasts generally will have a lower forecast error variance than either of the two individual forecasts. The key implication is that USDA forecasts may be less accurate (larger forecast error) than private market forecasts yet still contain valuable information that allows market participants to form revised forecasts with a lower forecast error variance. Consequently, market prices will react to the release of USDA production forecasts

important in corn and soybeans due to substitution in demand and/or supply. Using the data for this report, pooled regressions are estimated for corn and soybeans with both sets of surprises included in each equation. Paralleling Garcia et al.'s results, significant cross-price effects are found for both corn and soybeans. These results are available from the authors upon request. Williams and Wright (1991) provide a theoretical argument that the reaction of a storable commodity's price to news depends on market conditions. Since the path of both price and stocks can adjust to new information in a storable commodity market, price movements reflect a combination of the amount of news and its relative impact on stocks. A potential solution to this problem is to condition the price reaction of new crop futures to the release of USDA crop reports on a measure of ending stocks. This represents an interesting area for future research.

[16] At first glance, the plots in Figures 23 and 24 suggest that a demand curve is traced out by the variation in production (supply) surprises. Falk and Orazem's (1985) theoretical model implies this is unlikely to be the case. In their theoretical model, the estimated regression coefficient reflects the ratio of the weight the market places on USDA forecasts to the slope of the true demand curve. Without knowledge of the weight the market places on USDA forecasts, it is therefore impossible to infer the slope of the demand curve (elasticity) from the estimated coefficient.

even though USDA forecasts are less accurate than market forecasts formed before USDA forecasts are released. This is a reasonable explanation for the seemingly contradictory finding that USDA corn and soybean production forecasts in August are less accurate than private market forecasts (in absolute terms), yet market prices still react strongly to the release of the USDA forecasts.

Garcia et al. (1997) suggest another possible explanation for the difference in results. They argue that market participants have different perceptions of the riskiness of USDA and private market forecasts. Theoretical models suggest that informed, private traders may behave strategically with regard to the release of forecasts in advance of public announcements. Thus, it may be reasonable for market participants to regard USDA forecasts as less risky than private market forecasts. Since market participants make decisions based on both expected return and risk, USDA crop production forecasts that change perceptions of risk but not expected return would nonetheless still impact prices.

The theoretical model developed by Morris and Shin (2002) suggests still another possible explanation. In their model public information has a dual role in the economy. The first and widely-acknowledged role is to convey information on the “fundamentals” in the economy. The second and less obvious role is to serve as a focal point for beliefs about the state of the economy. This coordinating function of public information can be traced to the presence of what can be called “common knowledge” or “conventional wisdom” affects. Such affects arise in situations where decision-makers are interested parties in the actions of other parties and some kind of belief must emerge as common knowledge in order for equilibrium in the “game” to occur. At the extreme, public information may not convey any information on market fundamentals but still have an impact on the market due to its role in coordinating the beliefs of market participants. This may contribute to explaining the reaction of market prices to USDA corn and soybean production forecasts in August even though they are less accurate than private market forecasts (in absolute terms).

The 2005 Experience

USDA forecasts and corresponding private market forecasts for 2005 are presented in panel A of Table 3.[17] The final January estimate for corn and soybeans in 2005 also is presented for comparison purposes. For corn, the USDA forecast was larger than the private forecast in all months except October. For soybeans, USDA forecasts were smaller than private forecasts in August and October and larger in September and November. These patterns can be compared to the long-run tendency of market surprises to be mildly correlated across release months. The average month-to-month correlation of surprises is about 0.30 in both the corn and soybean markets. Whether this tendency is economically significant has yet to be determined.

Forecast errors associated with USDA and private production forecasts for 2005 are presented in panel B (million bushels) and panel C (percent) of Table 3. The comparisons reveal that the USDA provided more accurate forecasts of corn production in 2005 for each month except October. The USDA’s corn forecast error in August 2005 was 0.6 percentage points

[17] See Good and Irwin (2003, 2005) for similar reviews of USDA forecasting performance in 2003 and 2004.

smaller than the private market forecast error, the third year in a row that the USDA has outperformed the private forecast for corn in August. The superior performance of the USDA's August corn forecast in 2003, 2004, and 2005 is especially notable in light of the long-term trend in relative accuracy for this month (see Tables 1 and 2). The USDA's corn forecast error in October 2005 was 0.6 percentage points larger than the private market forecast error, the only case where the USDA's forecasting performance was inferior to the private market forecast in 2005. Overall, the forecasting performance of the USDA in 2005 relative to the private market was quite strong for corn.

For soybeans, USDA forecasts were less accurate than private forecasts in August and October. The USDA's soybean forecast error in August 2005 was 0.5 percentage points larger than the private market forecast error. The USDA's soybean forecast error in October 2005 was 1.3 percentage points larger than the private market forecast error. The USDA's relative performance was substantially better in September 2005, when the USDA's soybean forecast error was 0.9 percentage points smaller than the private market forecast error. Overall, the forecasting performance of the USDA in 2005 relative to the private market was mixed for soybeans.

Further perspective on the 2005 USDA corn and soybean crop production forecasts is provided by the information found in Table 4. Four key indicators are presented: 1) change in forecasts (where applicable), 2) forecast errors, 3) market surprises and 3) resulting price reactions. The value for 2005 is compared in each case to the previous high and low values over 1970-2004. Based upon a comparison of the absolute value in 2005 to the absolute value of previous highs and lows for corn and soybeans, the 2005 experience with USDA forecasts was well within historical ranges for the variables considered.

Additional perspective is provided by the price reaction comparisons found in Table 5. The actual price reaction for each of the 2005 production forecasts is the same as that presented in Table 3. Predicted price reactions for each month are based on the regression equations estimated from historical data over 1970-2004 (similar to the regressions presented earlier in Figures 21 and 22). In seven of the eight cases, the direction of price reaction predicted by the regression equations is the same as that actually observed. In three of the eight cases (September 2005 corn, October 2005 corn, and November 2005 corn), the signed magnitude of actual price reactions is within one percentage point or less of the predicted magnitude. In the other five cases (August 2005 corn, August 2005 soybeans, September 2005 soybeans, October 2005 soybeans, and November 2005 soybeans), the difference in signed magnitude exceeds one percentage point. It is not surprising that some of the predictions are off substantially, given the relatively modest "fits" of the estimated regression models. However, the large errors in these cases are within historical experience, which can be seen through inspection of Figures 21 and 22.

Summary and Conclusions

Comments from producers and others suggest that there has been an ongoing misunderstanding of the USDA's methodology for arriving at corn and soybean production forecasts. The purpose of this report is to improve understanding of USDA crop forecasting methods, performance and market impact. The sample period used for the study encompasses the 36-year period from 1970-2005.

The USDA uses a highly sophisticated and well-documented procedure to generate its crop production forecasts. For corn and soybeans, production forecasts are released in August, September, October, and November, with final estimates published in January. The USDA generates production forecasts based on estimates of planted and harvested acreage and two types of yield indications, a farmer-reported survey and objective measurements. A review of USDA's forecasting procedures and methodology confirmed the objectivity and consistency of the forecasting process over time.

Month-to-month changes in USDA corn and soybean production forecasts from 1970 through 2005 indicated little difference in magnitude and direction of monthly changes over time. The size of the monthly changes tended to diminish across the forecasting cycle (August through November). There was a positive relationship in the size and direction of forecast changes across months in both corn and soybeans, with the largest correlations found in corn. Monthly changes in USDA forecasts were partly to fully anticipated by the private sector. As measured against the production estimate in January after harvest, USDA production forecast errors were largest in August and smaller in subsequent forecasts. There appeared to be no trend in the size or direction of forecast errors over the study period.

On average, USDA corn production forecasts were more accurate than private market forecasts over 1970-2005. One exception in corn was the August forecast over 1985-2005. The forecasting comparisons for soybeans were somewhat sensitive to the measure of forecast accuracy considered. One measure showed that private market forecasts were more accurate than USDA forecasts for August regardless of the time period considered. Another measure showed just the opposite. As the growing season progresses the difference in the results across the two measures of forecast accuracy diminished, with USDA forecast errors in soybeans about equal to or smaller than private market errors for September, October and November.

USDA corn production forecasts had the largest impact on corn futures prices in August and recent price reactions have been somewhat larger than historical reactions. Similar to corn, USDA soybean production forecasts had the largest impact on soybean futures prices in August with recent price reactions appearing somewhat larger than in the past. As predicted by economic theory, there was a negative relationship between the direction of forecast surprises and the direction of price reactions for both corn and soybeans, with a somewhat stronger relationship for corn than for soybeans.

Overall, the forecasting performance of the USDA in 2005 relative to the private market was quite strong in corn, with the USDA providing more accurate forecasts of corn production in 2005 each month except October. The forecasting performance of the USDA in 2005 relative to the private market was mixed in soybeans, with USDA forecasts being less accurate than private forecasts in August and October. USDA corn and soybean production forecasts in 2005 were well within historical ranges in terms of magnitude of changes, forecast errors, market surprises and price reactions.

The analysis presented in this report suggests that over the long-run the USDA performs reasonably well in generating crop production forecasts for corn and soybeans. There is strong evidence that market participants view USDA corn and soybean production forecasts as important new information. There is nonetheless room for improvement. In particular, the USDA may want to consider expanding the scope of the subjective yield surveys to incorporate a wider range of market and industry participants.

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Appendix: Computational Formulas

For a given commodity and year, define $USDA_i$ as the USDA crop production forecast or estimate for month *i*, where *i* =1 for August forecasts, *i* = 2 for September forecasts, *i* = 3 for October forecasts, *i* = 4 for November forecasts and *i* = 5 for final January estimates. Next, define $Market_i$ as the average private market crop production forecast for month *i*, where *i* =1 for August forecasts, *i* = 2 for September forecasts, *i* = 3 for October forecasts and *i* = 4 for November forecasts. Now, define $p^c_{t-1,i}$ as the closing (settlement) futures price (corn: December contract; soybeans: November contract) on the day before a USDA crop report is released in month *i* and $p^o_{t,i}$ as the first non-limit opening or closing futures price on the day a USDA crop report is released in month *i*. Based on these variables, the following computational formulas can be defined,

Change in USDA Forecasts:

$$\left(\frac{USDA_i - USDA_{i-1}}{USDA_{i-1}}\right)\cdot 100 \qquad i = 2,\ldots 5$$

Expected Change in USDA Forecasts:

$$\left(\frac{Market_i - USDA_{i-1}}{USDA_{i-1}}\right)\cdot 100 \qquad i = 2,\ldots 4$$

USDA Forecast Error:

$$\left(\frac{USDA_5 - USDA_i}{USDA_5}\right)\cdot 100 \qquad i = 1,\ldots,4$$

Private Market Forecast Error:

$$\left(\frac{USDA_5 - Market_i}{USDA_5}\right)\cdot 100 \qquad i = 1,\ldots,4$$

Market Surprise:

$$\left(\frac{USDA_i - Market_i}{USDA_i}\right)\cdot 100 \qquad i = 1,\ldots,4$$

Price Reaction:

$$\left(\frac{p_{t,i}^{o} - p_{t-1,i}^{c}}{p_{t-1,i}^{c}} \right) \cdot 100 \qquad i = 1, \ldots, 4$$

Finally, note that the computational formula for price reaction technically only applies to crop reports released between May 1994 and November 2005. During this time period, reports were released at 8:30 am EST, before the start of futures trading on the release date. The computational formula is changed slightly for crop reports released between August 1970 and April 1994. During this earlier time period, reports were released at 3:00 pm EST, after the close of trading on the release date. As a result, day *t-1* has to be re-defined as the date a crop report is released and day *t* as the day after release.

Table 1. Mean Absolute Percentage Errors (MAPE) for USDA and Private Market Forecasts of Corn and Soybean Production, 1970-2005

	Corn			Soybeans		
	USDA Forecast	Private Forecast	Difference	USDA Forecast	Private Forecast	Difference
		---%---			---%---	
August						
1970-2005	5.2	5.4	-0.2	5.3	4.9	0.4
1970-1984	5.9	7.0	-1.1	4.9	4.8	0.1
1985-2005	4.8	4.3	0.5	5.6	5.0	0.6
2001-2005	3.7	4.0	-0.3	8.2	7.9	0.3
September						
1970-2005	4.1	4.4	-0.4	4.2	4.1	0.1
1970-1984	3.9	4.2	-0.3	3.2	3.3	-0.1
1985-2005	4.2	4.6	-0.4	4.9	4.7	0.2
2001-2005	3.5	4.4	-0.9	6.2	6.8	-0.6
October						
1970-2005	2.4	3.0	-0.6	2.4	2.8	-0.4
1970-1984	2.4	3.1	-0.7	2.7	2.7	0.0
1985-2005	2.3	2.9	-0.5	2.2	2.8	-0.6
2001-2005	1.2	2.1	-0.8	2.1	3.1	-1.0
November						
1970-2005	1.1	1.5	-0.4	1.4	1.5	-0.1
1970-1984	1.3	1.8	-0.4	1.8	2.1	-0.2
1985-2005	1.0	1.4	-0.4	1.1	1.1	0.0
2001-2005	0.7	0.8	-0.2	1.1	0.9	0.2

Note: Difference is calculated as USDA minus private market. Hence, a negative difference shows that the mean abolute error of the USDA was smaller than the mean absolute error of the private market and vice versa.

Table 2. Root Mean Squared Percentage Errors (RMSPE) for USDA and Private Market Forecasts of Corn and Soybean Production, 1970-2005

	Corn			Soybeans		
	USDA Forecast	Private Forecast	Difference	USDA Forecast	Private Forecast	Difference
		---%---			---%---	
August						
1970-2005	7.4	8.0	-0.6	6.5	6.7	-0.2
1970-1984	8.7	9.9	-1.2	6.2	6.3	-0.1
1985-2005	6.3	6.2	0.1	6.8	7.0	-0.2
2001-2005	4.7	5.2	-0.5	10.1	11.3	-1.2
September						
1970-2005	5.1	5.6	-0.6	4.9	5.2	-0.3
1970-1984	4.5	5.0	-0.5	4.0	4.5	-0.6
1985-2005	5.5	6.1	-0.6	5.5	5.7	-0.2
2001-2005	4.1	4.9	-0.8	7.0	8.2	-1.2
October						
1970-2005	3.2	3.8	-0.6	2.8	3.3	-0.5
1970-1984	2.8	3.4	-0.7	3.1	3.3	-0.2
1985-2005	3.5	4.0	-0.5	2.6	3.4	-0.8
2001-2005	1.4	2.4	-1.0	2.4	3.7	-1.3
November						
1970-2005	1.6	2.1	-0.5	1.8	2.0	-0.2
1970-1984	1.6	2.0	-0.4	2.3	2.7	-0.3
1985-2005	1.5	2.2	-0.6	1.3	1.4	-0.1
2001-2005	0.9	1.1	-0.3	1.2	1.2	0.0

Note: Difference is calculated as USDA minus private market. Hence, a negative difference shows that the root mean squared error of the USDA was smaller than the root mean squared error of the private market and vice versa.

Table 3. USDA and Private Market Forecasts for 2005 Corn and Soybean Production

	Corn		Soybeans	
Month	**USDA Forecast**	**Private Forecast**	**USDA Forecast**	**Private Forecast**
Panel A: Forecasts (million bushels)				
August 2005	10,350	10,277	2,791	2,807
September 2005	10,639	10,373	2,856	2,828
October 2005	10,857	10,921	2,967	3,005
November 2005	11,032	10,972	3,043	3,035
USDA January 2006 Final	11,112	11,112	3,086	3,086
Panel B: Forecast Errors (million bushels)				
August 2005	762	835	295	280
September 2005	473	740	230	259
October 2005	255	192	119	81
November 2005	80	140	43	52
Panel C: Forecast Errors (percent)				
August 2005	6.9	7.5	9.6	9.1
September 2005	4.3	6.7	7.5	8.4
October 2005	2.3	1.7	3.9	2.6
November 2005	0.7	1.3	1.4	1.7

Note: Forecast errors are computed as actual minus forecast values. Hence, a positive error implies the forecast value is less than the actual value and a negative error implies the forecast value is larger than the actual value. The difference between private forecasts and USDA final estimates may not exactly equal the forecast errors reported in the table due to rounding.

Table 4. Comparison of Performance Indicators for 2005 USDA Corn and Soybean Crop Production Forecasts and Historical Ranges over 1970-2004

	Corn				Soybeans			
Release Month	Change in Forecast	Forecast Error	Market Surprise	Price Reaction	Change in Forecast	Forecast Error	Market Surprise	Price Reaction
	---%---				---%---			
August								
2005	NA	6.9	0.7	-3.0	NA	9.6	-0.6	-0.9
Previous High	NA	9.6	4.5	12.7	NA	10.8	3.7	11.4
Previous Low	NA	-24.6	-6.3	-6.3	NA	-18.4	-3.8	-6.0
September								
2005	2.8	4.3	2.5	-2.8	2.3	7.5	1.0	-2.0
Previous High	4.5	9.3	3.1	2.2	5.3	9.5	4.2	5.3
Previous Low	-16.2	-14.0	-2.2	-3.8	-16.7	-9.3	-4.3	-5.6
October								
2005	2.0	2.3	-0.6	0.6	3.9	3.9	-1.3	2.6
Previous High	5.9	7.5	2.8	4.5	9.6	5.2	4.4	4.9
Previous Low	-5.5	-9.7	-2.6	-3.8	-6.6	-6.0	-4.9	-9.4
November								
2005	1.6	0.7	0.5	-0.8	2.6	1.4	0.3	-1.3
Previous High	4.4	5.1	2.1	10.1	4.4	3.6	2.3	5.2
Previous Low	-6.6	-2.5	-2.9	-2.7	-3.5	-5.8	-1.5	-2.2

Notes: NA stands for not applicable. The previous high and low for a given month refer to the high and low over the 1970-2004 period. Change in forecast is the percentage change in a USDA production forecast relative to the previous month. Market surprise is the percentage difference between the USDA forecast and the private market forecast for a given month. Price reaction is the percentage change in futures prices (December for corn; November for soybeans) from the closing (settlement) price the day before a crop report is released to the first non-limit opening or closing price after a report is released.

Table 5. Comparison of Actual Price Reaction to the Release of 2005 USDA Corn and Soybean Production Forecasts to the Price Reaction Predicted by Historical Relationships over 1970-2004

	Corn		Soybeans	
Month	Actual Price Reaction	Predicted Price Reaction	Actual Price Reaction	Predicted Price Reaction
	---%---		---%---	
August 2005	-3.0	-0.3	-0.9	1.0
September 2005	-2.8	-1.8	-2.0	-0.6
October 2005	0.6	0.8	2.6	1.3
November 2005	-0.8	-0.5	-1.3	-0.1

Note: The predicted price reaction is computed using a regression model of the relationship between market surprise and actual price reaction over 1970-2004. Similar models for 1970-2005 are presented in Figures 21 and 22.

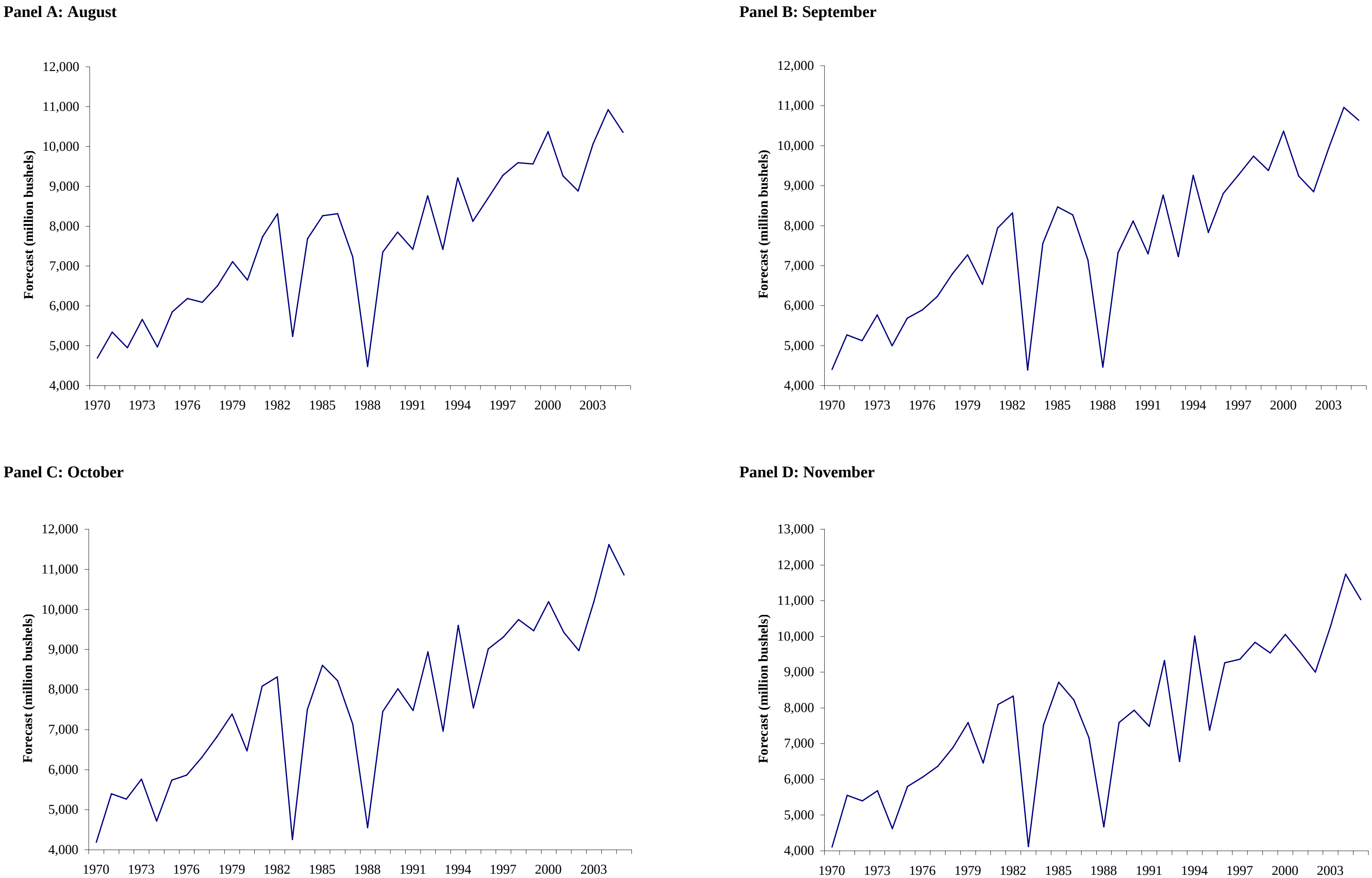
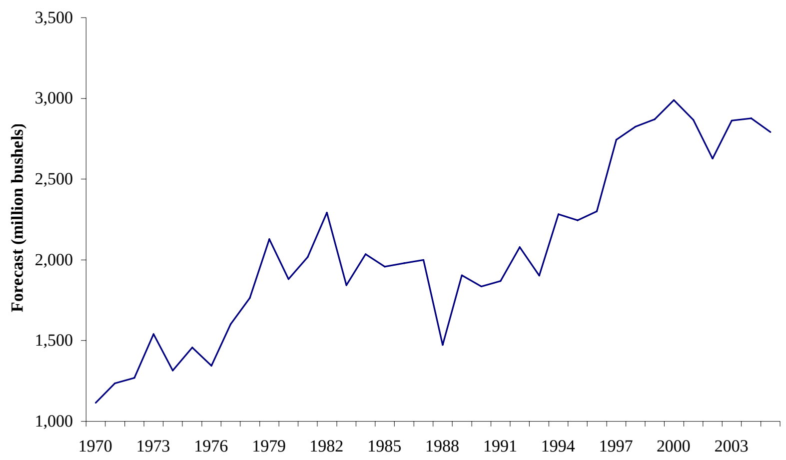
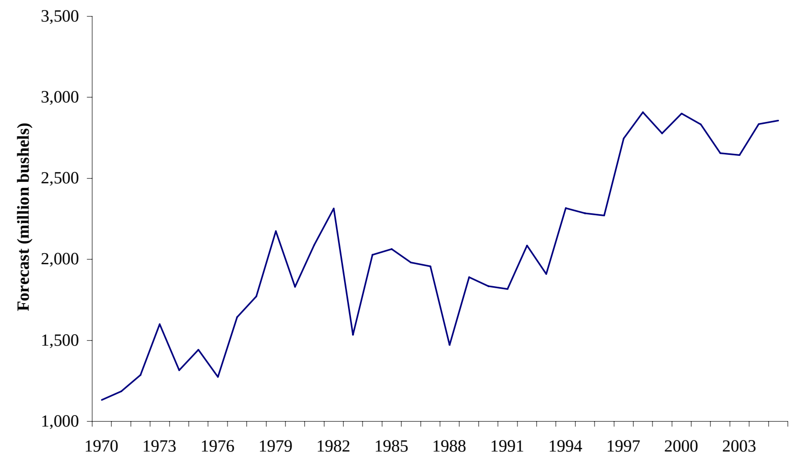


Figure 1. USDA Corn Production Forecasts, 1970-2005

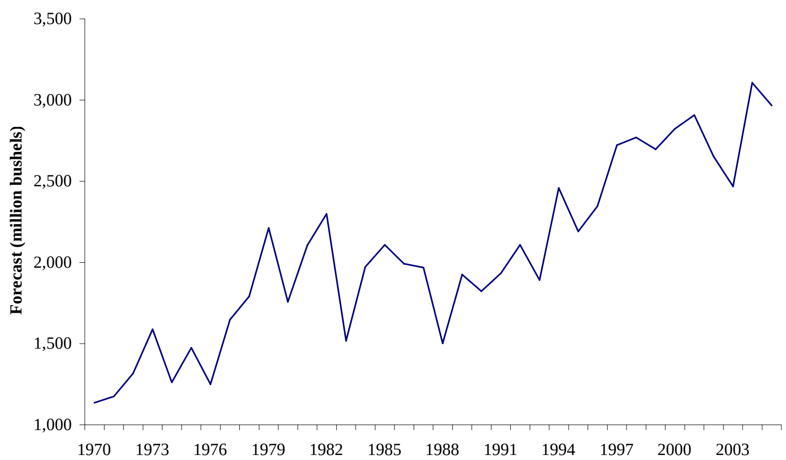
Panel A: August



Panel B: September



Panel C: October



Panel D: November

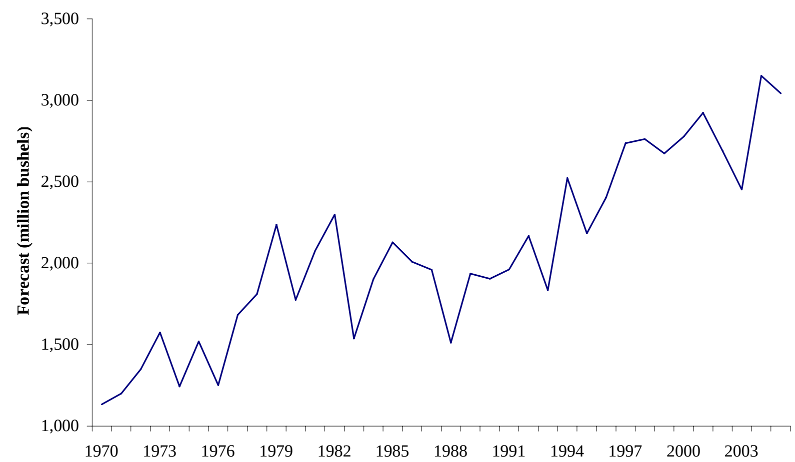
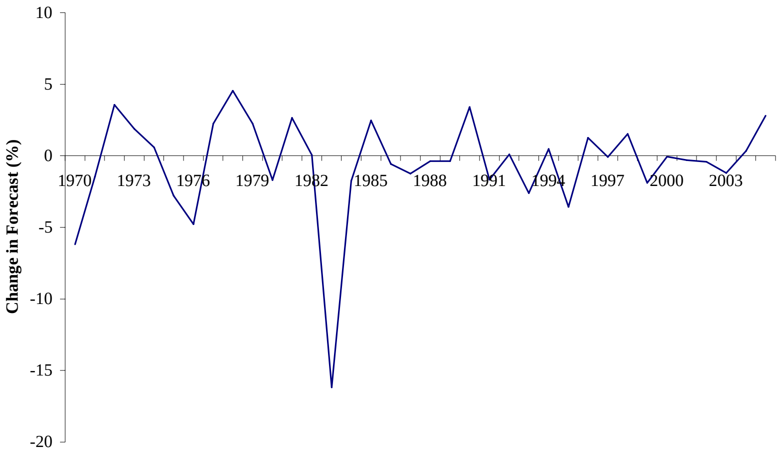
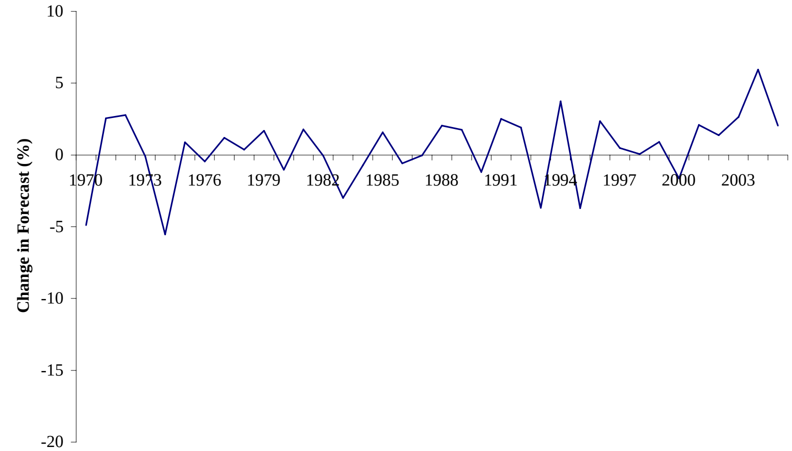


Figure 2. USDA Soybean Production Forecasts, 1970-2005

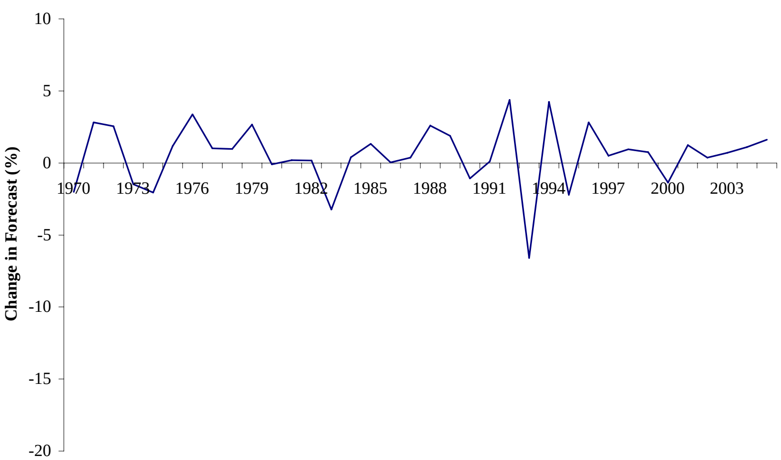
Panel A: September



Panel B: October



Panel C: November



Panel D: January

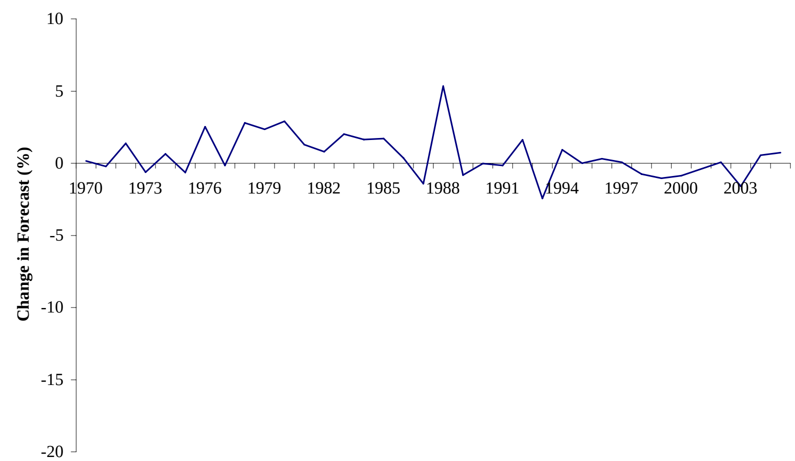
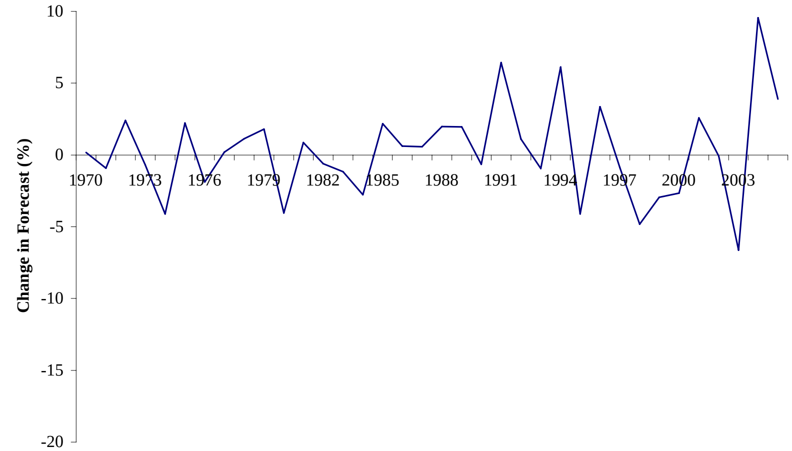


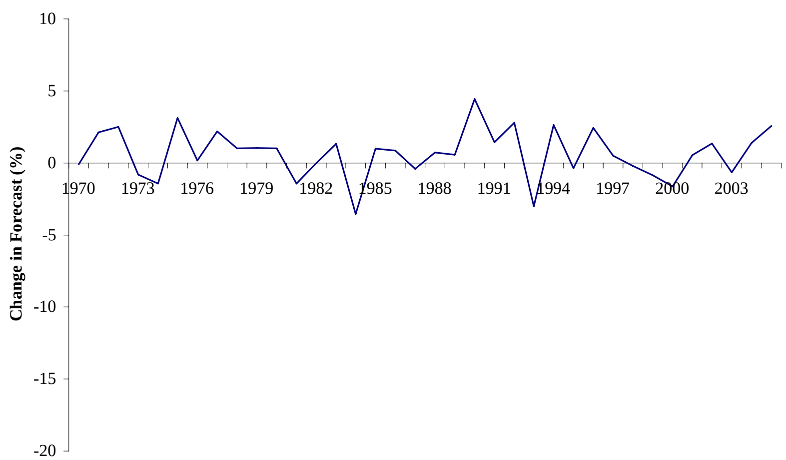
Figure 3. Change in USDA Corn Production Forecasts, 1970-2005

Panel A: September

Panel B: October



Panel C: November



Panel D: January

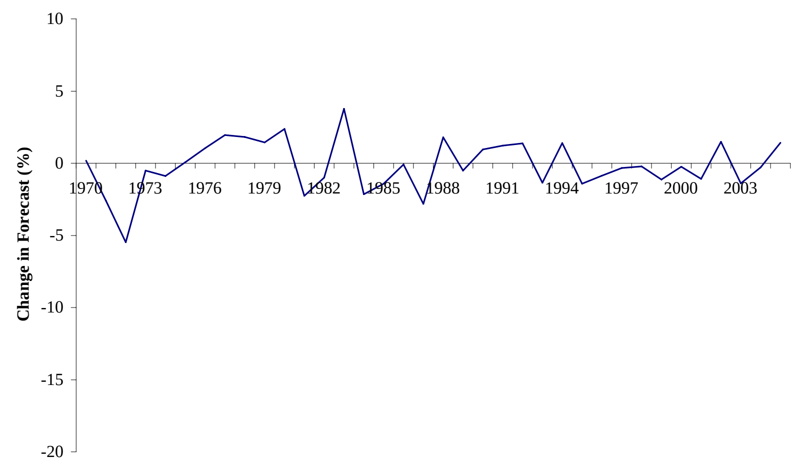
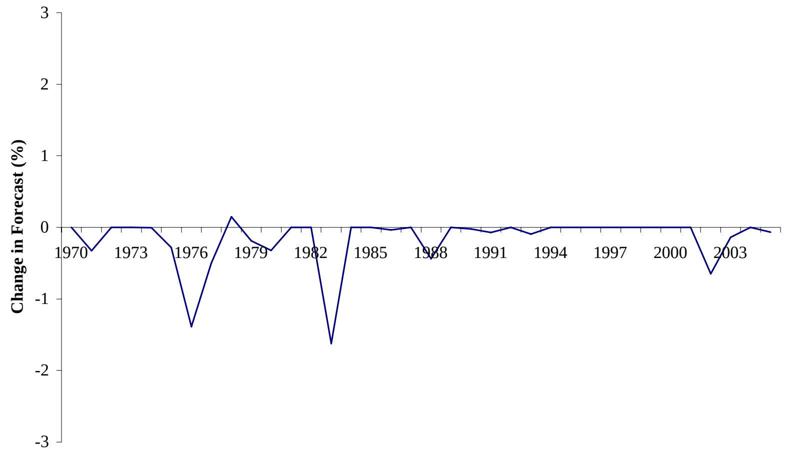
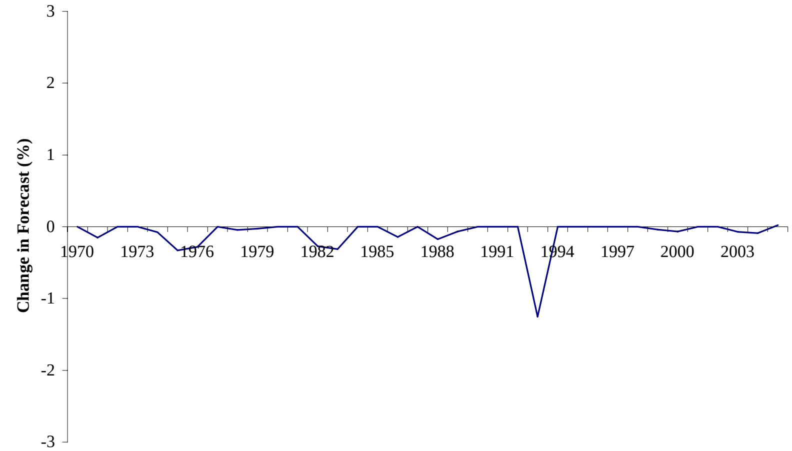


Figure 4. Change in USDA Soybean Production Forecasts, 1970-2005

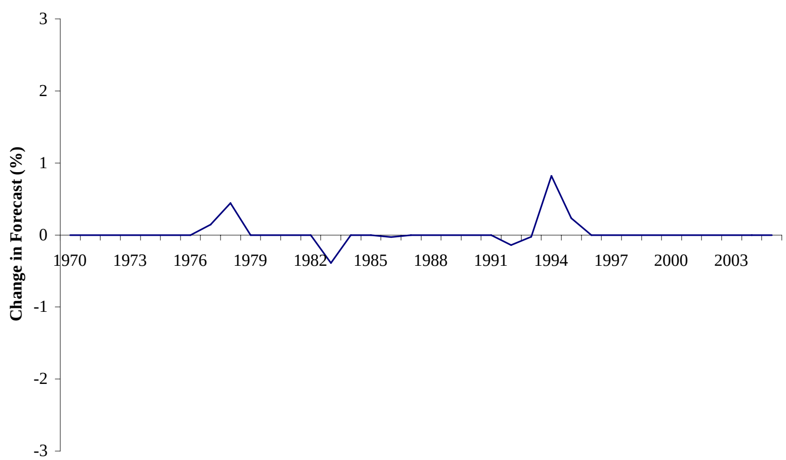
Panel A: September



Panel B: October



Panel C: November



Panel D: January

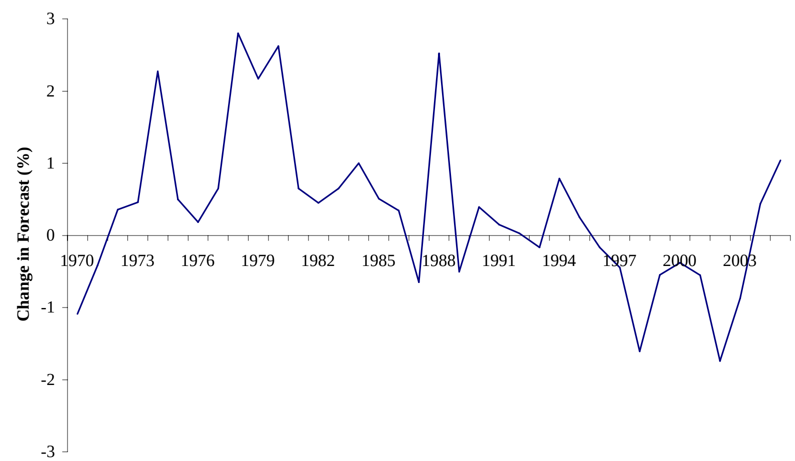


Figure 5. Change in USDA Corn Harvested Acreage Forecasts, 1970-2005

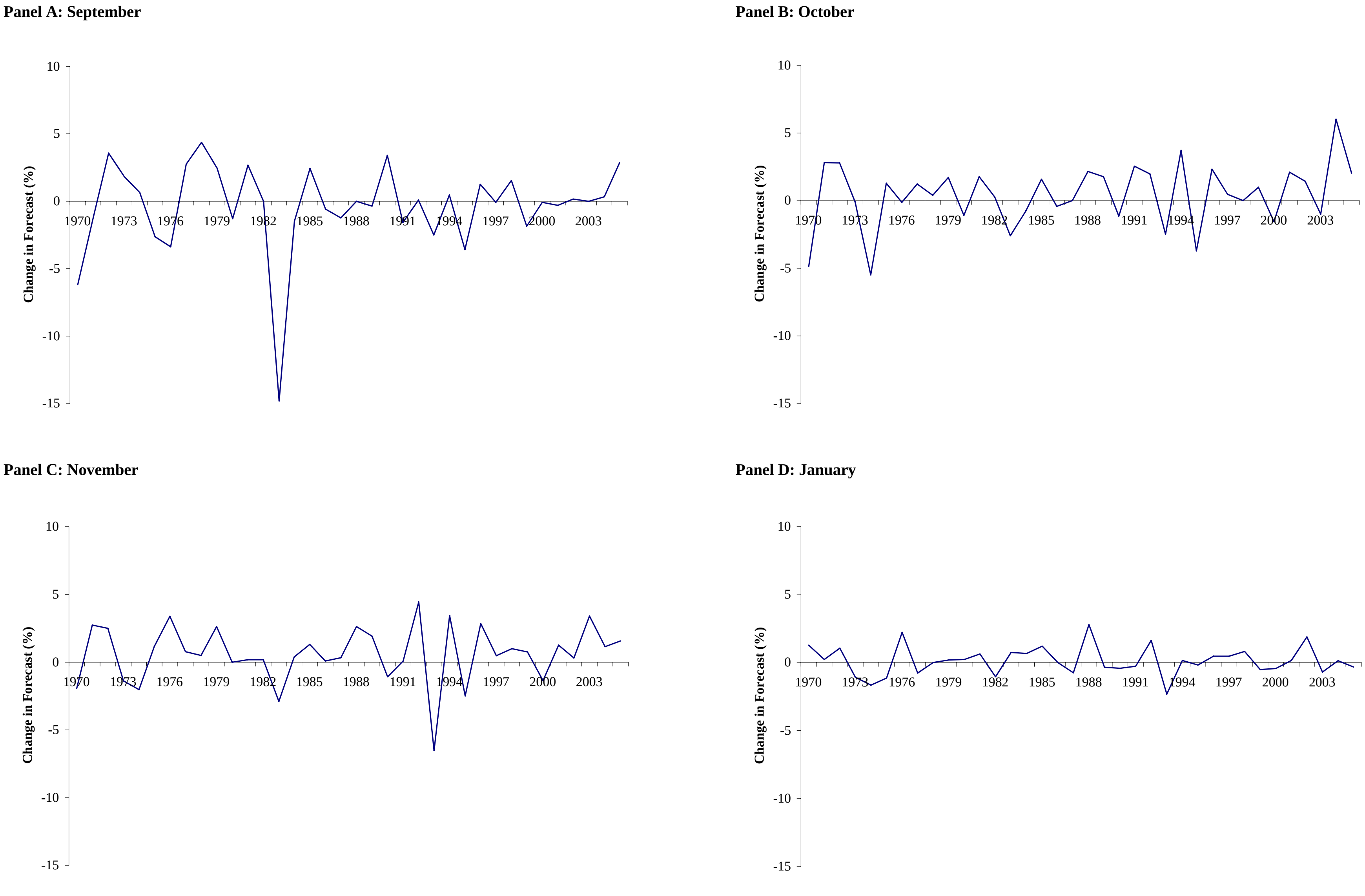
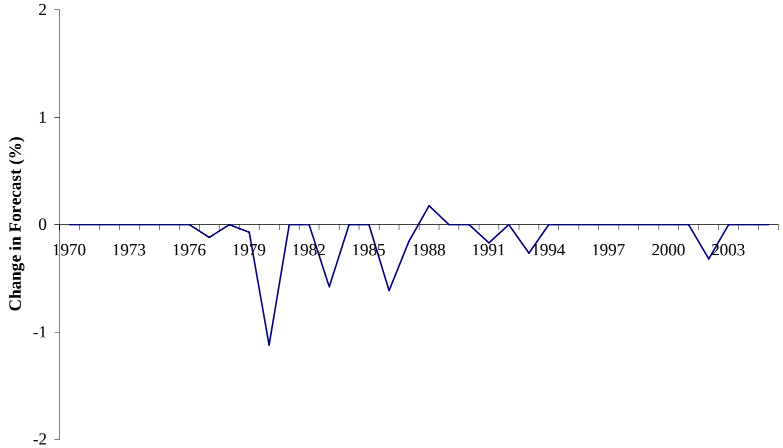
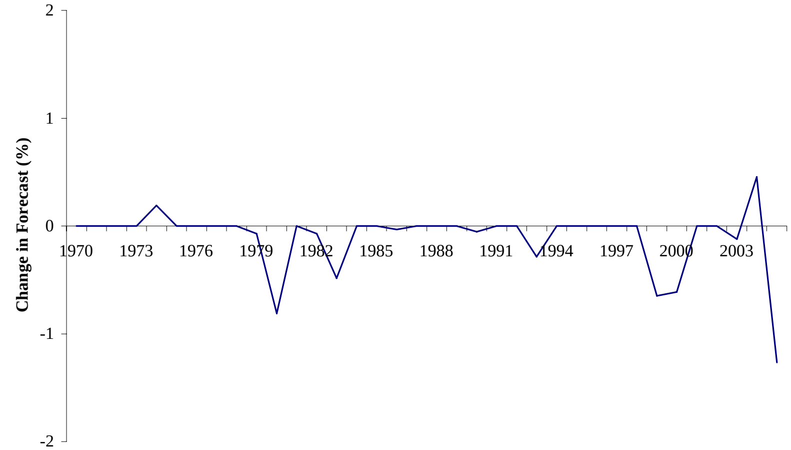


Figure 6. Change in USDA Corn Yield Forecasts, 1970-2005

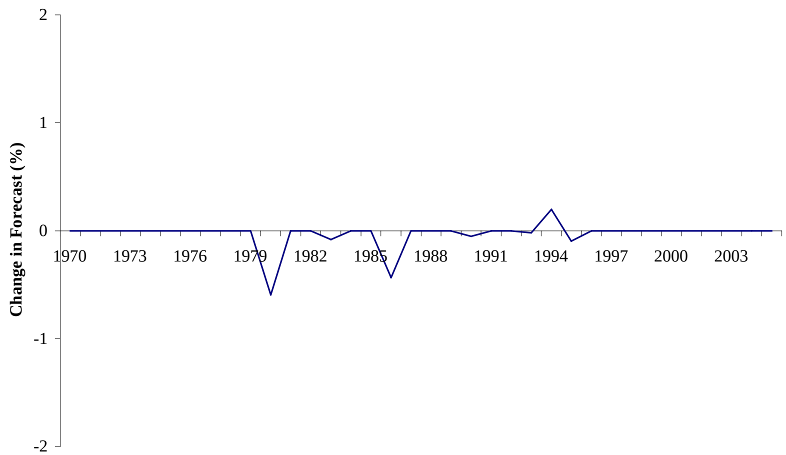
Panel A: September



Panel B: October



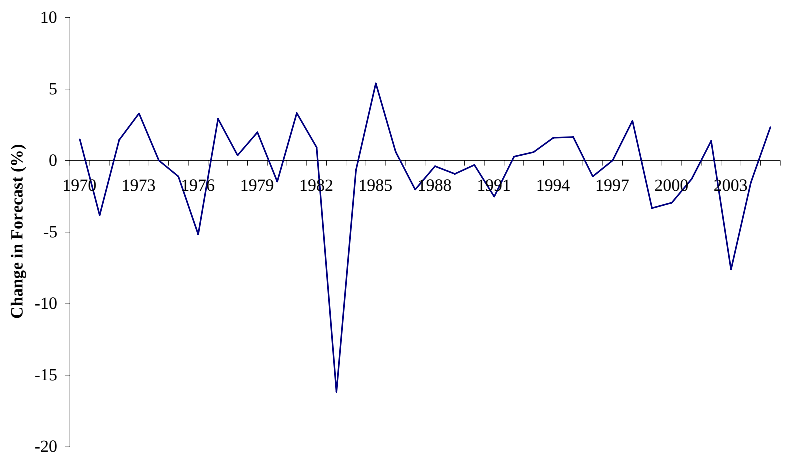
Panel C: November



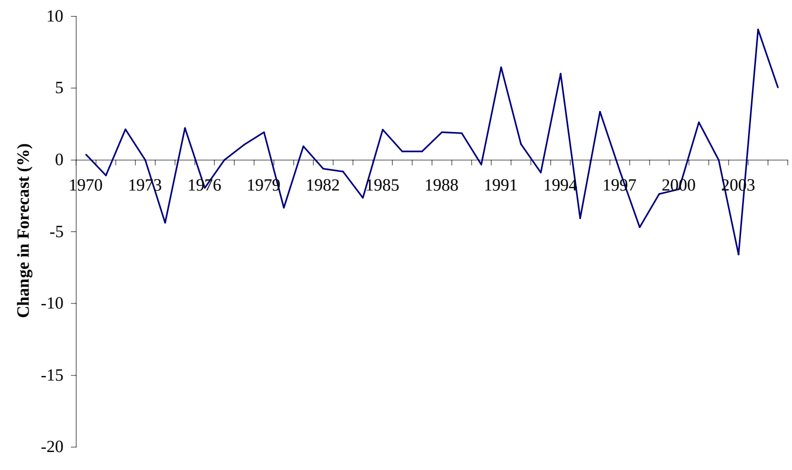
Panel D: January

Figure 7. Change in USDA Soybean Acreage Forecasts, 1970-2005

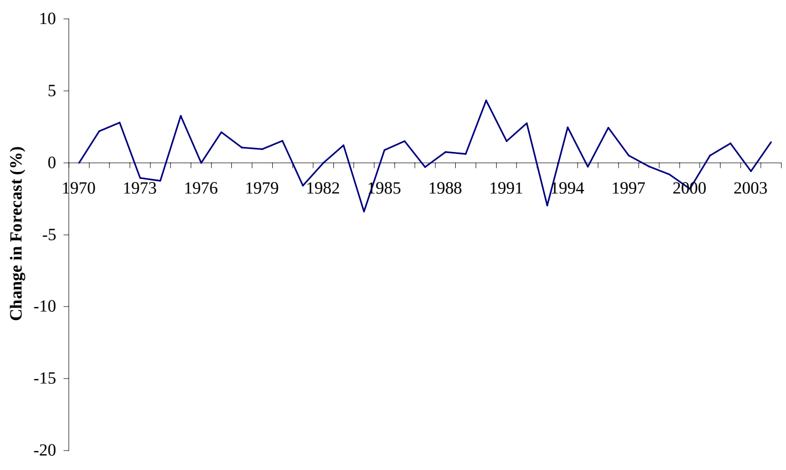
Panel A: September



Panel B: October



Panel C: November



Panel D: January

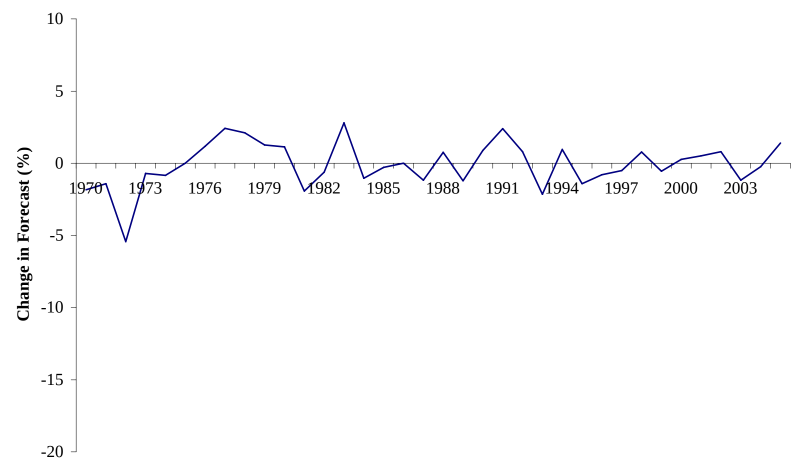
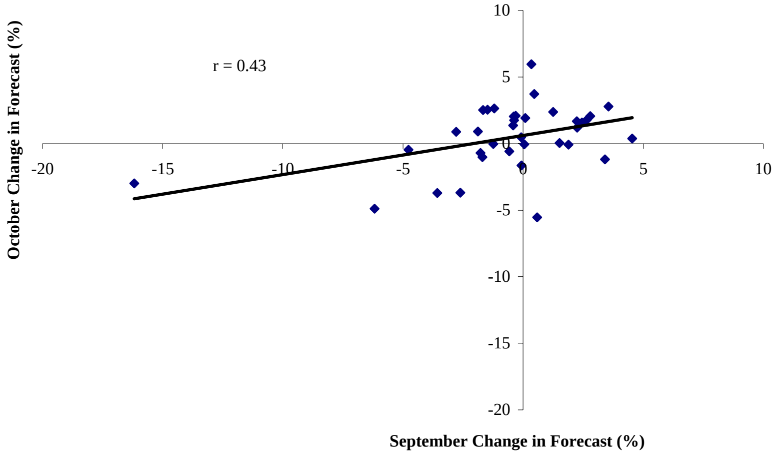
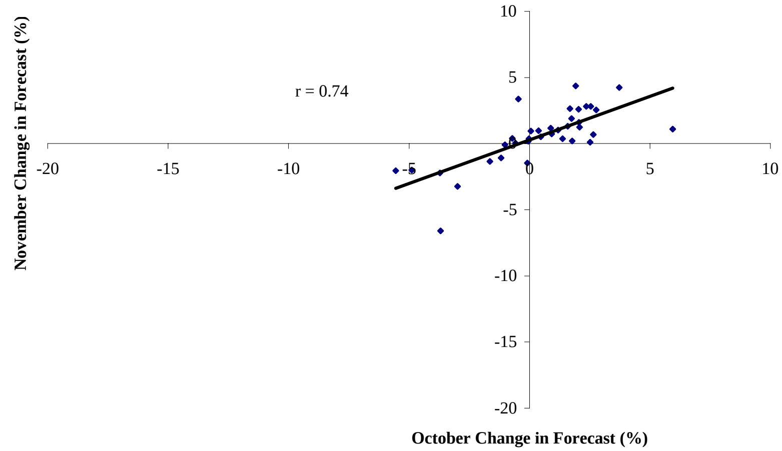


Figure 8. Change in USDA Soybean Yield Forecasts, 1970-2005

Panel A: October vs. September



Panel B: November vs. October



Panel C: January vs. November

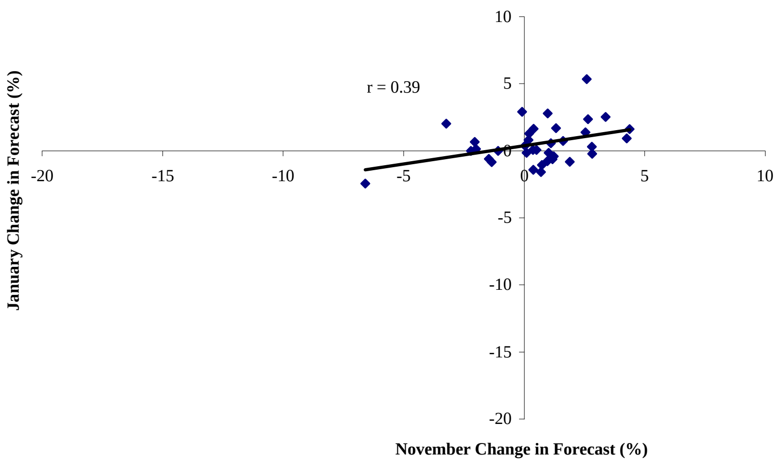
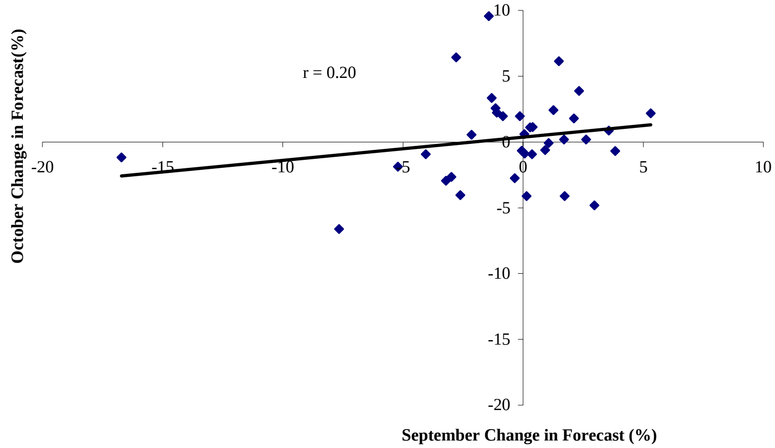
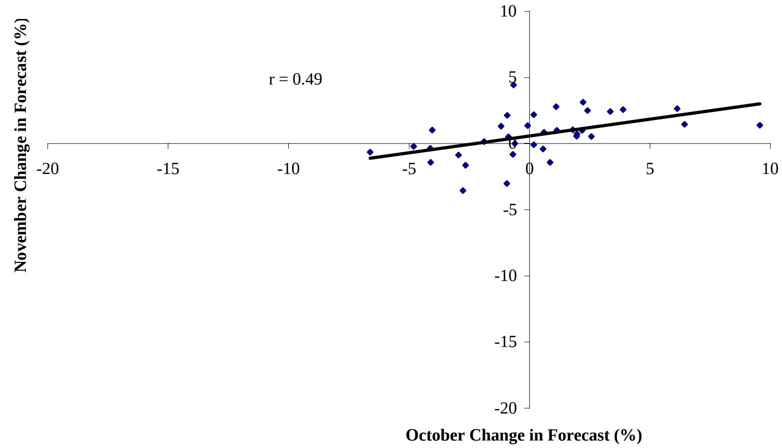


Figure 9. Relationship Between Changes in USDA Corn Production Forecasts, 1970-2005

Panel A: October vs. September



Panel B: November vs. October



Panel C: January vs. November

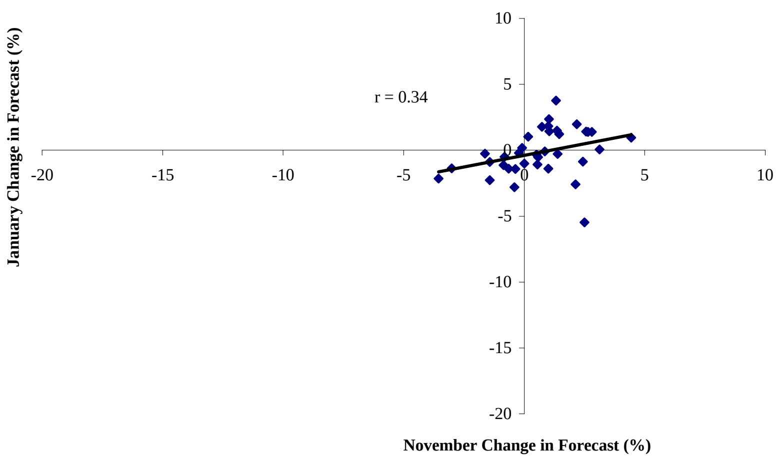
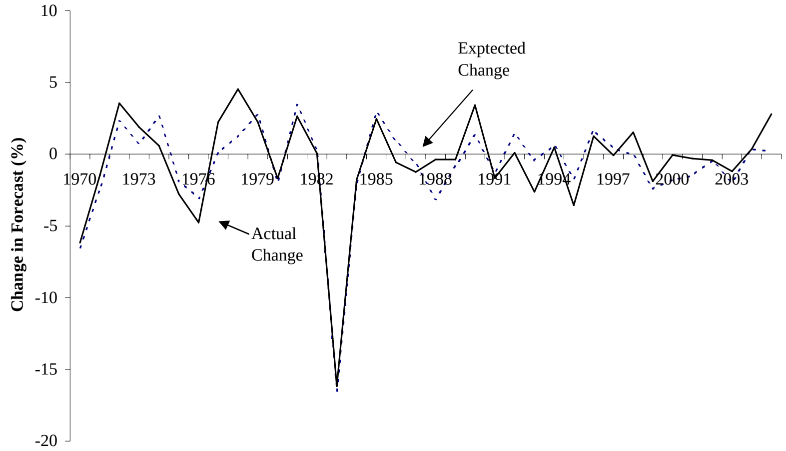
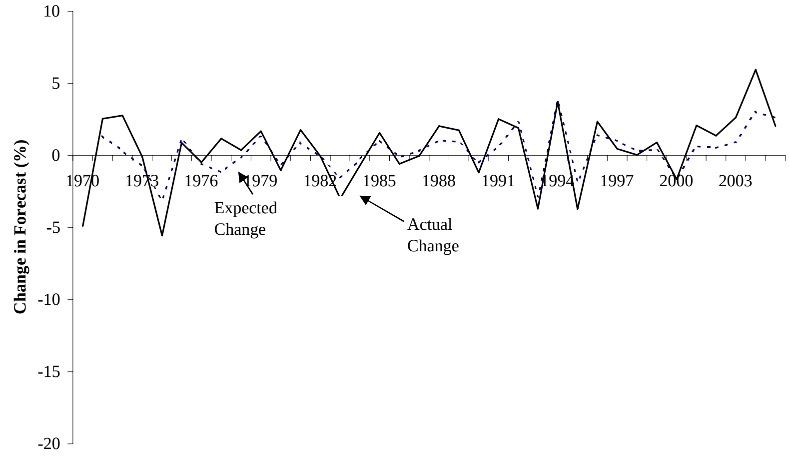


Figure 10. Relationship Between Changes in USDA Soybean Production Forecasts, 1970-2005

Panel A: September



Panel B: October



Panel C: November

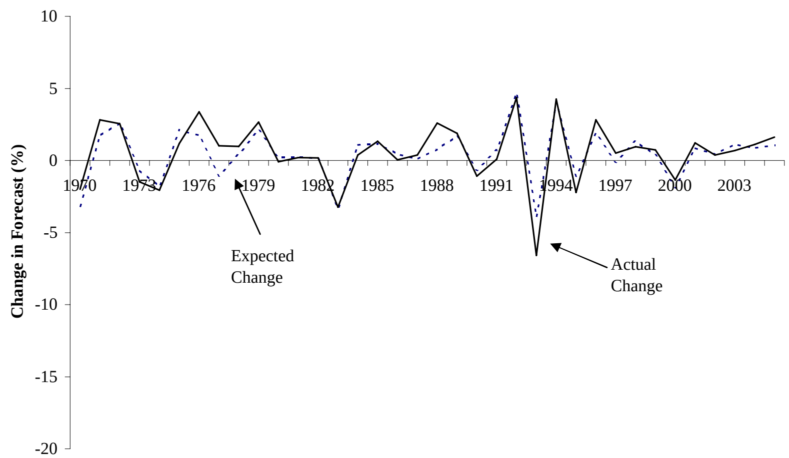
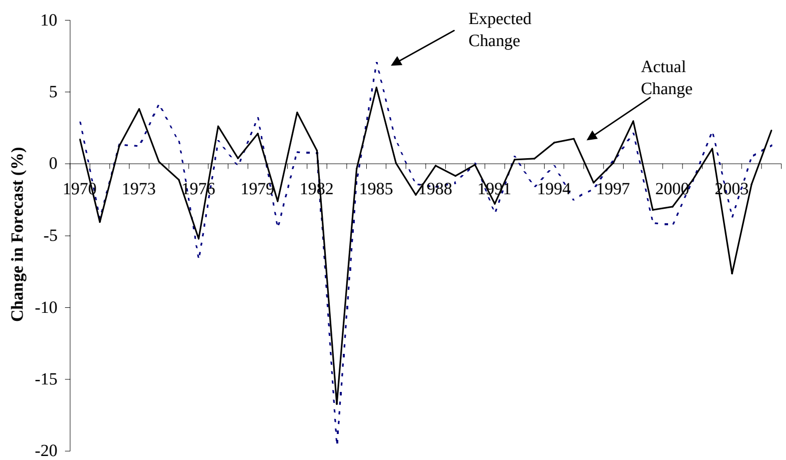
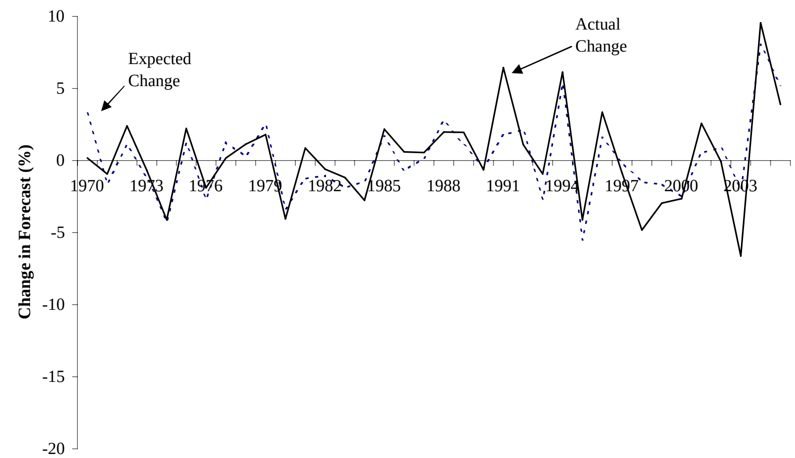


Figure 11. Actual and Expected Changes in USDA Corn Production Forecasts, 1970-2005

Panel A: September



Panel B: October



Panel C: November

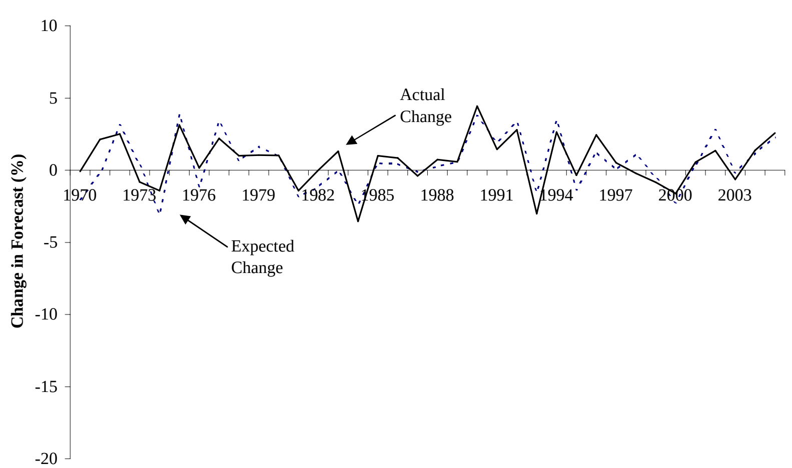
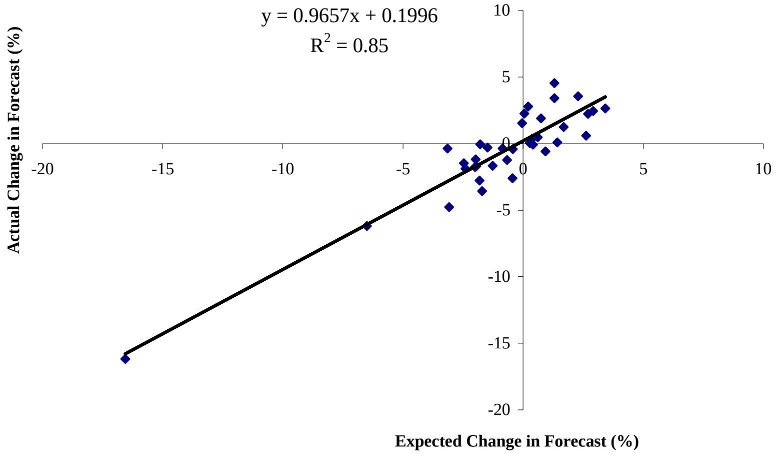
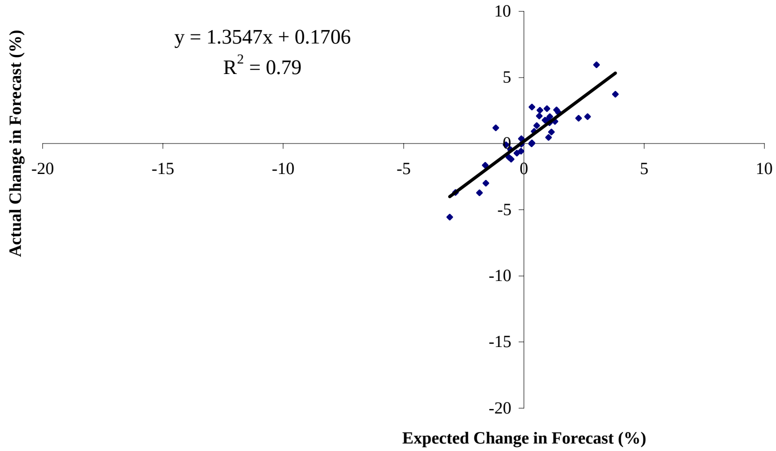


Figure 12. Actual and Expected Changes in USDA Soybean Production Forecasts, 1970-2005

Panel A: September



Panel B: October



Panel C: November

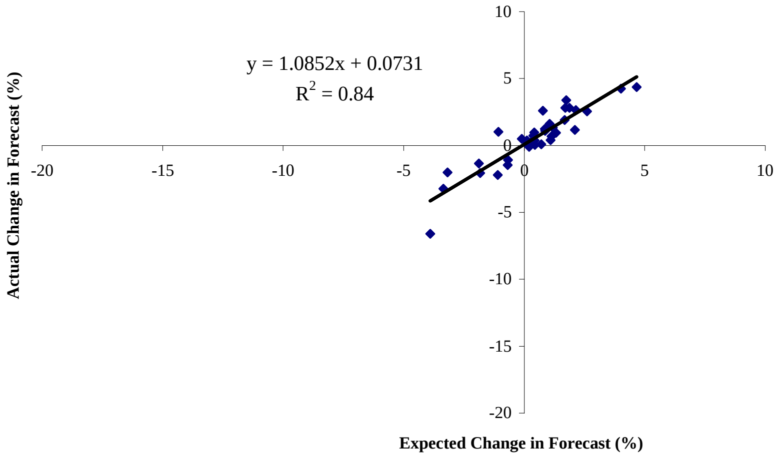
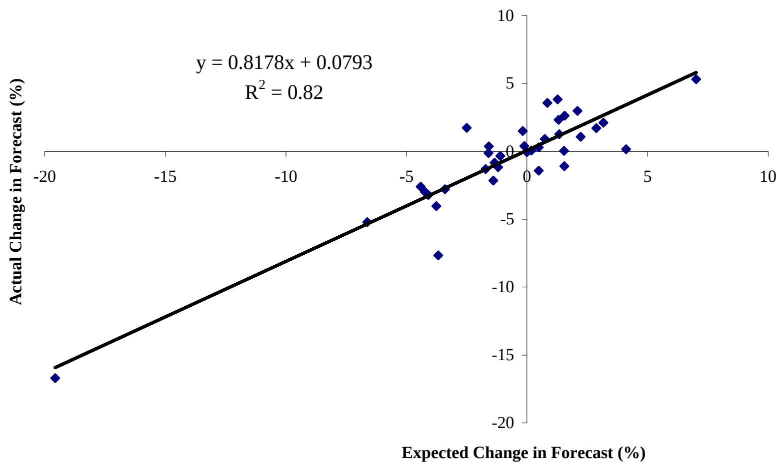
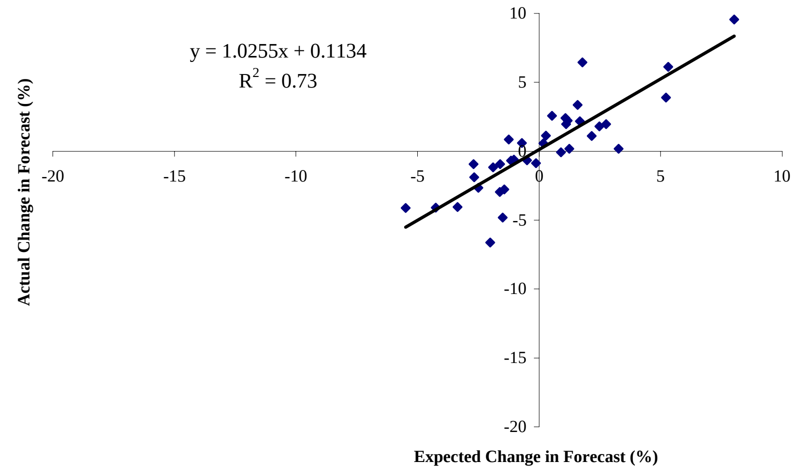


Figure 13. Relationship Between Actual and Expected Changes in USDA Corn Production Forecasts, 1970-2005

Panel A: September



Panel B: October



Panel C: November

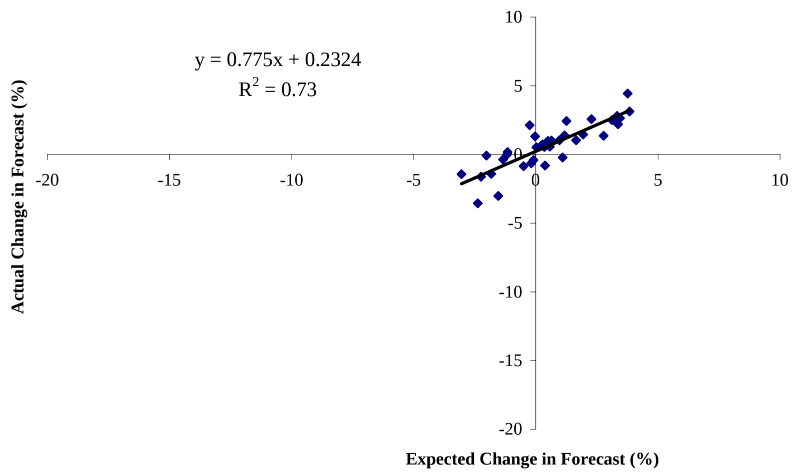
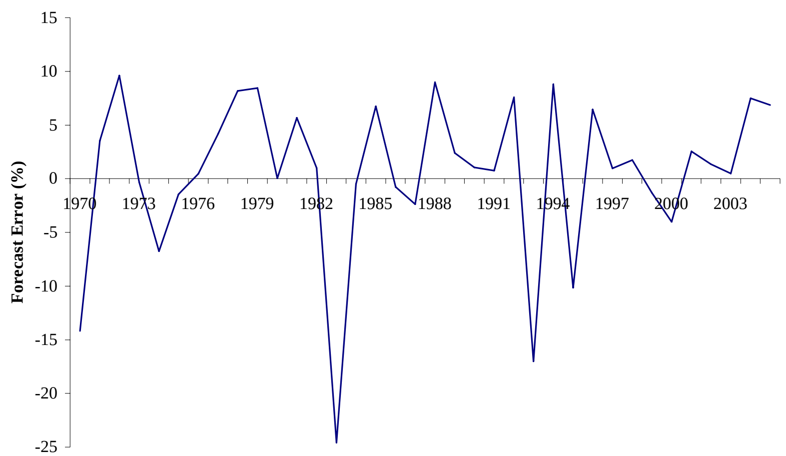
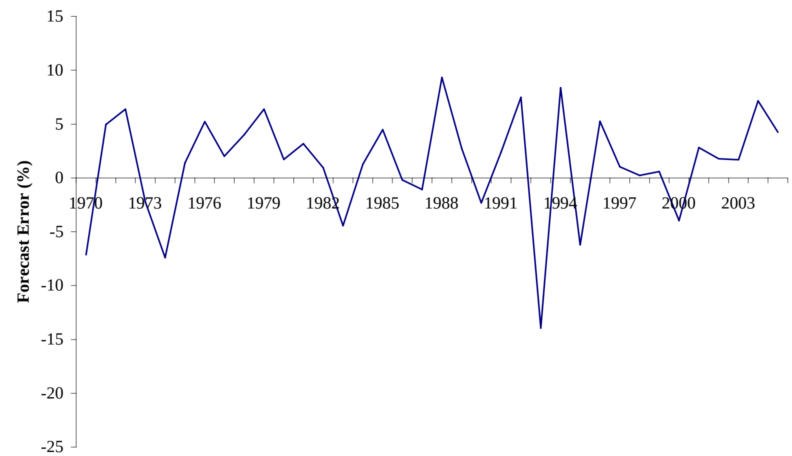


Figure 14. Relationship Between Actual and Expected Changes in USDA Soybean Production Forecasts, 1970-2005

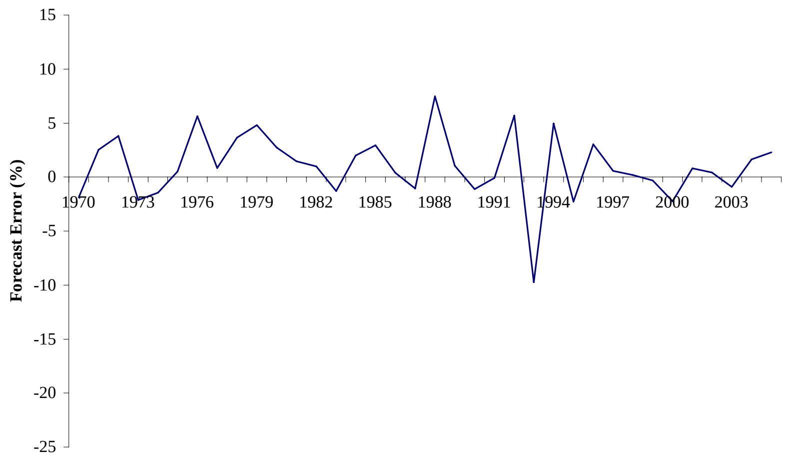
Panel A: August



Panel B: September



Panel C: October



Panel D: November

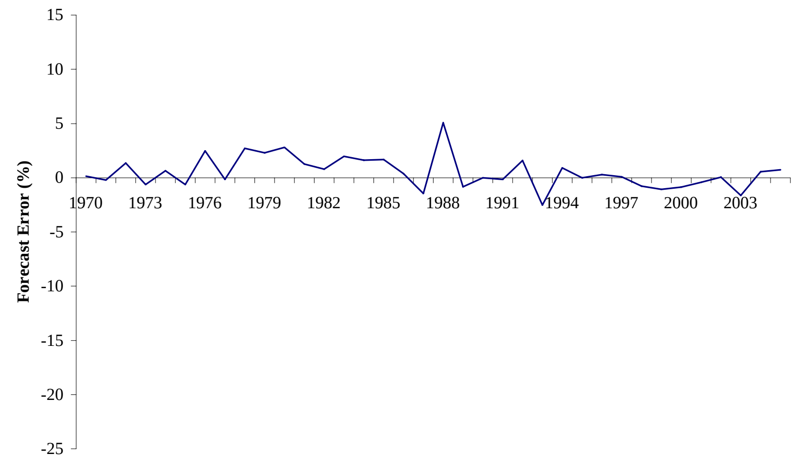


Figure 15. USDA Corn Production Forecast Errors, 1970-2005

Panel A: August

Panel B: September

Panel C: October

Panel D: November

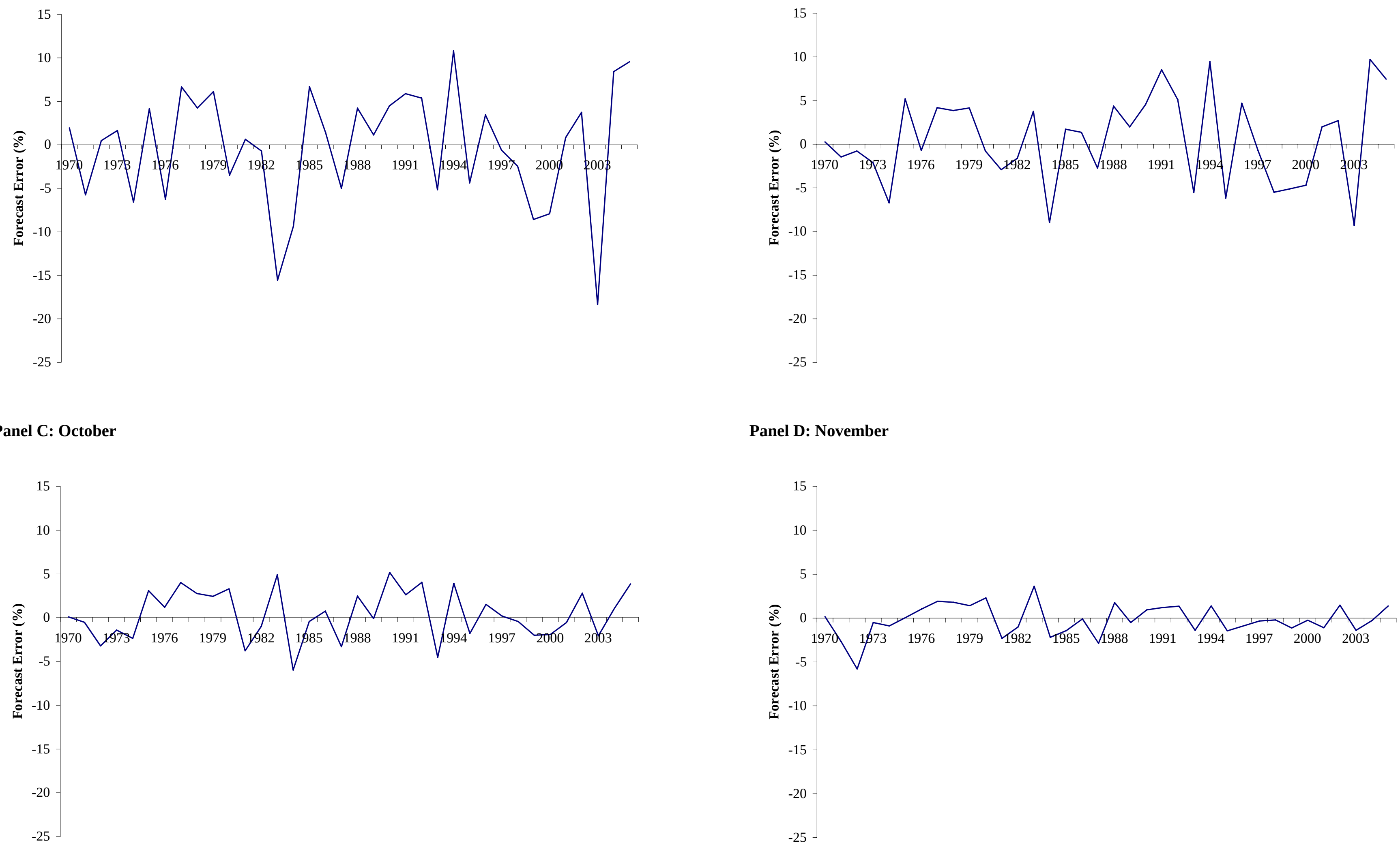
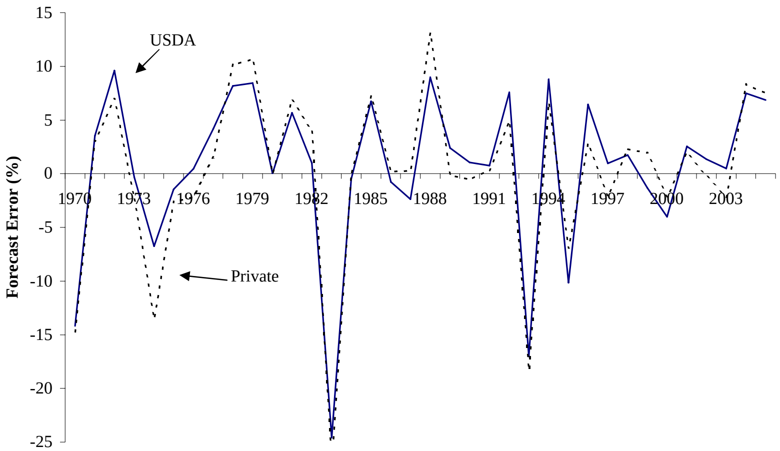
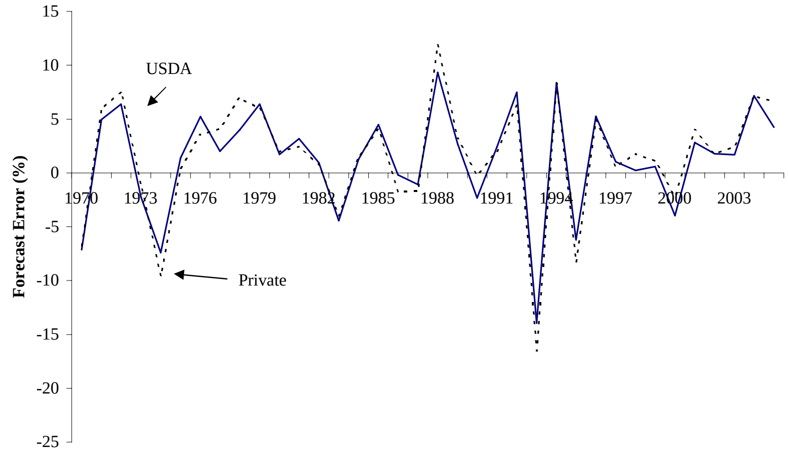


Figure 16. USDA Soybean Production Forecast Errors, 1970-2005

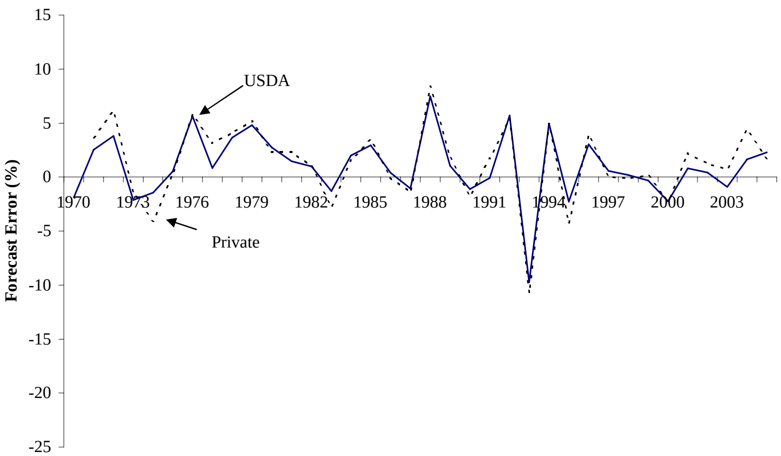
Panel A: August



Panel B: September



Panel C: October



Panel D: November

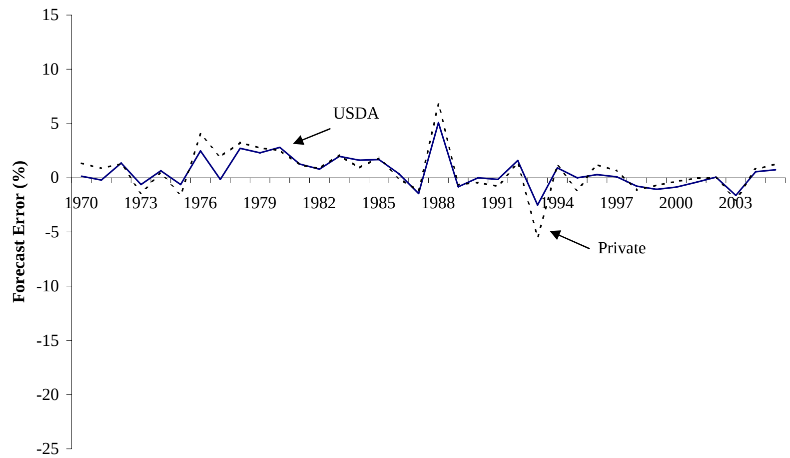
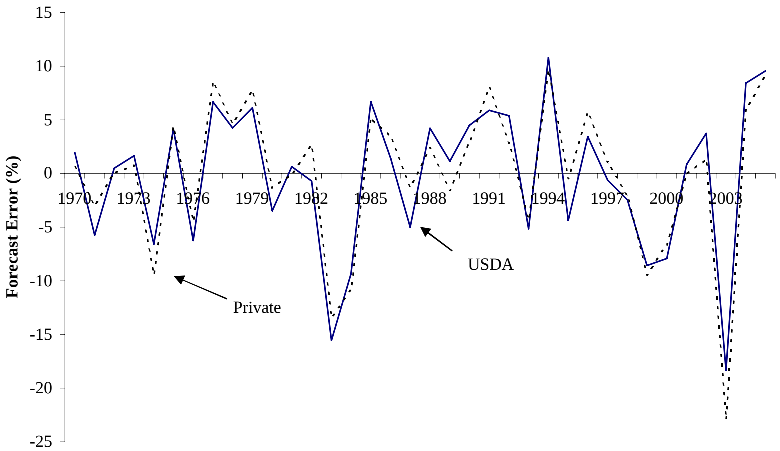
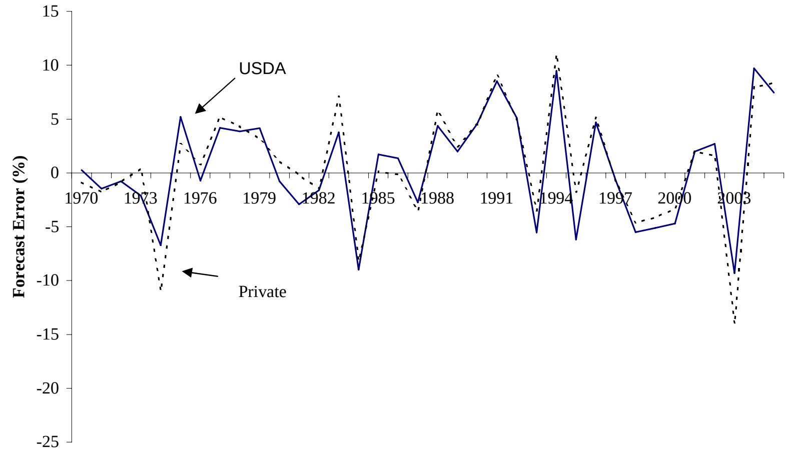


Figure 17. USDA and Private Market Corn Production Forecast Errors, 1970-2005

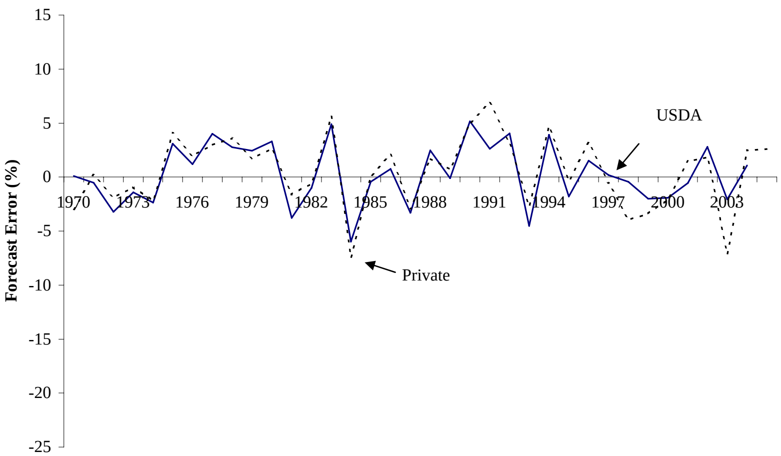
Panel A: August



Panel B: September



Panel C: October



Panel D: November

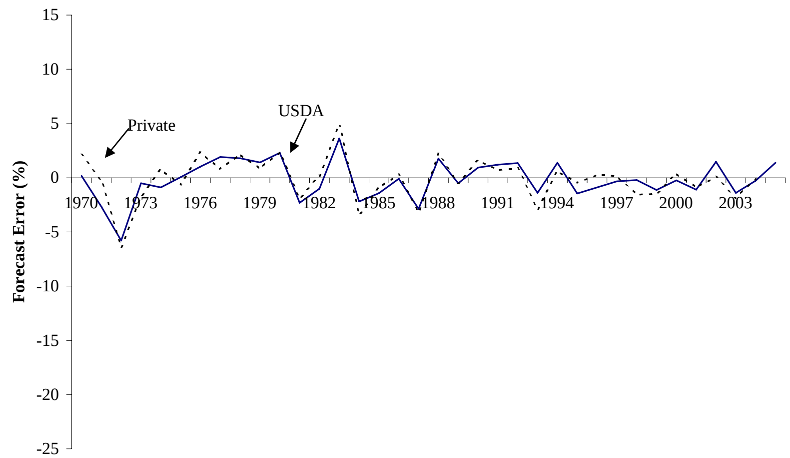
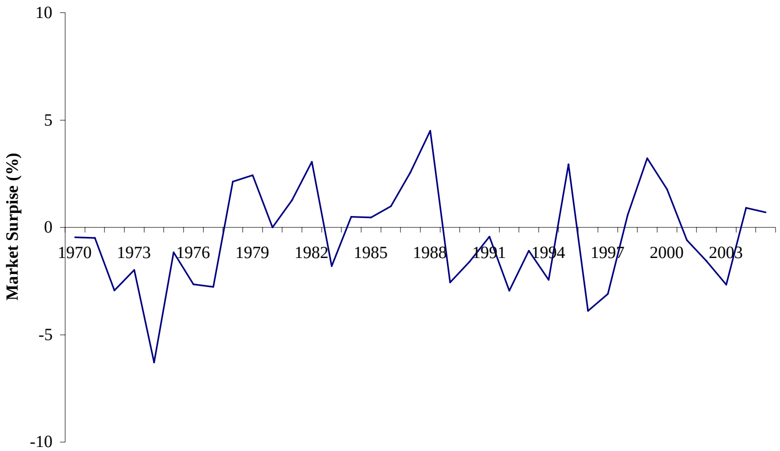
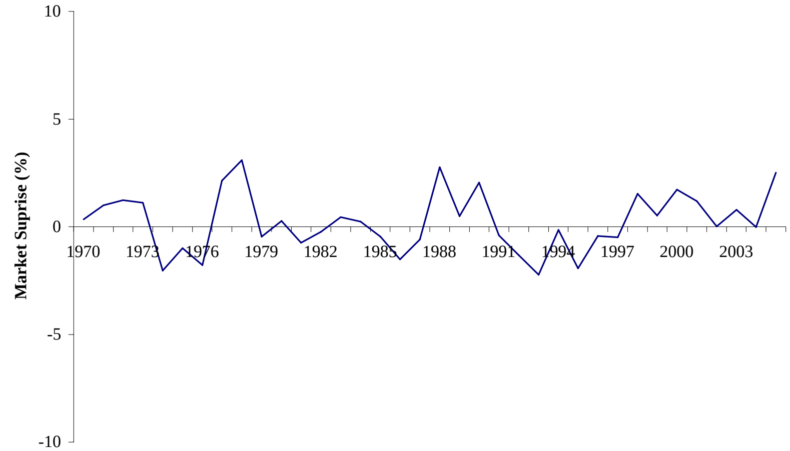


Figure 18. USDA and Private Market Soybean Production Forecast Errors, 1970-2005

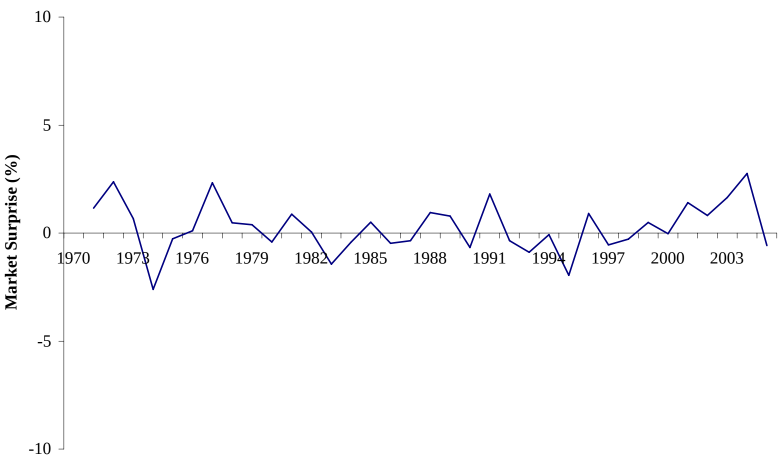
Panel A: August



Panel B: September



Panel C: October



Panel D: November

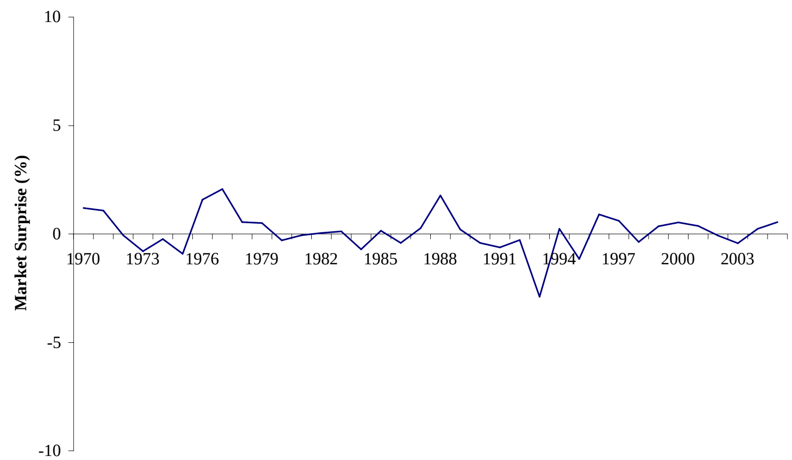
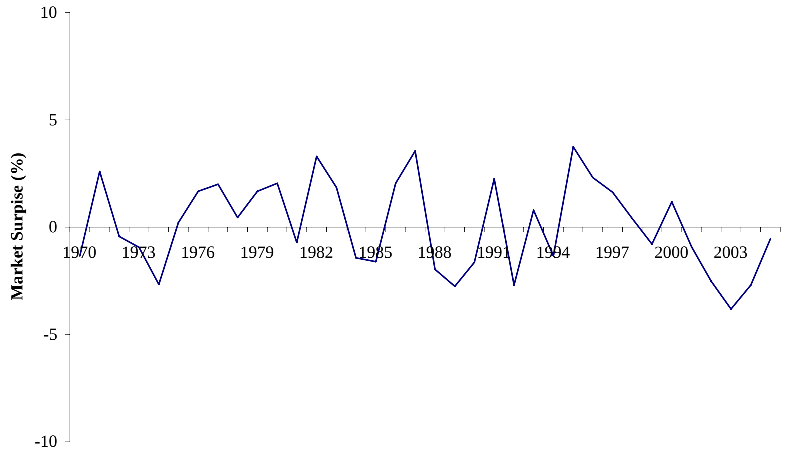
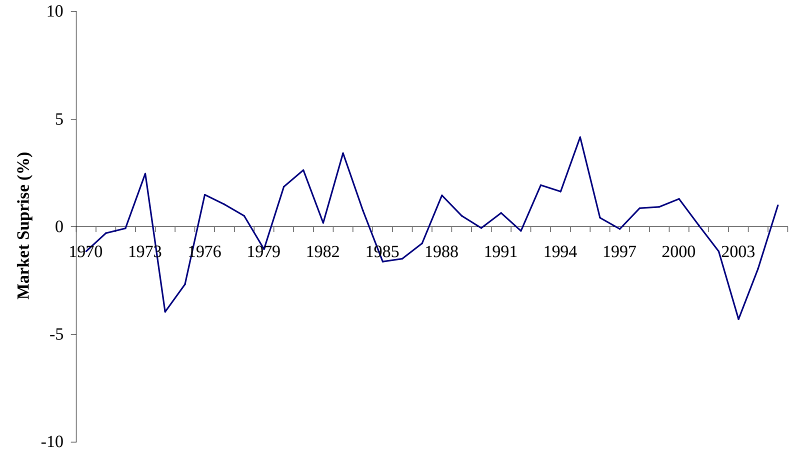


Figure 19. Market Surpise Associated with USDA Corn Production Forecasts, 1970-2005

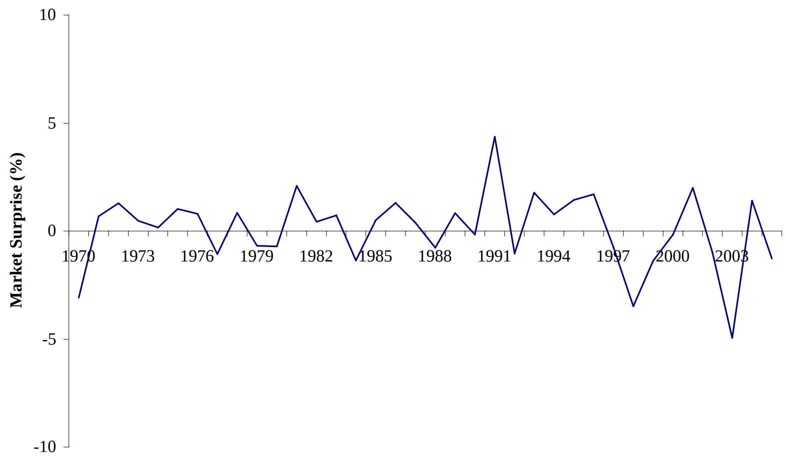
Panel A: August



Panel B: September



Panel C: October



Panel D: November

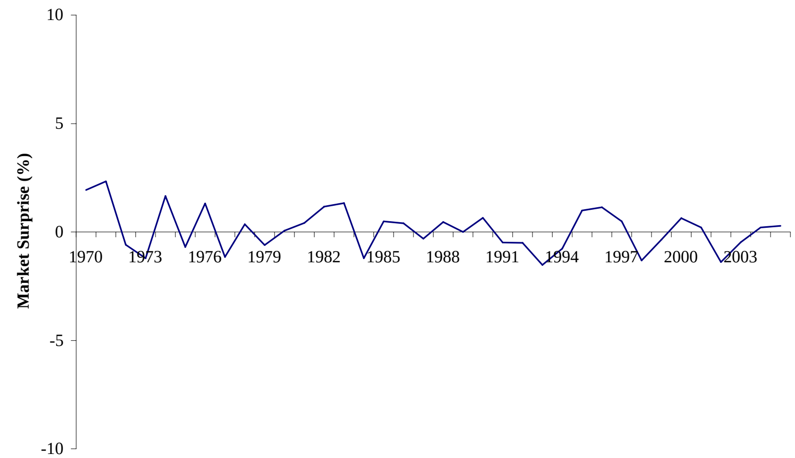


Figure 20. Market Surpise Associated with USDA Soybean Production Forecasts, 1970-2005

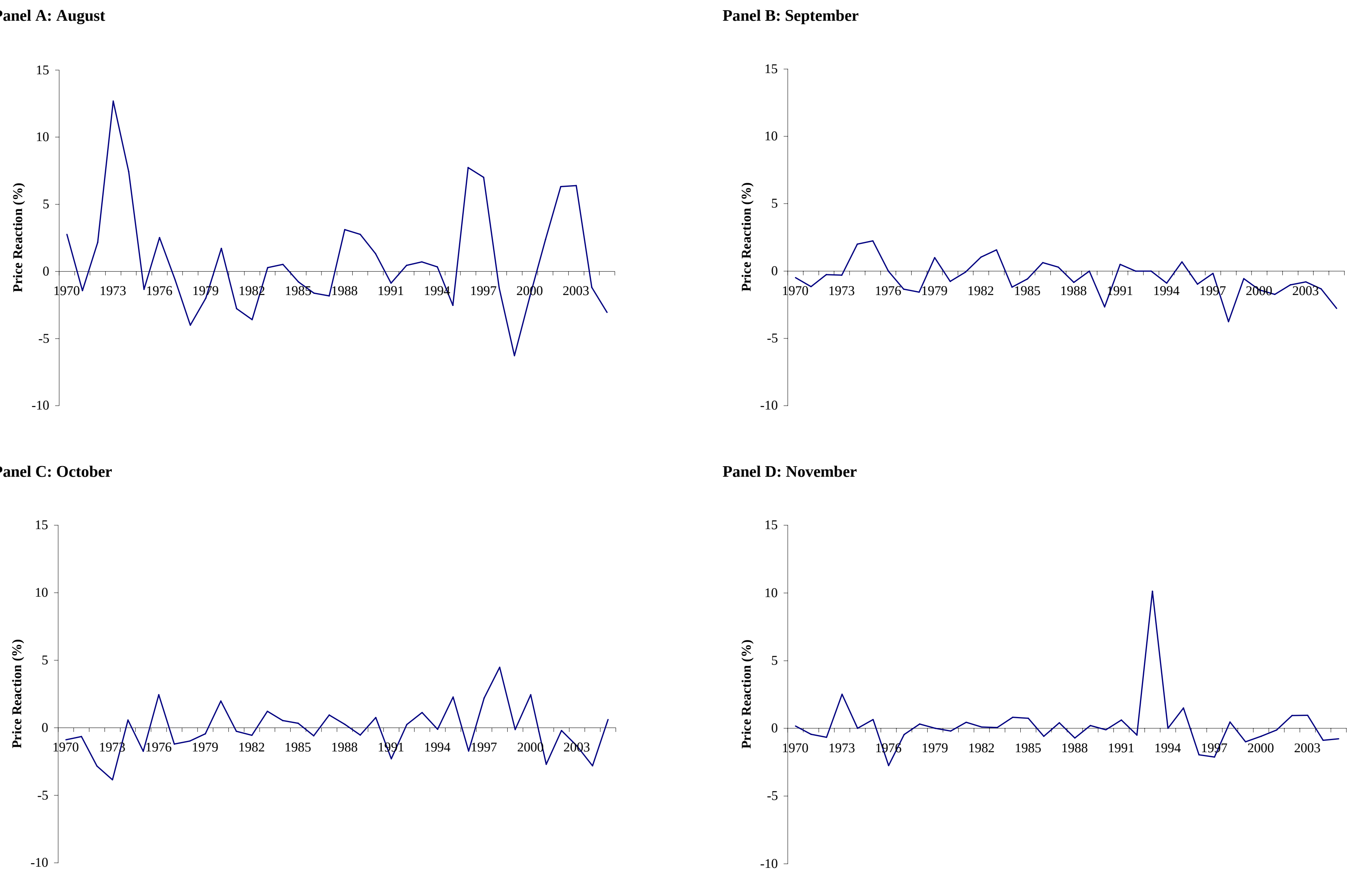


Figure 21. Reaction of December Corn Futures Prices to Release of USDA Corn Production Forecasts, 1970-2005

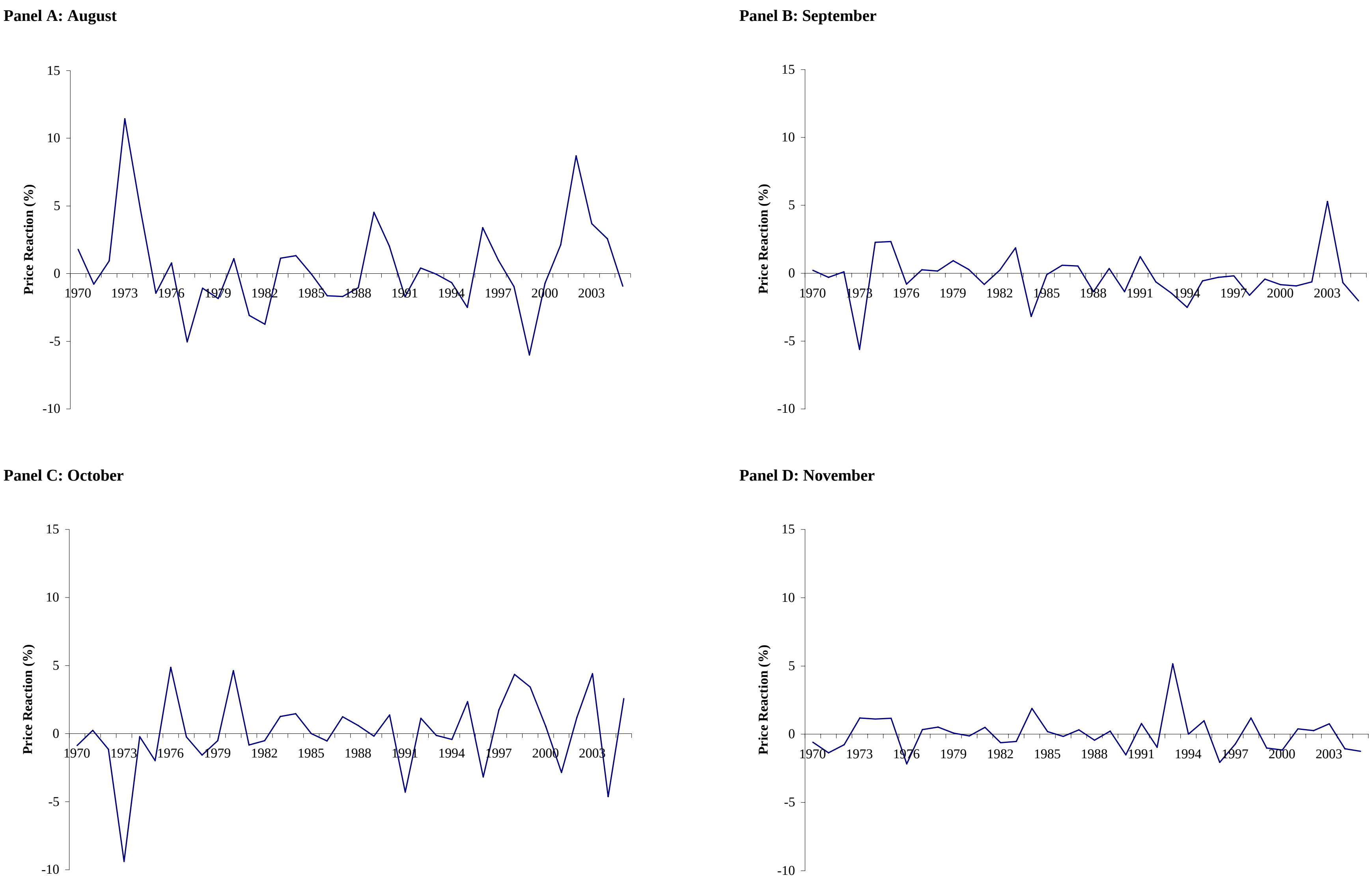
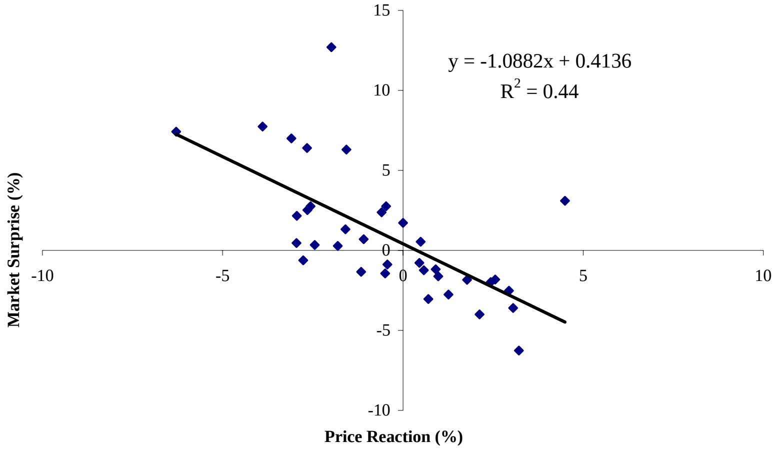
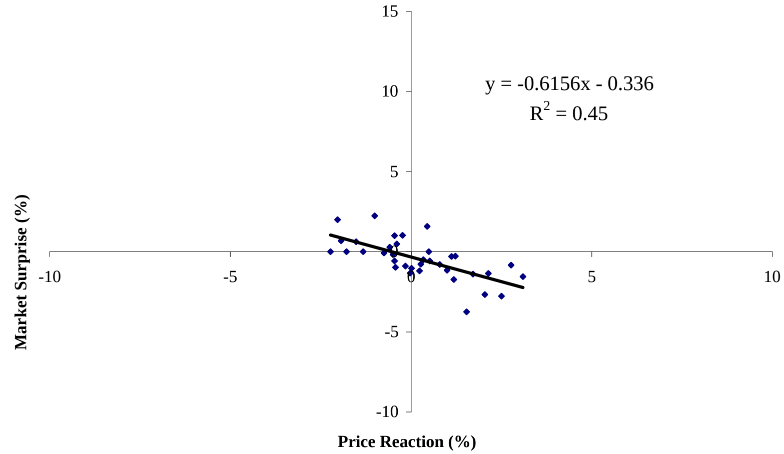


Figure 22. Reaction of November Soybean Futures Prices to Release of USDA Soybean Production Forecasts, 1970-2005

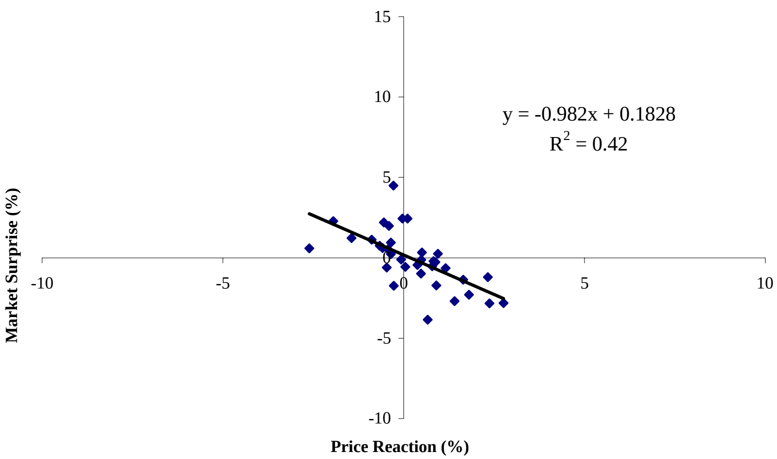
Panel A: August



Panel B: September



Panel C: October



Panel D: November

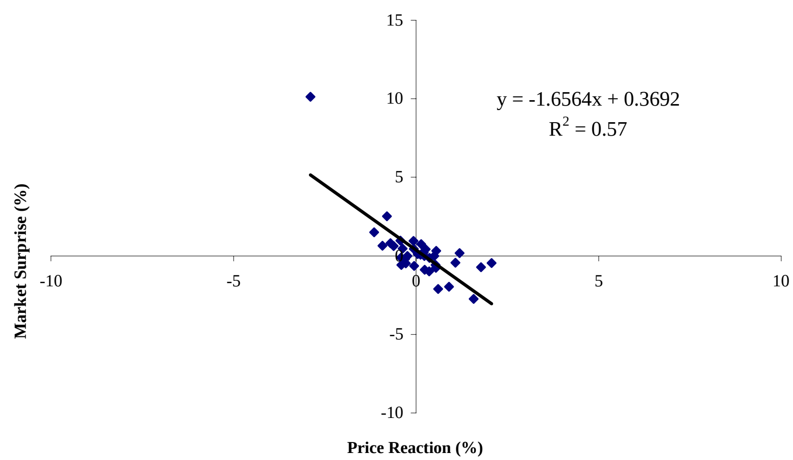
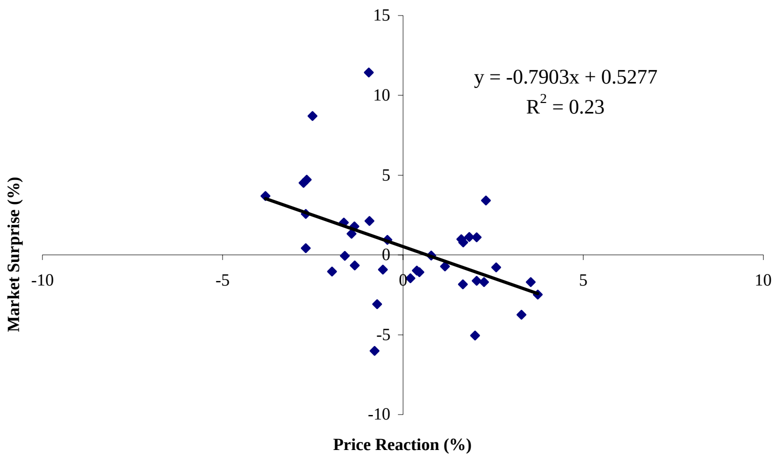
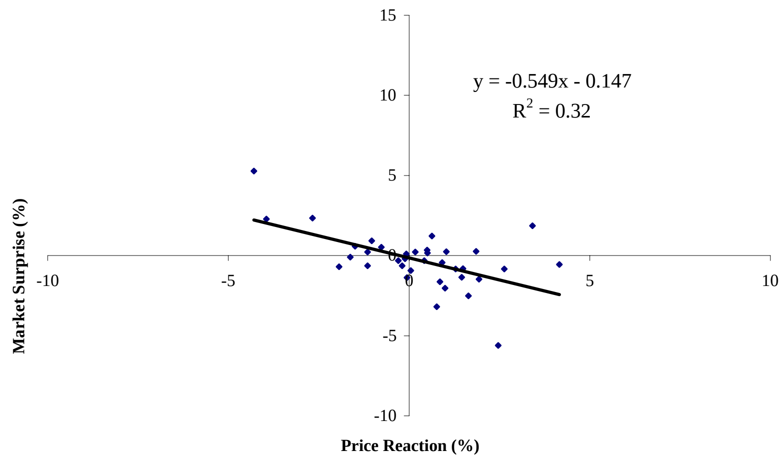


Figure 23. Relationship Between Reaction of December Corn Futures Prices and Market Surprises Associated with USDA Corn Production Forecasts, 1970-2005

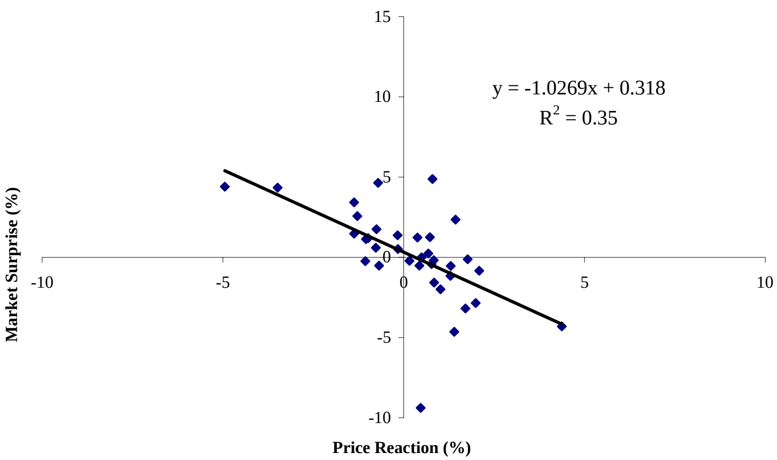
Panel A: August



Panel B: September



Panel C: October



Panel D: November

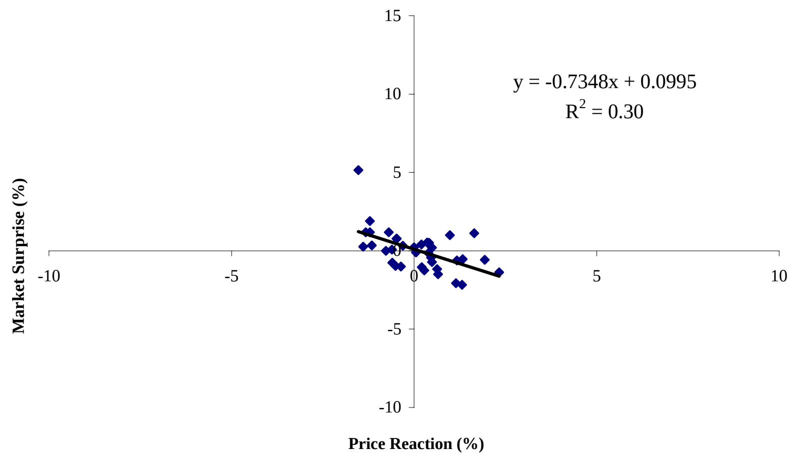


Figure 24. Relationship Between Reaction of November Soybean Futures Prices and Market Surprises Associated with USDA Soybean Production Forecasts, 1970-2005