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Using Futures Prices to Forecast the Season-Average U.S. Corn Price

by

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A model is developed using basis values (cash prices less futures), marketing weights, and a composite of monthly futures and cash prices to forecast the season-average U.S. corn farm price. Forecast accuracy measures include the absolute percentage error, mean absolute percentage error, squared error, and mean squared error. The futures model forecasts are compared to USDA's WASDE projections. No statistically significance difference was found between the futures model forecasts and the season-average price projections from the U.S. Department of Agriculture. Futures model forecasts are reliable, and timely.

Key words: Basis values (cash prices less futures), forecast accuracy, forecasting, marketing weights, U.S. corn futures prices, U.S. producer prices received for corn

Introduction

Price forecasts are critical to market participants making production and marketing decisions and to policymakers who administer commodity programs and assess the market impacts of domestic or international events. Price information has become even more important for market participants due to changes in U.S. agricultural policy. Passage of the 2002 Farm Act provides domestic support programs that are linked to the season-average price, such as the new counter-cyclical program.

The U.S. Department of Agriculture analyzes agricultural commodity markets on a monthly basis and publishes current year market information, including price projections (except for cotton). For example, see *World Agricultural Supply and Demand Estimates* (WASDE). In addition to analysts' judgment, econometric price forecasting models are used to help forecast the season-average price (Westcott and Hoffman; Childs and Westcott; and Meyer). Hoffman (1991, 2001) developed a futures price-forecasting model to provide a crosscheck against these different forecasts.

Futures prices are a composite indicator of expected supply and use and thus can be used to forecast short-run farm prices (Danthine 1978, Gardner 1974, Peck 1976, and Tomek 1997). Tomek states that "futures prices can be viewed as forecasts of maturity-month prices and the evidence suggests that it is difficult for structural or time-series econometric models to improve on the forecasts that futures markets provide." Although a futures price may be an unbiased forecast, the variance of forecast error may be large, and increases with the forecast horizon. Therefore, accurate price forecasts are a challenge, especially for more distant time periods.

Hoffman's initial futures model used futures prices to forecast the season-average price of corn at the U.S. farm level on a monthly frequency. Later, this model was converted to provide forecasts weekly. The mean absolute percentage error for the model forecasts was 15 percent beginning in May, the initial forecast period, but declined to 1 percent for August, the last month of the crop year. Interest in season-average price forecasts has been renewed because of counter-cyclical payments (CCP), one of the safety net programs from the 2002 Farm Act.

However, the futures model lacks a formal forecast evaluation and its methodology could benefit from further examination with a goal to reduce unnecessary forecast error. In addition to providing season-average price forecasts, the futures model is also used to forecast the annual counter-cyclical payment rate for corn and to provide information on the likelihood of triggering marketing loan benefits.

Objectives of this paper include: 1) present a futures price model that forecasts the season-average U.S. farm price for corn on a monthly frequency, 2) determine accuracy of the futures season-average price forecasts relative to USDA's projections (WASDE), and 3) determine whether existing forecast procedures produce unnecessary forecast error.

Theoretical Framework

The efficient market hypothesis provides a conceptual framework for the analysis of this study. The futures price is an unbiased predictor of the cash price for a given delivery location and time period based on the efficient market hypothesis (Fama 1970, 1991). According to the efficient market hypothesis, expert forecasts should contain no predictive information other than that contained in the futures market "forecast". Based on the hypothesis of rational expectations, Gardner (1976) suggested using a futures market price to reflect the market's estimate of next period's cash price. Just and Rauser (1981) found that forecasts made by several commercial forecasting companies were generally not superior to the corresponding futures market prices.

A review of pricing efficiency of agricultural futures markets by Garcia, Hudson, and Waller (1988) found mixed evidence regarding whether forecasting models can improve on the forecast performance of futures markets. The expectation is that forecasting studies will provide mixed evidence regarding market efficiency and trading profitability. However, whether consistent statistically significant results are found repeatedly for a given forecasting method is the real question.

Brandt (1985) suggested that forecasts by models or individuals can predict future price movements more accurately than the futures market and that producers and packers can gain from this information. Bessler and Brandt (1992) used vector autoregression of an expert's forecasts, the futures prices, and actual cash prices to show that cattle futures prices are not an efficient forecast of actual cash prices, while hog futures and the expert forecast are about equal. Irwin, Gerlow, and Liu (1992) found no significant difference between the forecast accuracy of live hog and live cattle futures prices compared to U.S. Department of Agriculture (USDA) expert predictions over a period of the first quarter of 1980 to the fourth quarter of 1991.

Kastens and Schroeder (1996) found that Kansas City July wheat futures from 1947 to 1995 outperformed econometric forecasting. Kastens, Jones, and Schroeder (1998) determined the forecast accuracy of five competing cash price forecasts over the 1987-96 period. Commodities examined were major grains, slaughter steers, slaughter hogs, feeder cattle, cull cows and sows. The traditional forecast method of deferred futures plus historical basis had the greatest accuracy. Adding complexity to forecasts, such as including regression models to capture nonlinear bases or biases in futures markets, did not improve accuracy.

Zulauf and Irwin (1997) cite that available evidence on individual-generated forecasts is largely consistent with an efficient market. Furthermore, they cite work by Patel, Neckhauser, and Hendricks (1991).

"Market efficiency is expected when investors play for significant stakes, investors have sustained opportunities for practice, economic selection eliminates non-rational traders, and poaching (i.e. arbitrage) opportunities can be seized readily. These characteristics describe futures and options markets where entry is easy, trading opportunities exist daily, and losses are visible daily and are magnified through the leverage provided by margin money." (Zulauf and Irwin, 1997, p. 324).

Although assumptions for the futures forecasting model differ slightly from those of the efficient market hypothesis, it was assumed that these differences would not invalidate the use of this hypothesis. The futures price is combined with a basis forecast to generate a forecast of the cash price received at the U.S. level. Monthly cash price forecasts are derived from futures prices for each contract traded throughout the marketing year plus a monthly basis. This information captures market carries or inversions. Actual cash prices are used for the monthly price, as they become available. Each month's marketings are used as a weight to construct a season-average weighted price.

Given that futures prices contain useful cash price information, they must be converted into specific cash price forecasts. Many prior studies using futures prices have focused on a given location, a given grade, and one time period, such as harvest. Most market participants need to be able to forecast a price for a given location and time when they plan to buy or sell a commodity. Thus, they need to predict the basis, which is the difference between the local cash price and the specified futures price. In contrast, government policy and commodity analysts are interested in forecasting a commodity's season-average price, including within-year monthly price patterns. Intra-year price patterns provide information about an expected "normal" or "inverted" market.

Using futures prices to forecast a season-average price is slightly different than using a futures price to forecast a price for a given location, a given grade, and a specified time period. First, the monthly cash price received represents an aggregation of different grades of corn and thus is different from the No. 2 yellow corn at the local elevator. The futures model uses the futures price for a specific grade of corn, U.S. No. 2 yellow, to predict the season-average cash price received for U.S. producers. Secondly, the model does not focus on a given location but on an average for the U.S. The monthly cash price received represents an average U.S. price received by producers, in contrast for a specific location. The monthly cash price received represents a U.S. average and the basis represents an average for the U.S., not a specific location. The cash price received by U.S. producers is an aggregation of all grades of corn and is collected by the National Agricultural Statistics Service. A monthly national basis is computed (cash price received less futures price) and it is assumed that the difference in grades will be captured by the basis. Thirdly, the time period is expanded from one period, such as harvest, to the entire marketing year thus requiring five futures contracts instead of one contract.

Forecast Model

The futures forecasting model consists of several components such as futures prices, basis values (cash less futures), cash prices received, and marketing weights. A season-average corn price forecast is computed from 12 monthly price forecasts, which in turn are based on five futures contracts traded throughout the forecasting period. The forecast period for each season-average price covers 16 months, beginning in May, four months before the start of the crop year, and concluding with August, the last month of the crop year. [2] The season-average forecast is initially based on futures prices but these prices are replaced with actual monthly cash prices, as they become available from the National Agricultural Statistics Service. Cash prices do not become available for September, the first month of the marketing year, until October the 6th month of the 16-month forecasting period. Consequently, the season-average price forecast becomes a composite of futures forecasts and actual cash prices beginning with the October forecast. The forecast error is expected to decline as the forecast period moves closer to the end of the crop year, as a greater portion of the season-average price becomes known and as information regarding the remainder of the crop year becomes more certain.

The forecast of the season-average farm price (SAP) is computed as follows:

$$(1)\quad SAP_m = \begin{cases} \sum\limits_{i=1}^{12} W_i\,(F_{mi} + B_i) & \text{for } m = 1 \text{ to } 5. \\ \sum\limits_{i=1}^{m-5} W_i\,P_i + \sum\limits_{i=m-4}^{12} W_i\,(F_{mi} + B_i) & \text{for } m = 6 \text{ to } 16. \end{cases}$$

The forecast of the season-average price made in month m is equal to SAP_m. The marketing weight for month i is equal to W_i. The cash price in month i is equal to P_i. The observed monthly price in month m for the nearby futures for month i is equal to F_{mi}. The expected basis, B_i, is equal to cash price in month i minus futures price in month i for the nearby futures contract for month i. [3] This basis is usually a negative number. The season-average price forecasts are made monthly (m), May through August, $m = 1, 2, 3, \ldots, 16$. The crop year has 12 months (i), September through August, $i = 1, 2, 3, \ldots, 12$.

Basis

The basis tends to be more stable than either the cash price or futures price. Several factors affect the basis and help explain why the basis varies from one location to another. Some of these factors include: local supply and demand conditions for the commodity and its substitutes,

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[2] The forecast period for each crop year is similar for both the futures model forecast and USDA's WASDE forecast. A corn marketing year begins on September 1st and ends on August 31st.

[3] The nearby futures price is always used except when the forecast month coincides with the closing month of the nearby futures contract. For this situation, the next nearby futures contract is selected.

transportation and handling charges, transportation bottlenecks, availability of storage space, storage costs, conditioning capacities, and market expectations. However, the basis used in this study reflects a composite of numerous basis-influencing factors because it represents an average of U.S. conditions, rather than a specific geographic location. Also since the cash price received consists of different quality levels but the futures price is for No. 2 yellow corn, the basis could vary differently (perhaps more) than when computing a basis for a specific grade level.

The basis computed for this analysis is a 5-year moving average of the monthly U.S. average corn price received by producers less a monthly average of the nearby futures closing price observed for the particular month. For example, the September basis is a 5-year moving average of the difference between the September average cash price received by producers and September's average closing price of the nearby December futures contract. The 12 monthly basis values for each crop year are updated at the end of each crop year.

Marketing Weights

Monthly crop marketings are used to construct a season-average weighted price. Each month's weight represents the proportion of the year's crop marketed in that month. A 5-year moving average of these monthly weights is constructed and updated annually.

Data

The futures forecasting model requires monthly data by crop year for the following items: 1) monthly average closing prices from the nearby futures contracts, 2) monthly (mid- and full-month) producer cash prices received, 3) monthly marketing weights, and 4) monthly futures closing prices (day before WASDE release) and (day of WASDE release) from the nearby futures contracts. These data are collected for crop years 1975 through 2003. The 5-year averages for monthly basis values and marketing weights begin with 1975-79 data and are updated to the present. A monthly futures forecast requires an update of monthly futures prices, available cash prices, and marketing weights on a periodic basis.

Historical daily closing prices by contract (December, March, May, July, and September) are obtained from the Chicago Board of Trade for crop years 1975 through 2003. Cash prices are obtained from *Agricultural Prices,* published by USDA's National Agricultural Statistics Service. Price projections from the U. S. Department of Agriculture are obtained from *World Agricultural Supply and Demand Estimates* (WASDE) published by USDA's World Agricultural Outlook Board. Marketing weights by month are derived from data published in various issues of USDA's December *Crop Production*. Marketing weights by month are published in the September issue of *Agricultural Prices* from 1992 through 1996, November issue for 1997 through 2002, and again in the September issue for 2003.

Forecast Procedure

Although a general mathematical representation of the model was presented earlier, this section provides an example of the detailed steps needed to provide the forecast for one of the sixteen forecast months, April. Table 1 illustrates the method used in forecasting the season-average corn price for the crop year 2003/2004 as of April 7, 2004 (the day before WASDE release). Later in the paper forecasts are also examined using monthly futures closing prices on the day of USDA's WASDE release. The futures model computes a monthly forecast of the season-average price based on futures closing prices, but could be computed daily or weekly should the need arise.

The latest available futures closing prices are gathered for the contracts that are trading. Closing prices for April 7, 2004 are used for illustration. Futures prices for the remainder of the 2003/04 crop year are from the following contracts: May, July, and September 2004 and are inserted on line 1 of the model's spreadsheet (table 1). Entries for December 2003 and March 2004 represent contract values in November 2003 and February 2004, the last time each of these contract prices were updated.

The futures price for April 2004 (line 2, table 1) represents the April 7th closing price of the nearby contract, May 2004. The closing price for the nearby July contract is used for the months of May and June and the nearby September contract for July and August. For those months when a futures contract matures, the next nearby contract is used because of greater potential price stability. Futures prices for the maturing contract may be affected by a decline in liquidity during the month of maturity. Also, a contract usually closes about the third week of the month, and using the current futures contract during its closing month would lower the number of observations that could be used to calculate the average monthly closing price and corresponding basis.

A 5-year moving average monthly basis (monthly cash price minus the nearby futures price), 1998-2002 crop year average, is found on line 3 of table 1. This average basis is updated during the first week of October, a time when the full-month August cash price is available and thus completes all monthly cash prices for the prior marketing year.

A forecast of the monthly average farm price received (line 4 of table 1) is computed by adding the basis (line 3) to the monthly futures price (line 2).

The actual monthly average farm prices received are shown on line 5 of table 1, as they become available. The monthly cash prices on line 5, represent the average price received for September, October, November, December, January, February, and mid-March, respectively. On April 7, 2004 the actual full-month February cash price was entered as obtained from *Agricultural Prices* issued in late March 2004 as well as the mid-month March cash price.

The actual and forecast farm prices are spliced together on line 6. The price forecast for crop year 2003/2004, as computed on April 7, 2004, uses futures forecasts for March through August (from line 4) and cash prices from line 5 for September through February.

The monthly weights, expressed as a percent of total crop year marketings, are found on line 7 of table 1. A 5-year moving average is used, 1998-2002 crop year average, and updated in October after the release of the September *Agricultural Prices* report.

A weighted forecast of the season-average U.S. farm price received is found on line 8 and is computed by multiplying the monthly weights on line 7 by the monthly farm prices on line 6 and summing their products. A simple average price forecast is also computed and found on line 9.

Forecast Accuracy and Performance

Forecast accuracy and performance measures are computed and evaluated for crop years 1980 through 2002. Accuracy measures examined include the absolute error, squared error, mean absolute percentage error, and mean squared error. The error provides information on a positive or negative deviation from the actual price but the mean error may be small, as the positive and negative errors tend to offset each other. The absolute error removes this problem by taking the absolute value of each error. The absolute percentage error provides still more information than the prior two measures because it relates the error to the actual price.

Comparing the futures model forecasts to the U.S. Department of Agriculture's monthly season-average price projections assesses performance. These projections are published in the monthly *World Agricultural Supply and Demand Estimates* (WASDE) report. The WASDE projection represents a composite projection from analysts' judgement supplemented with econometric model forecasts, futures prices, and monthly cash prices. The comparisons of the futures forecast to the WASDE projections are computed monthly. The monthly futures forecasts are computed from closing futures prices on the day before a WASDE release "Futures (1a)" and from closing futures prices on the day of WASDE release "Futures (1b)". One could expect the futures forecast to be less accurate than WASDE projections before the WASDE release and at least as accurate after release of the WASDE projections.

The test statistic used to determine whether the errors from two forecast methods are statistically significant is the Modified Diebold-Mariano test (MDM) proposed by (Harvey, Leybourne, and Newbold (1997). This test involves specifying a cost-of-error function, g(e) = squared error, of the forecast errors e and testing pair-wise the null hypothesis of expected equality of forecast performance. Harvey, Leybourne, and Newbold (1997) argue that critical values from the Student's t distribution with (n-1) degrees of freedom should be computed and compared from the two different forecast methods. The test statistic is

$$(2) \quad MDM = \sqrt{\frac{n-1}{1/n \sum (d_t - \bar{d})^2}}\ \bar{d}$$

and is computed for one-step ahead forecasts where $d_t = g(e_{1t}) - g(e_{2t})$, $\bar{d}$ is the average difference across all forecasts. The null hypothesis is $E[g(e_{1t}) - g(e_{2t})] = 0$; $t = 1, \ldots, n$.

Specific definitions for the MDM test applied to the futures forecasts and WASDE projections are given next. When testing the significant differences of the squared errors of the futures forecasts and the WASDE projections, $g(e_{1at}) = e^2_{1at}$ is the squared error for the futures forecasts for the day before release of WASDE ("futures (1a)"), $g(e_{1bt}) = e^2_{1bt}$ is the squared error for the futures forecasts for the day of release of WASDE ("futures (1b)"), and $g(e_{wt}) = e^2_{wt}$ is the squared error for the WASDE projections. The difference between the squared errors of the futures forecasts ("futures (1a)") and WASDE projections at time t is $d_{1t} = e_{1at} - e_{wt}$. The average difference across these forecasts, crop years 1980-2002, is $\bar{d}_{1m}$ for each forecast month (*m*), May through August, $m = 1, 2, 3, ... ,16$. The MDM test statistic for "futures (a)" forecasts and WASDE projections is referred to as MDM_{1m} for each forecast month (*m*). The difference between the squared errors of the futures forecasts ("futures (1b)") and WASDE projections at time t is $d_{2t} = e_{1bt} - e_{wt}$. The average difference across these forecasts, crop years 1980-2002, is $\bar{d}_{2m}$ for each forecast month (*m*), May through August, $m = 1, 2, 3, ... ,16$. The MDM test statistic for "futures (b)" forecasts and WASDE projections is referred to as MDM_{2m} for each forecast month (*m*). The null hypothesis is $E[g(e_{1at}) - g(e_{wt})] = 0$; $t = 1, \ldots, n$, where $n = 23$ and $E[g(e_{1bt}) - g(e_{wt})] = 0$; $t = 1, \ldots, n$, where $n = 23$.

Advantages of the MDM test are that it is insensitive to contemporaneous correlation between the forecast errors and its power declines only slightly with departures from normality as demonstrated by Harvey, Leybourne, and Newbold (1997). These characteristics are important because sometimes one tries to differentiate between forecasts that are correlated and possess occasional large errors. Further advantages of the MDM test include its applicability to multiple-step ahead forecast horizons, its non-reliance on the assumption of forecast unbiasedness, and its applicability to cost-of-error functions in addition to the conventional quadratic loss. Harvey, Leybourne, and Newbold (1997) argue that the MDM statistic is the best available method for determining the significance of observed differences in competing forecasts.

Results

The futures model spreadsheet was automated to facilitate forecasting and further analysis. A monthly season-average forecast of the U.S. corn price received by producers for crop years 2003/04 and 2002/03 is presented below (fig. 1 and fig. 2). This focus provides more information on how the forecasts are produced. The futures forecast is provided monthly. The first forecast ("futures (1a)") is provided on the day before release of USDA's WASDE report and the second forecast ("futures (1b)") is provided on the day of the WASDE report release. The accuracy and performance of these forecasts, crop years 1980-2002, are examined further. Lastly, alternative forecast procedures are examined to determine effects on forecast accuracy.

Futures Forecasts for Crop Year 2003/04

Season-average price forecasts from the futures model are based on expectations reflected in the futures market and, if available, actual monthly farm prices. The futures forecast of the season-average price for 2003/04 as of May 2003 was $2.31, based somewhat on concerns of planting difficulties (fig. 1). USDA's May 2003 price projection for 2003/04 corn was $2.10/bu. The futures forecast was significantly higher than the WASDE projection, sometimes called a weather-uncertainty premium, most likely due, in part, to planting difficulties causing the market to question whether the crop would achieve the assumed trend yield.

The USDA outlook for U.S. corn in 2003/2004, as of May 2003, was based on March planting intentions, a recent 3-year average of harvested-to-planted relationships and trend yields. These assumptions provided a supply that exceeded the prior year by 5 percent. Total corn use in 2003/2004 was expected to expand due to gains in domestic use and exports. Domestic use was expected to rise slightly as expanding industrial use more than offset reduced feed and residual use because of a decline in cattle on feed. U.S. corn exports were projected up 225 million bushels due to less competition from foreign corn exporters and reduced global feed wheat supplies. Ending stocks were expected to increase by 250 million bushels, as production was projected to exceed use.

The futures forecast then declined to $2.04/bu. in July as initial indications were of a record large crop. However, these production estimates were reduced in the August *Crop Production* which was released in the August WASDE report. Consequently, the WASDE price projection for August rose to $2.20/bu. The futures forecast incorporating the WASDE report information, "Futures (1b)", responded by rising to $2.15, $0.10/bu. higher than the futures forecast from the day before release, "Futures (1a)". USDA's expected production in August reflected acres planted and a yield survey resulting in lower supply and stocks for 2003/04. Furthermore, total U.S. corn use was not expected to decline as much as supply, thus tightening stocks.

USDA production estimates were increased in October, as expected production was revised to record levels and both the WASDE and futures forecasts declined. The futures forecast "Futures (1b)" incorporating this WASDE information declined to $2.07/bu. as of October 2003 (fig. 1), $0.05/bu. lower than the "Futures (1a)" forecast, and $0.03/bu. lower than WASDE's projection of $2.10/bu.

USDA's November price projection remained at $2.10/bu. as the November 2003 production forecast was revised upward by 71 million bushels over October but exports were also increased by 75 million bushels. In contrast, both futures forecasts rose perhaps anticipating greater export demand. Starting in January 2004 the futures forecast and WASDE projections have increased due to rising use. Two use categories, food, seed, and industrial (FSI) and exports have increased above original May 2003 expectations.

Futures Forecasts for Crop Year 2002/03

The futures model season-average price forecast for 2002/03 started at $2.12/bu. in May of 2002, compared to the WASDE mid-point projection of $1.95/bu. (fig. 2). The U.S. 2002/03-corn crop was projected at 9.9 billion bushels, an increase of nearly 5 percent from the prior year. Expected supplies were up only slightly because of the smaller expected beginning stocks. Total use in 2002/03 was expected to expand due to gains in industrial use and exports. With use exceeding production, 2002/03 ending stocks of corn were expected down slightly from the forecasted carryin.

However, corn production for 2002/03 was reduced to 9 billion bushels by drought. A 6-percent drop in yield accounted for the decline because harvested area was up slightly. Futures model forecasts reflected the uncertainty of crop size between June and September as forecasts rose from about $2.09/bu. to about $2.75/bu. in September. However, price forecast variability declined significantly in October and thereafter, as more information about the crop size became available. Total domestic use was projected at a record and tighter stocks led to higher prices than the initial forecast made in May of 2002.

The mean absolute percentage error ranged from 18 percent (September 2002) to 0.2 percent (May 2003) for the "Futures (1a)" forecast, compared to WASDE's forecast error range of 16 percent (May 2002) to .9 percent (March through August 2003). When incorporating WASDE's information in the futures forecasts, "Futures (1b)", the mean absolute percentage error ranged from 15 percent (September 2002) to .2 percent (May 2003). WASDE information seemed to make the most difference to the futures forecasts (difference between before release "Futures (1a)" and day of release "Futures (1b)") in August and September of 2002 and January of 2003.

Forecast Accuracy and Evaluation—Crop Years 1980-2002

A forecast accuracy measure, the mean absolute percentage error, is shown in table 2 for the two futures forecasts ("Futures (1a)" and "Futures (1b)") and the WASDE projections. The mean absolute error ranged from 15 percent in May to 1 percent in August (16 months later) for the "Futures (1a)" and "Futures (1b)" forecasts. WASDE's mean absolute percentage error was similar ranging from 13 percent in May to 1 percent in August. There is a fair degree of similarity among the forecasts and the futures forecast before the release of WASDE, "Futures (1a)", does a credible job of forecasting. Nevertheless, for some months, as was shown from forecasts for the 2002 crop year, the WASDE information can reduce the forecast error for "Forecast (1b)". This occurred in 5 out of the 16 forecast months, mostly during the harvest period of September through November (table 2). This was especially obvious in September.

When comparing the two futures forecasts ("Futures (1a)" and "Futures (1b)") to the WASDE projections throughout the forecast period it is interesting to observe the declining rate of the mean absolute percentage error. For example, regardless of forecast method, the mean absolute percentage error for 1980-2002 declined by 2 percentage points between the second and third forecast months (June and July), reflecting, in part, new crop information such as the June acreage report and crop progress. The mean absolute percentage error dropped another 2 percentage points between July and August, reflecting, in part, information on the new crop's estimated yield and crop progress. The difference between the August and September is less pronounced. Remember that forecasts from May through September rely on all futures prices for the monthly price forecasts but the October forecast uses a mid-month September cash price plus futures prices for the eleven remaining months.

The difference between the September and October forecasts represents a 2-percentage point decline in the mean absolute percent error. [4] This difference reflects, in part, information from the grain stock report (beginning inventories to start the new crop year), production information on the new crop, and an estimate of the mid-month cash price received for September.

The decline in the mean absolute percentage error begins to slow with October. The percentage error declines by 1 percentage point per month between October and November and November and December, reflecting additional information on production, an additional cash price estimate for each month, and the grain stocks report for January. Additional use information, such as monthly exports, becomes available from the Census Bureau approximately two months after the month observed.

[6] Forecasts from May through September rely on all futures prices for the monthly price forecasts, but the October forecast includes the mid-month September cash price and uses futures prices for the eleven remaining months.

Furthermore, the rate of decline continues to slow between January and June as the average forecast error declines a total of about 2 percentage points over this six-month period. This period reflects additional cash prices, the grain stock reports, and additional use information. The remaining two months, July and August, each reflect about a 1-percentage point error. The July futures forecast of the season-average price consists of a futures forecast for July and August prices and cash prices for the previous 10 months. The August futures forecast includes a futures forecast for the August price and 11 cash prices for the previous months. Despite the few months remaining to determine the actual-season average price, the 5-year average marketing weights or 5-year average basis values may be other sources of error.

Are the futures forecasts statistically different from the WASDE projections? To answer this question, the Modified Diebold-Mariano (MDM) test was applied to the squared errors of each forecast month (May through August) for crop years 1980-2002 of the "Futures (1a)" forecast and WASDE projections and the "Futures (1b)" forecast and WASDE projections. The error function is specified as the squared error and is tested for statistical significance in the differences of the squared errors between the WASDE projections and each of the two futures forecasts, "Futures (1a)" and "Futures (1b)". The null hypothesis states that the squared errors from either distribution are equal. Therefore, we must reject the null hypothesis to find statistical differences in the forecasts. Based on a 5 percent significance level and a t distribution with (n-1) degrees of freedom the critical value of t is 2.07. The modified Diebold-Mariano test statistics (MDM_{1m} and MDM_{2m}) are shown in table 3. Since both MDM test statistics are smaller than the critical t value of 2.07, we cannot reject the null hypothesis of equality. Thus, the MDM test results indicate no statistically significant difference between squared errors of the futures forecasts ((1a) and (1b)) and the WASDE projections for any of the forecast months.

Re-examination of Model's Forecast Procedures [5]

Several issues have been raised that may cause forecast errors to be larger than necessary.

September Contract Prices--The first issue is the use of the September contract prices to represent prices for July and August. September contract prices for July and August forecasts seem reasonable when September represents the old crop, but in short crop years, September often functions as a new crop contract (1996 for example), which could affect forecast accuracy.

In order to adjust for this situation July contract prices, which are presently used to represent May and June prices, are also used to represent July and August prices for crop years 1980 through 2002. This change removes the September contract from representing July and August prices. Historical bases are adjusted to reflect this change, as well as monthly futures prices for forecasting purposes. New futures forecasts are determined for 1980-2002 crop years.

Based on preliminary results in table 2, forecast accuracy (futures forecasts (2a) and (2b) vs. futures forecasts (1a) and (1b)) is improved for many of the forecast months with such an approach. Statistical significance tests were not applied to these forecasts. Further analyses of

[5] Appreciation is expressed to Scott Irwin for raising the issues discussed in this section.

these preliminary results are necessary before any procedures will be incorporated into the model.

Monthly Cash Prices Received--The second issue on potential forecast errors is the cash price received used in this analysis. This price is an average monthly cash price received by producers as reported by the National Agricultural Statistics Service (NASS). Thus, it is an aggregation of different grades but also different pricing dates for the delivered stocks. For example, this is most obvious in October or January when the marketing weights are much higher than other months. Much pre-harvest forward contracting is delivered in October and many post-harvest forward contracts are delivered in January. So NASS prices for these two months represent both forward and spot sales with the forward price determined at dates prior to harvest. It is not clear how this influences the analysis (or whether this is a problem).

A comparison to a reconstructed season-average price forecast is evaluated to determine this situation. A spot bid price series is used consisting of a simple average forecast, rather than a weighted average forecast. A south central Illinois pricing district was selected to construct the price series from 1975 to 2004 (http://www.farmdoc.uiuc.edu/marketing/cash/CashTableChart.asp). New futures forecasts are determined for 1980-2002 crop years.

Based on results in table 2, the revised forecasts provided a mean absolute percentage forecast error that was 2-percentage points higher for each month, October and January, than the original forecasts. In general, the futures forecast errors ("Futures (3a)" and "Futures (3b)" were larger than the original forecasts ("Futures (1a)" and "Futures (1b)") for nearly all of the forecast months. Statistical significance tests were not applied to these forecasts. Further analyses of these preliminary results are necessary before any changes will be made to the original model.

Suggestions for Further Research

Examination of the model's forecast procedure should be completed. Further analysis of alternative procedures is required before any conclusions can be reached about their preliminary results.

Furthermore, an examination of the effects of alternative estimates for basis values and marketing weights should be explored. Improved estimates of basis values or marketing weights may improve forecasts. For example, Jiang and Hayenga found that a modified 3-year average basis model, which included current market information and a seasonal autoregressive, integrated moving average (ARIMA) term provided a better forecast of the basis than a simple 3-year average.

In addition to the efforts behind the futures forecasts for method 3(a) and 3(b), a comparison of bases from futures less a national cash price received by producers and the futures less the central Illinois bid price could prove useful. Are they different? An analysis of these basis values could determine their statistical difference by month. Would the basis values from the central Illinois bid price improve the futures forecast of the season-average price?

Next, the model's ability to predict intra-year price patterns should be examined. Efforts in this area would help in forecasting marketing loan benefits.

Conclusions

This analysis demonstrates that the futures forecast method provides a useful tool for commodity and policy analysts. These forecasts provide timely and reasonable forecasts of the season-average price received for U.S. corn producers. The futures forecast also provides a useful crosscheck with other season-average price forecasts.

Although there were slight differences between the futures forecasts ("futures (1a)" and "futures (1b)") and WASDE projections these differences were not statistically significant. Futures forecasts were derived from a 5-year moving average of the basis and marketing weights. Improved estimates of the basis and marketing weights could further enhance futures forecasts.

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Table 1. Futures Forecast of U.S. Corn Producers' Season-Average Price, Crop Year 2003-2004

	Item	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.
								Dollars per bushel						
(1)	Current futures price [a] by contract (settlement)				2.33			2.85		3.30		3.38		3.37
(2)	Monthly futures price based on nearby contract	2.33	2.33	2.33	2.85	2.85	2.85	3.30	3.30	3.38	3.38	3.37	3.37	
(3)	Plus the historical basis (cash less futures)	-0.30	-0.27	-0.22	-0.18	-0.15	-0.13	-0.15	-0.14	-0.18	-0.15	-0.18	-0.24	
(4)	Forecast of monthly average farm price	2.03	2.06	2.11	2.67	2.70	2.72	3.15	3.16	3.20	3.23	3.19	3.13	
(5)	Actual monthly farm price	2.20	2.12	2.20	2.32	2.39	2.61	2.79						
(6)	Spliced actual/forecast monthly farm price	2.20	2.12	2.20	2.32	2.39	2.61	2.75	3.16	3.19	3.21	3.12	3.09	
								Percent						
(7)	Marketing weights	8.64	13.78	10.88	7.14	14.00	6.34	7.26	5.54	5.18	5.66	7.30	8.28	
Annual price projections:														
(8)	Weighted average	2.61												
(9)	Simple average	2.71												

Contract months include December, March, May, July, and September. Futures price quotation from the Chicago Board of Trade, April 7, 2004 closing prices.

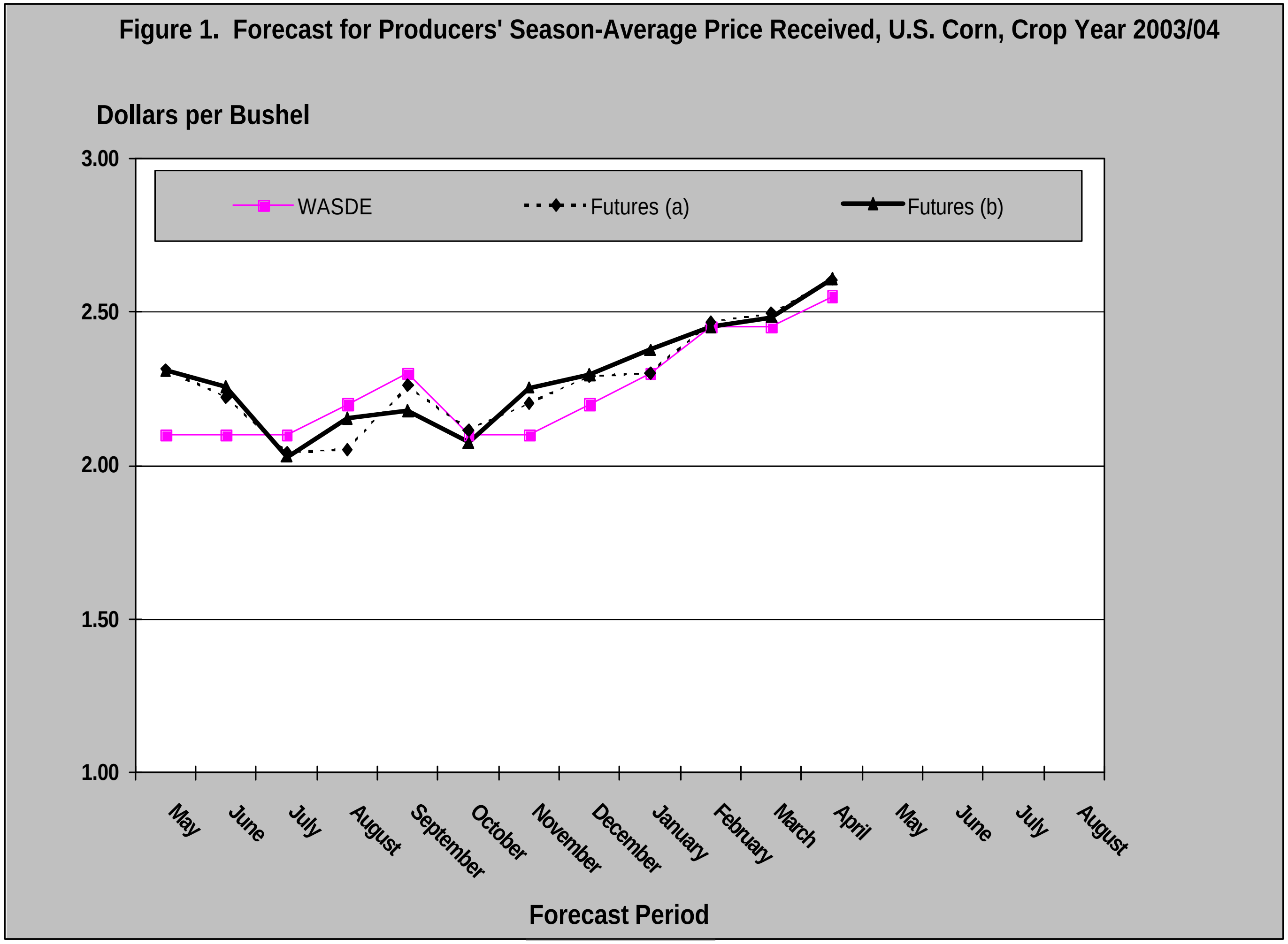
Figure 1. Forecast for Producers' Season-Average Price Received, U.S. Corn, Crop Year 2003/04
Dollars per Bushel
3.00
2.50
2.00
1.50
1.00
WASDE
Futures (a)
Futures (b)
May
June
July
August
September
October
November
December
January
February
March
April
May
June
July
August
Forecast Period

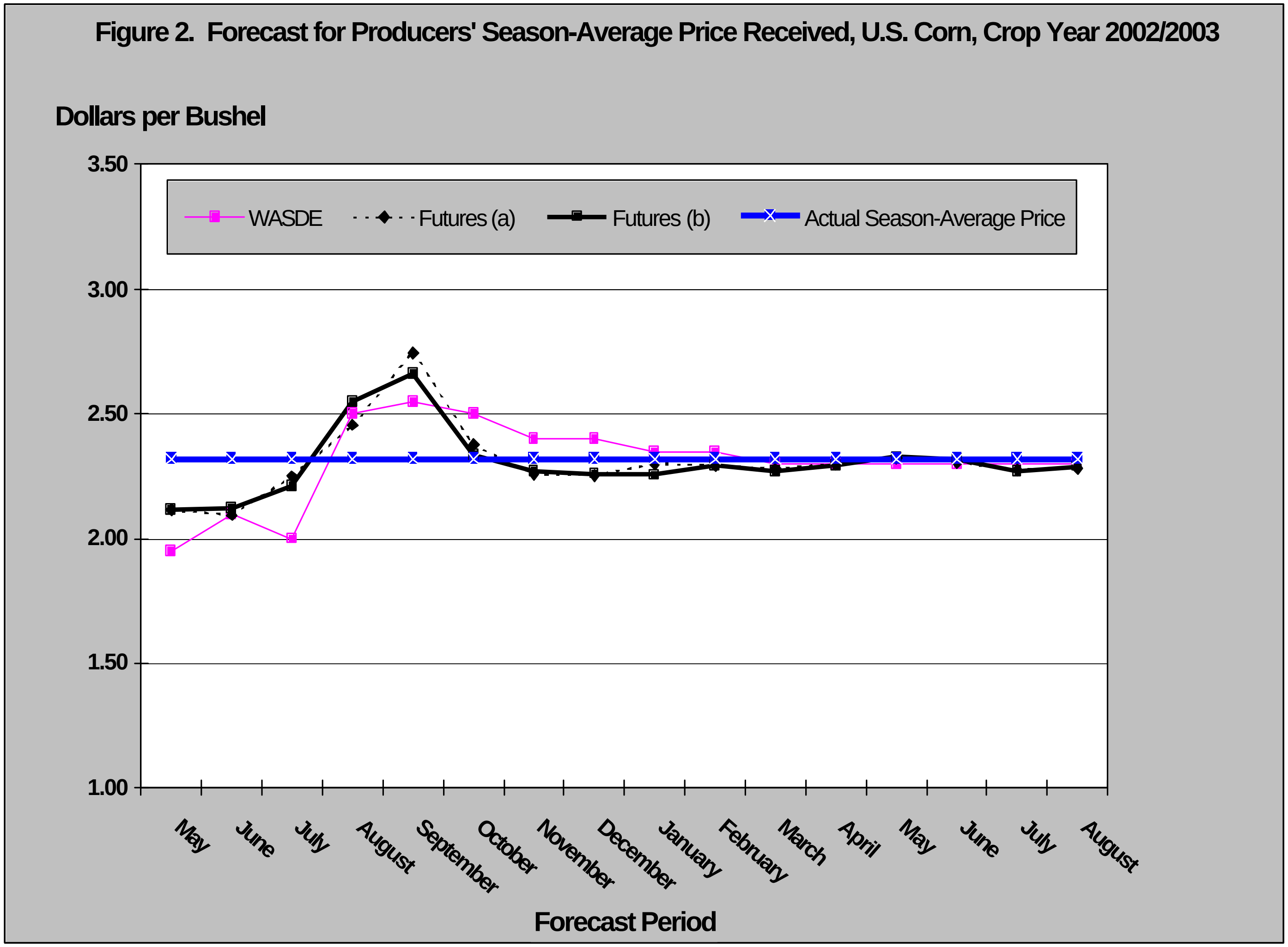
Figure 2. Forecast for Producers' Season-Average Price Received, U.S. Corn, Crop Year 2002/2003
Dollars per Bushel
3.50
3.00
2.50
2.00
1.50
1.00
WASDE
Futures (a)
Futures (b)
Actual Season-Average Price
May
June
July
August
September
October
November
December
January
February
March
April
May
June
July
August
Forecast Period

Table 2. Accuracy of Alternative Forecasts by Month for the Season-Average Farm Price, U.S. Corn, Average Crop Years 1980-2002.

Forecast Month	Futures (1) a/		WASDE	Futures (2) b/ Replace Sept. with July Contract Values		Futures (3) c/ Replace Cash price received with Central Ill. "spot" bid price	
	(1a)-- Day Before WASDE Release	(1b)--Day of WASDE Release		(2a)--Day Bef WASDE Release	(2b)--Day of WASDE Release	(3a)--Day Bef WASDE Release	(3b)--Day of WASDE Release
	Mean Absolute Percentage Error						
May	14.9	14.5	12.8	15.8	15.9	16.5	16.4
June	13.4	13.5	13.0	14.7	15.1	15.7	15.8
July	11.1	11.2	11.1	12.3	12.7	12.9	13.2
August	9.0	9.1	9.2	9.0	8.7	10.9	10.9
September	8.8	8.1	8.5	8.2	7.3	10.6	10.1
October	6.2	6.1	7.0	5.7	5.2	8.3	8.2
November	5.2	5.1	5.5	4.3	4.2	7.5	7.4
December	3.9	4.0	4.6	3.3	3.5	6.2	6.2
January	3.8	3.8	3.6	3.5	3.5	6.1	6.0
February	3.2	3.2	3.1	3.1	3.1	5.2	5.1
March	3.3	3.3	2.8	3.1	3.2	4.9	4.9
April	2.8	2.5	2.3	2.3	2.3	4.0	3.7
May	2.5	2.5	2.1	2.3	2.2	3.3	3.2
June	1.9	1.9	2.0	1.9	1.9	2.4	2.2
July	1.3	1.4	1.3	1.8	1.7	1.6	1.6
August	0.9	0.9	1.0	1.2	1.2	0.7	0.6

a/ Original futures forecasts. Futures (1)
b/ Alternative futures forecasts. Futures (2)--replace September contract prices with July contract prices.
c/ Alternative futures forecasts. Futures (3)--replace cash price received with Central Illinois "spot" bid price.

Table 3. Mean Squared Error Differences and Modified Diebold Mariano (MDM) Test Statistic used to Compute Statistical Significance between Futures Forecasts (1a) and (1b) and WASDE Projections.

Forecast Month	Mean Squared Error Differences: Futures Forecast (1a) less WASDE Avg. d(1m)	Mean Squared Error Differences: Futures Forecast (1b) less WASDE Avg. d(2m)	(MDM) Test Statistic: Futures Forecast (1a) less WASDE MDM(1m)	(MDM) Test Statistic: Futures Forecast (1b) less WASDE MDM(2m)
May	0.03887	0.04112	0.80981	0.83144
June	0.02719	0.03005	0.60707	0.65123
July	0.04641	0.04966	1.06790	1.08812
August	0.00498	0.00278	0.28128	0.21687
September	0.01035	0.00088	0.63711	0.05605
October	-0.00661	-0.00551	-0.53080	-0.40768
November	-0.00488	-0.00649	-0.55023	-0.72559
December	-0.00838	-0.00790	-1.02042	-1.02603
January	-0.00154	-0.00222	-0.36072	-0.53843
February	-0.00162	-0.00147	-0.44907	-0.43593
March	0.00089	0.00077	0.36234	0.35017
April	0.00073	-0.00065	0.37891	-0.48192
May	0.00081	0.00089	0.55692	0.62279
June	-0.00027	-0.00037	-0.24946	-0.33195
July	-0.00029	-0.00022	-0.36202	-0.26755
August	-0.00064	-0.00061	-0.77543	-0.71942