Evaluating the Use of Futures Prices to Forecast the Farm Level U.S. Corn Price

By

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Abstract

A model is developed using bases, marketing weights, and a composite of monthly futures and cash prices to forecast a season-average U.S. farm price for corn. Forecast accuracy measures include the mean absolute percentage error and Theil's U-statistic. Futures forecasts are compared with a naïve forecast and WASDE projections. Futures price forecasts are timely and reliable.

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Introduction

Information regarding corn prices is critical to market participants making production and marketing decisions and to policymakers who must 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 Federal Agriculture Improvement and Reform Act of 1996 (1996 Act) continues the sector's trend toward market orientation and transfers risk from the government to the private sector.

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). Econometric price forecasting models have been re-estimated because of policy changes associated with the FAIR Act of 1996 (Westcott and Hoffman; Childs and Westcott; and Meyer). Despite this re-estimation, alternative price forecasting models are needed to provide a cross-check against existing forecasts. Futures prices are considered a composite indicator of expected supply and use and thus can be used to forecast short-run farm prices (Danthine; Gardner; Peck; Rausser and Just; and Tomek).

In a recent article, Tomek summarized the literature on futures prices and their use as a price forecasting tool. He 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.

Given that futures prices contain useful cash price information, how can this information be converted into specific cash price forecasts, particularly for a crop year or other designated time periods? 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 observed 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. More recently, policy analysts have become interested in intra-year price patterns and their implications for marketing loan benefits.

Hoffman (1991) originally designed a model that uses futures prices to forecast the season-average cash price of corn at the U.S. farm level. His model provided forecasts with a mean absolute percentage error of 4 to 8 percent for crop years 1986-89. While this model provided reasonable forecasts, additional spreadsheet programming would reduce the time required to provide forecasts and would provide an assessment of the forecast accuracy.

The objective of this paper is to develop a model that can forecast the season-average corn price at the U.S. farm level, including within-year monthly price patterns. The model is designed to be easy to use and requires minimal time from the analyst. The accuracy and performance of the season-average price forecasts are analyzed. Sensitivity analyses are conducted on the futures forecasts by computing different bases or marketing weights.

Methodology

The forecast model, procedure, data, forecast accuracy and performance measures, and sensitivity analyses are discussed in this section.

Forecast Model

The futures forecasting model consists of several components such as futures prices, cash prices, bases, 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 year covers 16 months, beginning in May, four months before the start of the crop year, and concluding with the last month of the crop year, August. For each month, the season-average forecast is initially based on futures prices but

monthly cash prices are used as they become available. Consequently, the season-average price forecast becomes a composite of forecast and actual cash prices. As we move closer to the end of the marketing year there are more months with actual cash prices and fewer months with forecast prices. Not surprisingly, the forecast error is expected to decline as the forecast period moves closer to the end of the crop year.

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

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

where:

SAP_m = forecast of the season average price made in month m.

W_i = marketing weight for month i.

P_i = cash price in month i.

F_{mi} = observed price in month m for the nearby futures to month i.

B_i = expected basis, which is equal to cash price in month i minus futures price in month i for the nearby futures contract to month i. This basis is usually a negative number.

m = 1, 2, 3, ... ,16, months during which forecasts are made (May – August).

i = 1, 2, 3, …,12 crop year months, September through August.

Basis--The difference between the cash price at a specific location and the price of the nearby futures contract is known as the basis. The basis tends to be more stable or predictable 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, transportation and handling charges, transportation bottlenecks, availability of storage space, storage costs, conditioning capacities, and market expectations.

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 settlement price observed for the particular month. For example, the September basis is the difference between the September average cash price received by producers and September's average settlement price of the nearby December futures contract. The basis for each month is updated at the end of each crop year. The basis used in this study therefore reflects a composite of the basis-influencing factors because it represents an average of U.S. conditions, rather than a specific geographic location.

Marketing Weights--Monthly marketings are used to construct a weighted season-average 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.

Forecast Procedure

The steps taken to provide the forecast are explained in more detail in this section. Table 1 illustrates the method used in forecasting the season-average corn price for the crop year 2001/2002. This method computes a forecast of the season-average price based on futures settlement prices. This forecast is computed weekly, but could be computed daily or monthly. The Thursday futures settlement price for each of the nearby contracts is used for the weekly futures price. [2]

Eight steps are involved in the forecast process:

1. The latest available futures settlement prices are gathered for the contracts that are trading. Settlement prices for Thursday, July 12, 2001 are used for illustration (line 1). Futures quotes are for the following contracts: December 2001, and March, May, July, and September 2002.
2. Monthly futures prices are the settlement prices of the nearby contracts. For example, the futures price for September, October, and November 2001(line 2) represents the July 12th settlement price of the nearby, December 2001 contract. The nearby (March) contract settlement price is used for December, January, and February. For those months when a futures contract matures, the next nearby contract is used because of greater price stability.

[2] Thursday is picked because there are fewer holidays and no beginning or end of week surprises.

Futures contracts are 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 would lower the number of observations that could be used to calculate the average monthly closing price.

3. A 5-year moving average basis (monthly cash price minus the nearby futures price) is entered on (line 3). This average is updated annually during the first week of October, a time when the full-month August cash price is available.
4. A forecast of the monthly average farm price (line 4) is computed by adding the basis (line 3) to the monthly futures price (line 2).
5. The actual monthly average farm price is entered on line 5 as it becomes available. This line remains blank until October 5, 2001 when the mid-month September price will be entered and obtained from the *Agricultural Prices* report issued in late September. On November 4, 2001 the actual full-month September cash price will be entered as obtained from the *Agricultural Prices* report issued in late October and the mid-month October cash price is entered.
6. The actual and forecast farm prices are spliced together on line 6. The price forecast for crop year 2001/2002, as computed on July 12, 2001, uses futures forecasts for each month September through August (from line 4) because there are no available cash prices yet.
7. The monthly weights, expressed as a percent of total crop year marketings, are entered on line 7. A 5-year moving average is used and updated in early December after the release of the November *Agricultural Prices* report.
8. A weighted season-average U.S. farm price forecast is computed (line 8) by multiplying the monthly weights in line 7 by the monthly farm prices in line 6 and summing their products.
9. A simple average price forecast is also computed (line 9).

Data

The futures forecasting model requires monthly data by crop year for the following items: 1) monthly settlement prices from the nearby futures contracts; 2) monthly (mid- and full-month) producer cash prices, 3) monthly marketing weights, and 4) weekly settlement prices from the nearby futures contracts. These data are collected for crop years 1981 through 2000. The 5-year averages for bases and monthly marketing weights begin with 1981-85 data and are updated to the present. A weekly futures forecast requires an update of weekly futures prices, available

cash prices, and marketing weights on a periodic basis.

Historical daily settlement prices by contract (December, March, May, July, and September) are obtained from the Chicago Board of Trade for crop years 1981 through 2000. 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. Weights for monthly marketings are derived from data published in various issues of USDA's December *Crop Production*. Beginning in 1997, monthly marketing weights are published in the November issue of *Agricultural Prices*.

Forecast Accuracy and Performance

Forecast accuracy and performance measures are computed and evaluated for crop years 1986 through 1999. Accuracy measures considered include the mean error, mean absolute error, and mean absolute percentage 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 mean absolute error removes this problem by taking the absolute value of each error. The mean absolute percentage error, the measure chosen for this analysis, provides still more information than the prior two measures because it relates the error to the actual price.

The performance of the futures method is compared to two other forecasts. One method is a naïve forecast, which uses last year's price as a forecast for the upcoming crop year. The second method is the U.S. Department of Agriculture's monthly price projections of the season-average price, published in the monthly *World Agricultural Supply and Demand Estimates* (WASDE*)* report. The WASDE projection represents a composite projection from econometric models, futures prices, analysts' judgement, and monthly cash prices. Because WASDE projections are released monthly, the weekly futures forecasts are averaged for each month in order to make a monthly comparison. The average futures price includes the week in which the WASDE projection was released and each subsequent week prior to the release of the next WASDE projection. The WASDE projection represents the mid-point of the published range.

For each crop year, Theil's U statistic is computed covering the 16 monthly forecasts for that year. This measure is computed for both the futures forecast and the WASDE projection and indicates their performance relative to the naïve (t-1) forecast.

$$\text{Theil's U-statistic}_t = \sqrt{\frac{\sum_{i=1}^{16}\left(\frac{F_{ti} - Y_t}{Y_{t-1}}\right)^2}{\sum_{i=1}^{16}\left(\frac{Y_t - Y_{t-1}}{Y_{t-1}}\right)^2}}$$

Where:

F_{ti} is the forecast for year t made in month i for either the futures forecast or WASDE projection. Y_{t-1} is the naïve forecast for year t, and Y_t is the actual price for year t.

Thiel's U-statistic provides a relative comparison between the futures and naïve methods and WASDE and naïve methods. A value of 1 means that the naïve method is as good as the forecasting technique being evaluated. A value of less than 1 means that the forecasting technique being used is better than the naïve method. The smaller the U-statistic, the better the forecasting technique relative to the naïve method. When the U-statistic is greater than 1 the naïve method will produce better results.

Sensitivity Analyses

Two variables that affect the futures forecast are the bases and marketing weights. First, we want to determine the effect that perfect knowledge of the basis or marketing weight would have on the forecast. Next, will alternative estimates of the basis and marketing weights contribute to a more accurate price forecast? Alternative bases and marketing weights, 8-year average and olympic average, are computed to determine their effect on the futures forecast error. Crop year 1999/2000 is selected for this analysis because its forecast error of 11 percent was the greatest of any of the crop years.

Alternative bases may improve the futures price forecasts. For example, Jiang and Hayenga found that a 3-year average basis model that included market information and a seasonal autoregressive integrated moving average (ARIMA) basis model provided a better basis forecast

than a simple 3-year average. Tomek also acknowledges the merits of different basis forecasting models. The first one relates to bases involved with inventories carried into the next year and the second one relates to bases involved with intrayear inventories.

Results

Forecast Accuracy for Crop Years 1986/87 through 1999/2000

Annual--A forecast accuracy measure, the mean absolute percentage error, is shown in Figure 1 for all three forecast methods: naïve (t-1), futures, and WASDE. This percentage error was about the same, 5 to 6 percent, for both the futures and WASDE forecasts. However, the naive (t-1) method's error was decidedly greater at 18 percent. The futures forecast and WASDE projections were clearly better than the naïve (t-1) forecasts. However, the navie forecast was superior to the futures method in 1990/91 and 1999/00 and superior to the WASDE projections in 1989/90, 1990/91, and 1991/92. Theil's U-statistic exceeded 1 in these years (appendix table 1).

WASDE projections were faster to react to dropping prices during 1996/97 than the futures or naïve forecast, as the mean absolute percentage error was 7 percent for WASDE projections, 9 percent for the futures forecast and 20 percent for the naïve forecast. The WASDE projections also did a better job of forecasting in the 1998/99 and 1999/00 crop years, during which the basis seemed to widen. Because the futures method uses a 5-year average to compute the basis, its estimate of the basis was too low and so price forecasts were too high.

Monthly--Average monthly forecast errors for the 1986/87 – 1999/00 period are shown in Figure 2. Only the futures and WASDE forecast errors are examined because the naïve forecast error remains the same for each of the forecast months. As expected, the error is generally largest in the beginning of the forecast period and declines as we progress through the crop year as more information becomes available. For example, we first start with planting intentions and yield trends, next actual acreage planted becomes available in NASS's June *Acreage Report*, next yield estimates are published by NASS in August's *Crop Production*, followed by monthly production estimates and reports of quarterly stocks. Monthly exports become available from the Census Bureau approximately two months after the month observed.

It is interesting to note that the futures forecasts generally have a larger error for the November through August period than do the WASDE projections. Does this suggest that USDA's information is better than information maintained by traders? Probably not, since these numbers are averages and only some of the years fit this finding (see appendix table 1). This finding may have more to do with the method of basis computation than information available to the public sector. A 5-year basis computation may be a good proxy of the basis in some years but not for those years when the basis changes. For example, the basis has widened in the last several years and so has the futures forecast error relative to WASDE's projections.

Price Forecasts for Crop Years 2001/2002 and 2000/2001

Season-average price forecasts are based on expectations reflected in the futures market and, if available, actual farm prices. As of July 12, 2001, the futures forecast of the U.S. corn price received by farmers for 2001/02 was $2.34 per bushel (Fig. 3). In comparison, USDA's WASDE farm price projection for 2001/2002 was $1.95 per bushel (USDA, July 11, 2001). The naïve forecast, the corn price from last crop year, 2000/2001, was estimated at $1.85 per bushel. The futures forecast is significantly higher than the WASDE projection most likely because the market does not believe that this year's crop will achieve the assumed trend yield, thereby including a weather-uncertainty premium.

USDA's May, 2001 price projection for corn was $1.85 per bushel, the same as last year's estimate. The May 2001 USDA outlook for U.S. corn in 2001/2002 was based on March planting intentions and trend yields. These assumptions yielded supplies nearly the same as the year earlier because of larger expected carryover stocks. Total corn use in 2001/2002 is expected to be equal to last year. Domestic use is expected to decline slightly as larger industrial use mostly offsets reduced feed and residual use because of a decline in the number of cattle on feed. U.S. corn exports are projected to increase slightly because of reduced competition from foreign exporters. U.S. ending stocks of corn are expected to be about the same as beginning stocks. Since May, 2001, USDA's expected production reflects acres planted and trend yield resulting in lower supply, use, and stocks for 2001/02 thus leading to a rise in July's price projection of $1.95. However, the futures price forecast has risen more.

The futures price forecasts for the 2000/2001crop year are shown in Figure 4. [3] Price projections from the futures and WASDE methods differed the most in the early months of the forecast period, but then generally moved in a similar direction. Convergence of the two forecasts began to occur in mid-April 2001. The futures forecast was always higher than the WASDE projections reflecting, in part, that the 5-year average basis was much smaller than the actual basis.

Timely rains occurred and no significant weather shocks were experienced during the 2000 crop growing season. Despite lower beginning stocks an abundant corn crop raised total supply to a near record of 11.7 billion bushels. Although total use rose, its increase did not match the increase in supply, so ending stocks increased and the stocks-to-use ratio rose from 18 to 20 percent.

Sensitivity Analyses

Basis--For the 1999/00 crop year, perfect knowledge of the basis would lower the mean absolute percentage error by 3 percentage points (Fig. 5). Unfortunately, none of the alternative basis computations provides an improved forecast. The 8-year average basis increased the error by about 1 percentage point while the olympic average created a mean forecast that was about equal to the 5-year average. Additional basis estimating techniques warrant further examination to determine their effects on the futures forecast.

Marketing Weights--Surprisingly, perfect knowledge of the marketing weights would slightly increase the mean absolute percentage error (Fig. 6). This is in contrast to prior expectations, but can be explained given that the basis for this year was underestimated and so the effects of the incorrect basis carried a greater weight than the effects of knowing the actual marketing weights. None of the estimates of alternative bases improved the mean futures price forecast. The 8-year average about equaled the 5-year basis forecast and the error of the olympic average was about 1 percentage point larger. Further analysis of marketing weights and their alternative estimating techniques seems warranted.

[3] These forecasts are compared with the WASDE price projections to determine the reliability of both methods. Although WASDE price projections are released monthly, they are given a weekly frequency for ease of comparison to the futures forecasts.

Conclusions

This analysis demonstrates that the futures forecast method can provide a timely and reasonable forecast of the U.S. farm level corn price. This procedure provides a useful tool for commodity and policy analysts. The futures forecast also provides a useful cross-check for other season-average price forecasts.

Suggestions for Further Research

First, further research should examine the effects of alternative estimates for bases and marketing weights for the other crop years analyzed in this study. Improved estimates of bases or marketing weights should improve forecasts in crop years where information is more certain. Next, the model's ability to predict intra-year price patterns should be examined. Efforts in this area would help in forecasting the payment of marketing loan benefits.

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Table 1--Futures Forecast of U.S. Corn Producers' Season-Average Price, Crop Year 2001-2002

Item	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.
							Dollars per bushel						
(1) Current futures price 1/ by contract (settlement)				2.46			2.56		2.60		2.66		2.61
(2) Monthly futures price based on nearby contract	2.46	2.46	2.46	2.56	2.56	2.56	2.60	2.60	2.66	2.66	2.61	2.61	
(3) Plus the historical basis (cash less futures)	-0.15	-0.25	-0.24	-0.23	-0.21	-0.20	-0.25	-0.27	-0.28	-022	-0.01	-0.06	
(4) Forecast of monthly average farm price	2.31	2.21	2.22	2.32	2.35	2.36	2.35	2.33	2.37	2.44	2.60	2.55	
(5) Actual monthly farm price													
(6) Spliced actual/forecast monthly farm price	2.31	2.21	2.22	2.32	2.35	2.36	2.35	2.33	2.37	2.44	2.60	2.55	
Annual price projections:													
(7) Marketing weights (in percent)	7.06	14.14	11.20	7.64	15.4	7.82	8.18	5.56	4.58	5.28	5.96	7.14	
(8) Weighted average	2.34												
(9) Simple average	2.37												

1/ Contract months include December, March, May, July, and September. Futures price quotation from the Chicago Board of Trade, July 12, 2001 settlement prices.

Figure 1. Accuracy of Alternative Season-Average Farm Price Forecasts for U.S. Corn

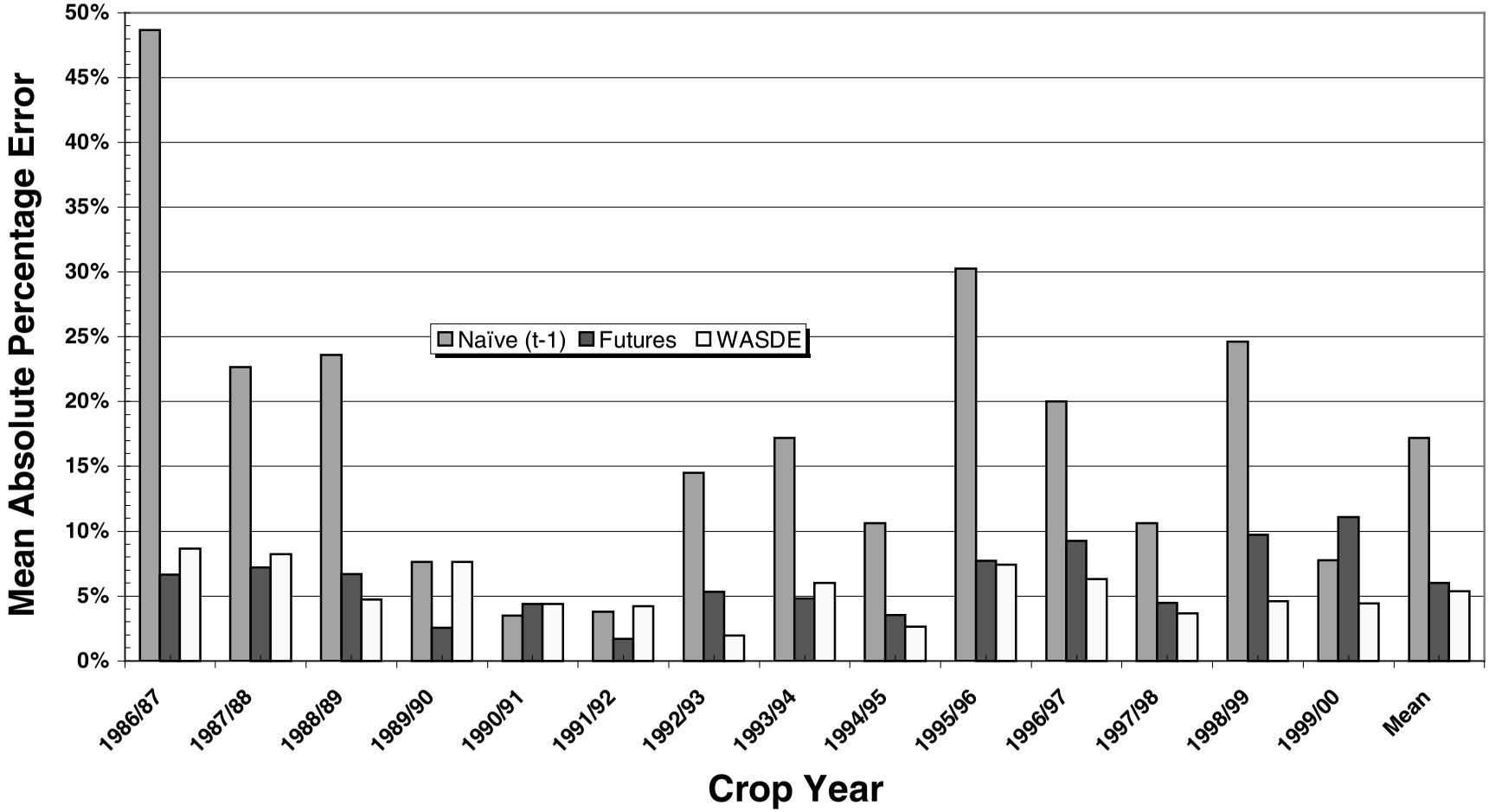


Figure 2. Accuracy of Monthly Season-Average Farm Price Forecasts for U.S. Corn, Crop Years 1986-1999

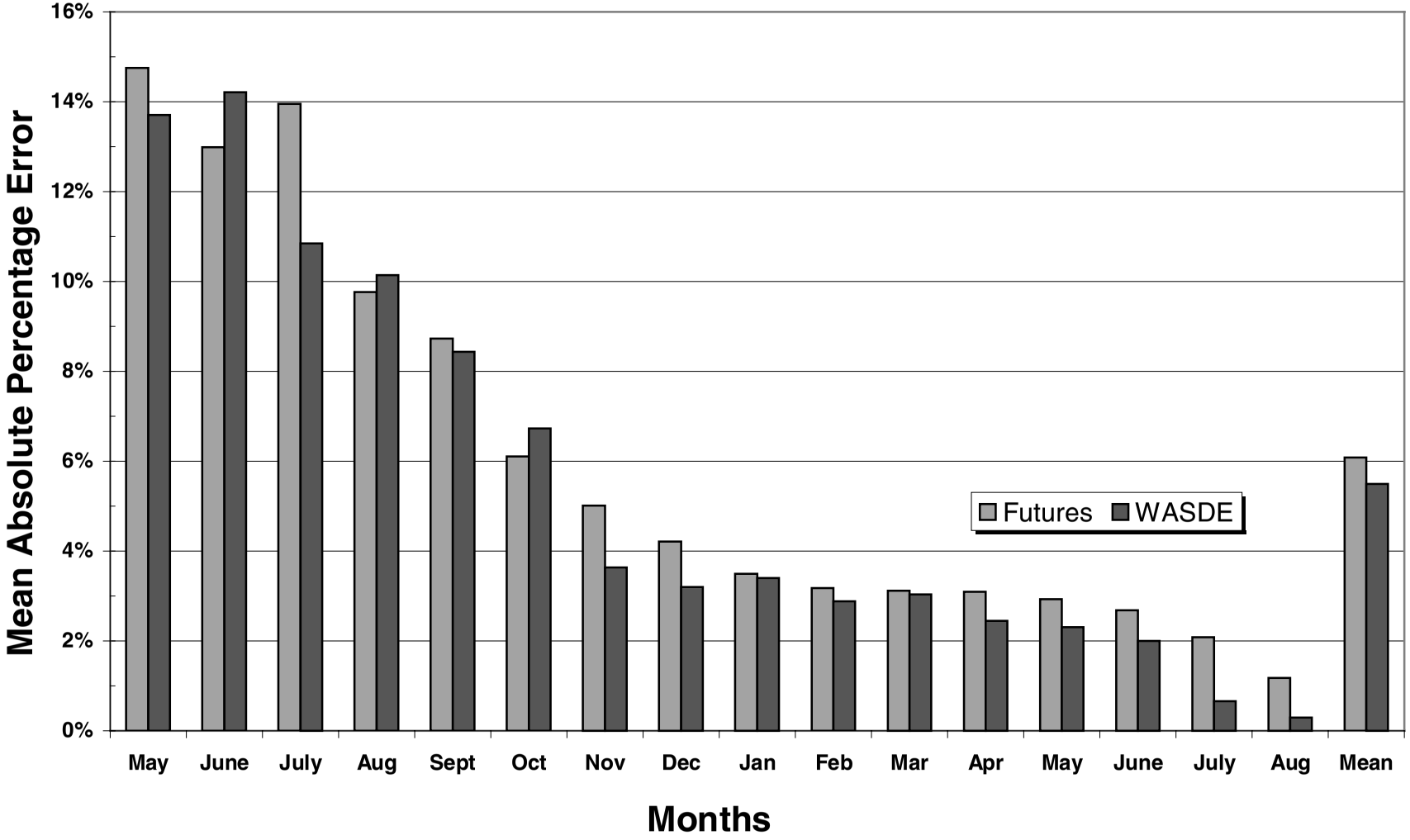


Figure 3. Producers' Season Average Price Forecasts for U.S. Corn, Crop Year 2001-2002

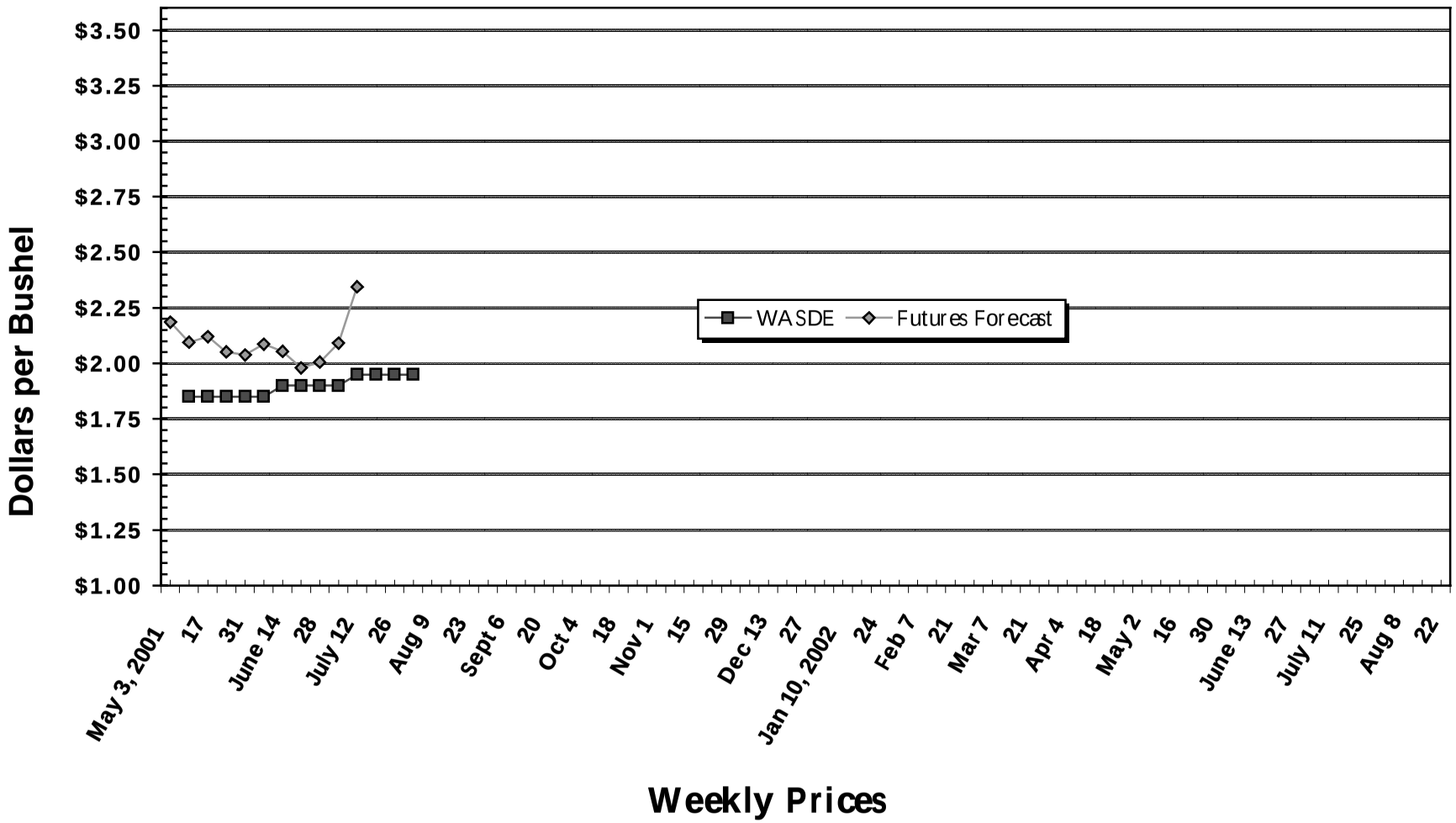
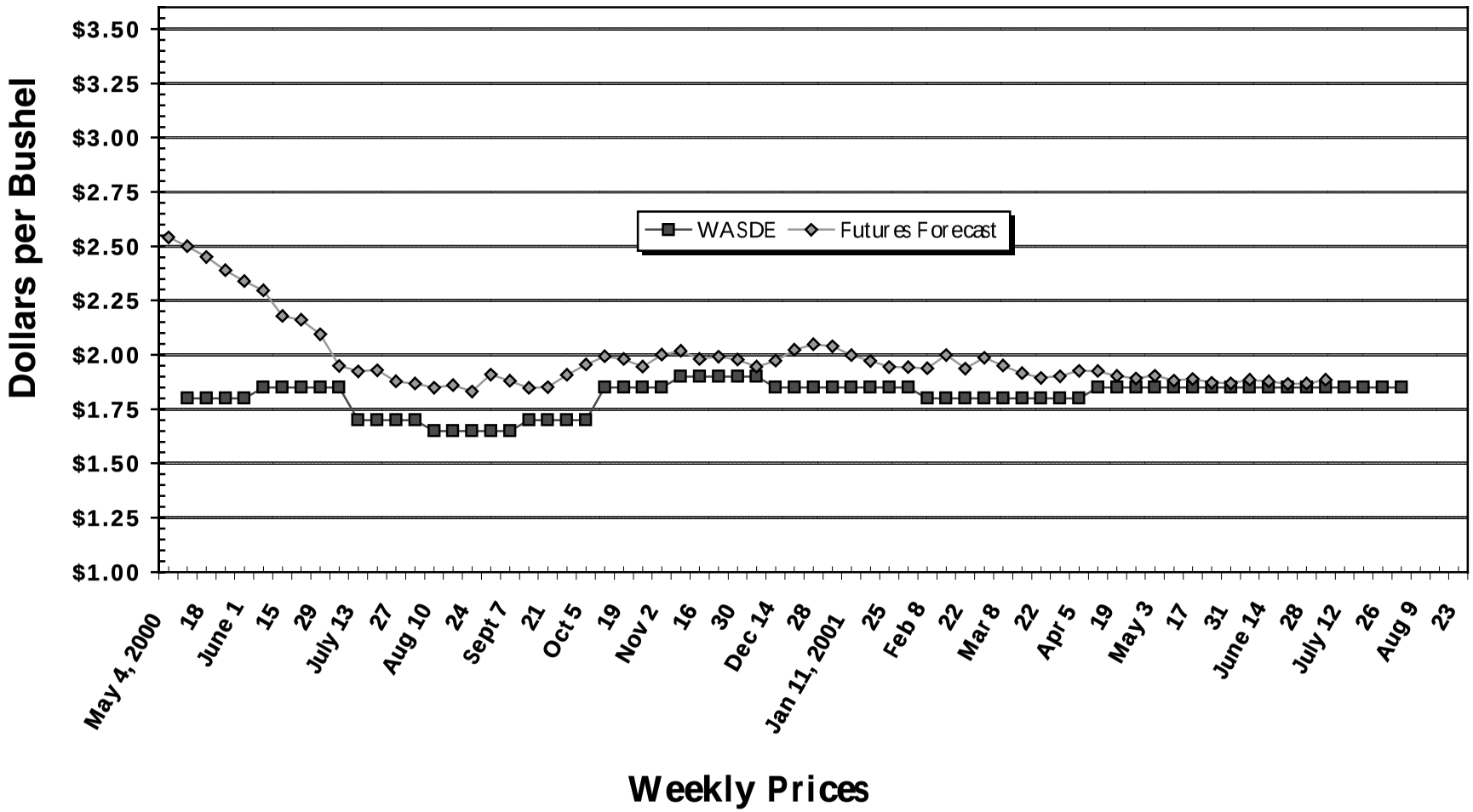


Figure 4. Producers' Season Average Price Forecasts for U.S. Corn, Crop Year 2000-2001



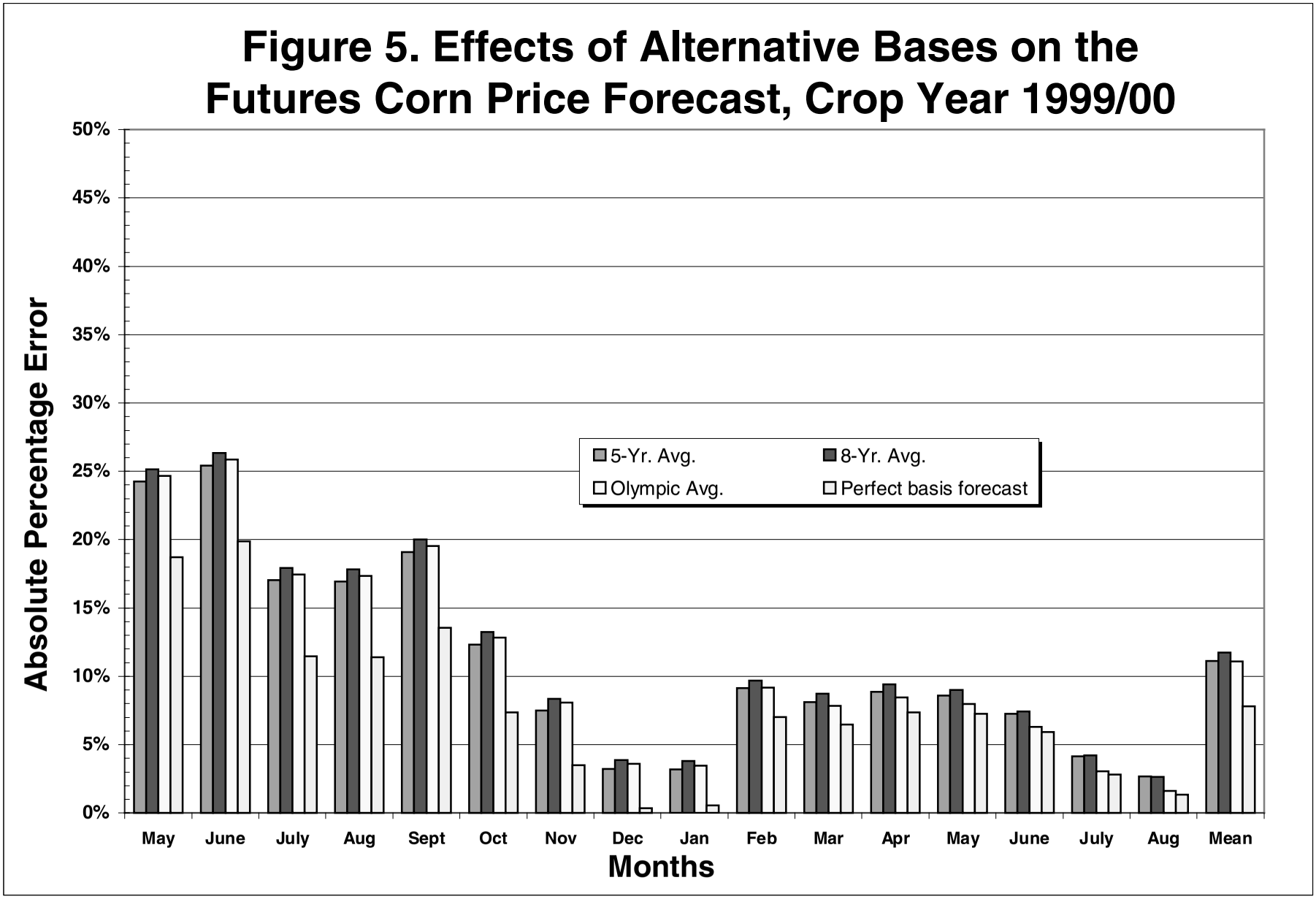


Figure 5. Effects of Alternative Bases on the Futures Corn Price Forecast, Crop Year 1999/00
Absolute Percentage Error
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
5-Yr. Avg.
8-Yr. Avg.
Olympic Avg.
Perfect basis forecast
May
June
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
July
Aug
Mean
Months

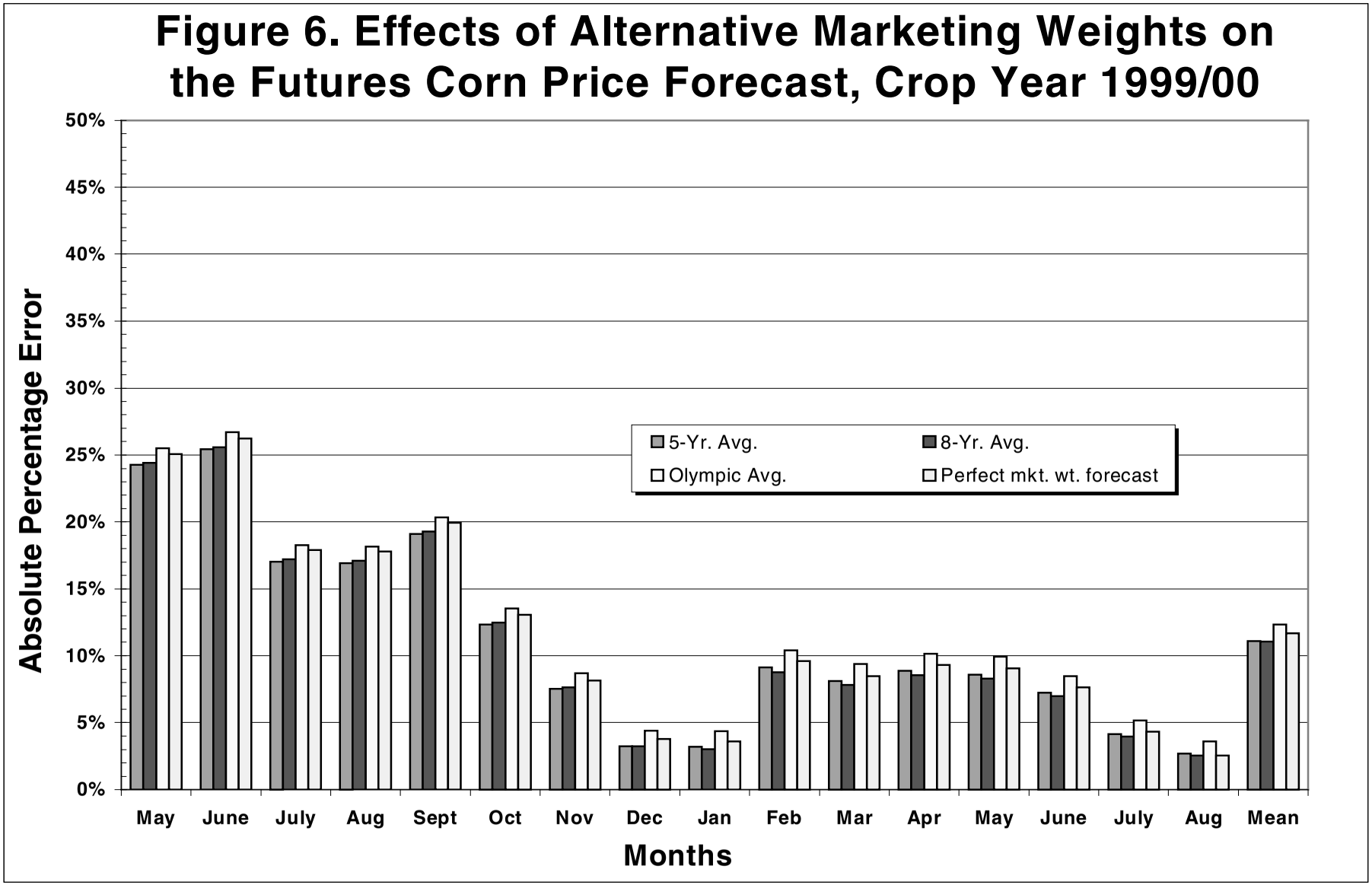


Figure 6. Effects of Alternative Marketing Weights on the Futures Corn Price Forecast, Crop Year 1999/00
Absolute Percentage Error
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
5-Yr. Avg.
8-Yr. Avg.
Olympic Avg.
Perfect mkt. wt. forecast
May
June
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
July
Aug
Mean
Months

Appendix Table 1 -- Accuracy of Alternative Season-Average Farm Price Forecasts for U.S. Corn, Crop years 1986/87-1999/00

Forecast Month	1986-87 Futures	1986-87 WASDE	1987-88 Futures	1987-88 WASDE	1988-89 Futures	1988-89 WASDE	1989-90 Futures	1989-90 WASDE	1990-91 Futures	1990-91 WASDE	1991-92 Futures	1991-92 WASDE	1992-93 Futures	1992-93 WASDE
	Marketing Year and Forecast Method													
	Percentage Error Between Actual and Forecast													
May	+ 27.5	+ 28.3	- 4.1	- 9.8	- 12.7	- 28.1	+ 6.6	- 21.6	+ 15.6	+ 7.5	+ 2.3	- 9.3	+ 22.1	+ 18.4
June	+ 20.5	+ 28.3	- 2.6	- 9.8	- 6.9	- 28.1	- 1.2	- 21.6	+ 15.5	+ 11.8	+ 0.7	- 9.3	+ 22.0	+ 12.0
July	+ 13.0	+ 25.0	- 4.5	- 4.6	+ 25.9	+ 4.3	+ 3.0	- 15.3	+ 18.0	+ 18.4	- 4.3	- 11.4	+ 19.3	+ 4.7
August	+ 5.9	+ 18.3	- 14.8	- 7.2	+ 17.3	- 1.6	- 5.0	- 12.1	+ 7.6	+ 11.8	+ 2.2	+ 5.5	+ 5.8	+ 6.3
September	+ 2.9	+ 15.0	- 15.7	- 9.8	+ 12.2	- 1.6	- 2.9	- 13.1	+ 3.6	+ 0.9	+ 2.9	+ 7.6	+ 3.2	+ 4.7
October	+ 3.5	+ 11.7	- 10.2	- 9.8	+ 10.3	+ 2.4	- 3.7	- 13.1	- 1.8	+ 5.3	+ 2.1	+ 3.4	+ 0.6	+ 4.7
November	+ 5.4	0.0	- 10.2	- 9.8	+ 7.6	+ 2.4	- 2.6	- 6.8	- 0.5	+ 5.3	+ 2.5	- 0.8	- 1.0	+ 4.7
December	+ 7.6	0.0	- 8.3	- 9.8	+ 1.8	+ 2.4	- 2.9	- 4.7	- 1.8	+ 3.1	- 0.1	+ 1.3	+ 2.0	+ 10.5
January	+ 2.1	0.0	- 8.8	- 9.8	+ 5.3	- 1.6	- 2.7	- 2.5	- 1.3	+ 3.1	+ 0.5	+ 5.5	+ 1.0	+ 6.7
February	+ 0.3	0.0	- 6.1	- 9.8	+ 2.4	+ 0.4	- 2.4	- 2.5	+ 0.9	+ 0.9	+ 3.2	+ 3.4	+ 0.6	+ 16.3
March	- 2.8	0.0	- 5.9	- 9.8	+ 2.9	+ 0.4	- 1.2	- 2.5	+ 1.3	+ 0.9	+ 3.5	+ 3.4	- 0.1	+ 8.6
April	- 0.3	0.0	- 6.0	- 9.8	+ 1.8	+ 1.4	+ 0.1	- 0.4	+ 2.2	+ 0.9	+ 2.7	+ 1.3	+ 2.0	+ 4.7
May	+ 3.3	+ 3.3	- 6.6	- 9.8	+ 1.5	+ 1.4	+ 2.2	- 0.4	+ 1.8	+ 0.9	+ 0.5	+ 1.3	+ 0.9	+ 4.7
June	+ 4.5	+ 3.3	- 5.4	- 7.2	+ 0.2	+ 0.4	+ 2.1	+ 0.6	+ 0.6	+ 0.9	+ 1.0	+ 1.3	+ 0.2	+ 7.0
July	+ 3.5	+ 3.3	+ 3.3	+ 0.5	+ 0.7	+ 0.4	+ 2.4	+ 0.6	- 0.2	- 0.2	+ 1.0	+ 0.2	+ 0.2	+ 7.6
August	+ 1.2	+ 0.7	- 0.0	+ 0.5	- 0.2	+ 0.4	+ 1.0	+ 0.8	+ 0.8	+ 0.9	- 0.5	0.0	+ 0.8	+ 6.5
	Mean Absolute Percentage Error													
16 Month Forecast Period	6.5	8.6	7.0	8.0	6.9	4.8	2.6	7.4	4.6	4.5	1.9	4.0	5.1	8.0
	Dollars per Bushel													
Actual Price	1.50	1.50	1.94	1.94	2.54	2.54	2.36	2.36	2.28	2.28	2.37	2.37	2.07	2.07
Naïve Forecast (t-1)	2.23	2.23	1.50	1.50	1.94	1.94	2.54	2.54	2.36	2.36	2.28	2.28	2.37	2.37
	Theil's U-Statistic													
Naïve forecast comparison	0.2	0.3	0.4	0.4	0.4	0.4	0.4	1.4	2.1	2.0	0.6	1.4	0.7	0.1

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Appendix Table 1 -- Accuracy of Alternative Season-Average Farm Price Forecasts for U.S. Corn, Crop years 1986/87-1999/00--continued

Forecast Month	1993-94 Futures	1993-94 WASDE	1994-95 Futures	1994-95 WASDE	1995-96 Futures	1995-96 WASDE	1996-97 Futures	1996-97 WASDE	1997-98 Futures	1997-98 WASDE	1998-99 Futures	1998-99 WASDE	1999-00 Futures	1999-00 WASDE
	Marketing Year and Forecast Method													
	Percentage Error Between Actual and Forecast													
May	- 7.8	- 18.0	+ 4.1	+ 1.8	- 20.6	- 22.8	+ 17.7	+ 7.4	+ 6.0	0.0	+ 35.3	+ 15.4	+ 24.2	+ 11.1
June	- 9.2	- 18.0	+ 9.9	+ 1.8	- 17.6	- 18.2	+ 25.5	+ 14.8	+ 0.6	0.0	+ 24.3	+ 15.4	+ 25.4	+ 11.1
July	- 8.4	- 12.0	+ 6.5	- 2.7	- 15.9	- 15.1	+ 27.2	+ 14.8	- 5.8	+ 2.0	+ 26.4	+ 10.3	+ 17.0	+ 2.8
August	- 5.7	- 6.0	- 4.2	- 4.9	- 15.3	- 18.2	+ 18.7	+ 24.1	- 2.7	+ 10.2	+ 14.5	+ 10.3	+ 16.9	+ 5.6
September	- 7.7	- 6.0	- 2.6	- 2.7	- 14.2	- 15.1	+ 22.4	+ 18.5	+ 5.8	+ 8.2	+ 7.2	+ 2.6	+ 19.1	+ 8.3
October	- 6.3	- 4.0	- 5.3	- 7.1	- 8.5	- 9.0	+ 11.3	+ 11.1	+ 4.1	+ 8.2	+ 5.3	+ 2.6	+ 12.3	+ 2.8
November	- 2.4	+ 2.0	- 4.5	- 9.3	- 4.0	- 2.8	+ 0.7	0.0	+ 11.3	+ 8.2	+ 9.9	+ 2.6	+ 7.5	0.0
December	+ 5.0	+ 4.0	- 4.6	- 4.9	- 5.3	- 2.8	- 0.9	- 1.9	+ 7.6	+ 6.1	+ 7.7	+ 2.6	+ 3.2	0.0
January	+ 7.9	+ 6.0	- 3.0	- 2.7	- 2.5	- 1.2	- 2.7	0.0	+ 4.0	+ 6.1	+ 4.0	0.0	+ 3.2	+ 2.8
February	+ 6.5	+ 6.0	- 0.2	- 2.7	- 3.3	- 1.2	- 0.5	0.0	+ 5.8	+ 4.1	+ 2.9	0.0	+ 9.1	+ 5.6
March	+ 4.2	+ 4.0	+ 0.3	- 2.7	- 2.3	- 2.8	+ 2.8	0.0	+ 4.9	+ 4.1	+ 3.2	+ 2.6	+ 8.1	+ 5.6
April	+ 3.0	+ 2.0	+ 1.2	- 0.4	- 1.3	- 2.8	+ 5.0	+ 3.7	+ 4.3	+ 2.0	+ 4.5	+ 2.6	+ 8.9	+ 5.6
May	+ 1.2	+ 2.0	+ 1.1	- 0.4	+ 3.1	- 1.2	+ 3.8	+ 1.9	+ 2.8	0.0	+ 3.6	+ 2.6	+ 8.6	+ 5.6
June	+ 2.0	+ 2.0	+ 2.1	- 0.4	+ 4.1	- 1.2	+ 2.5	+ 0.9	+ 1.8	0.0	+ 3.6	+ 2.6	+ 7.2	+ 5.6
July	+ 1.6	+ 2.0	+ 2.8	- 0.4	+ 2.5	- 1.2	+ 2.3	0.0	+ 2.0	0.0	+ 2.6	0.0	+ 4.1	0.0
August	+ 0.1	0.0	+ 2.8	- 0.4	+ 1.3	+ 0.3	+ 2.3	0.0	+ 0.8	0.0	+ 2.2	0.0	+ 2.7	0.0
	Mean Absolute Percentage Error													
16 Month Forecast Period	4.9	5.9	3.5	2.8	7.6	7.3	9.1	6.2	4.4	3.7	9.8	4.5	11.1	4.5
	Dollars per Bushel													
Actual Price	2.50	2.50	2.26	2.26	3.24	3.24	2.70	2.70	2.45	2.45	1.95	1.95	1.80	1.80
Naïve Forecast (t-1)	2.07	2.07	2.50	2.50	2.26	2.26	3.24	3.24	2.70	2.70	2.43	2.43	1.94	1.94
	Theil's U-Statistic													
Naïve forecast comparison	0.3	0.5	0.4	0.4	0.3	0.4	0.7	0.5	0.5	0.5	0.6	0.3	1.7	0.7