An Assessment of a Futures Method Model For Forecasting the Season-Average Farm Price for Soybeans

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Abstract: Futures prices are used to develop historical forecasts of U.S. soybean season-average farm prices (SAFP) during crop-years 1981/82 to 1999/2000. The method for forecasting soybean SAFP is outlined and the accuracy of these forecasts is assessed by comparing them with actual season-average farm prices during those years. The accuracy of "futures method" forecasts is also compared with those published monthly by USDA in the World Agricultural Supply and Demand Estimates (WASDE) reports. Findings suggest that both the futures method and WASDE forecasts are generally accurate and comparable, but the futures method provides more accurate forecasts by some criteria.

Keywords: Soybeans, price forecasts, futures prices, futures-method forecast, season-average farm price.

Introduction

The U.S. Department of Agriculture (USDA), in its efforts to provide reliable market information on agricultural products, develops short-run forecasts of production, use, and trade for numerous agricultural commodities, including soybeans. Based on expected supply and demand conditions, USDA also issues forecasts of annual commodity prices on a monthly basis, and these projections are used as an important planning tool by both the private and public sectors. For producers, forecasts of the season-average farm price (SAFP) can affect marketing decisions. Furthermore, producers and users of agricultural commodities rely on forecasts to manage income and price risk. For policymakers, accurate forecasts can be important for budgetary purposes related to farm programs.

Given the importance of price forecasts to market participants, the objectives of this study are twofold. First, we construct an alternative set of monthly soybean season-average farm price forecasts using the "futures method" model previously developed by Hoffman and Davison (1992), and assess the accuracy of these forecasts by comparing them with actual season-average farm prices during crop years 1981/82 to 1998/99. Second, we compare the accuracy of futures method forecasts to those published monthly by USDA in the *World Agricultural Supply and Demand Estimates* (WASDE) report. Our aim is to determine whether the futures method represents a generally reliable approach to forecasting commodity prices, as well as to provide an overall assessment of WASDE and futures method forecast accuracy.

In addition to our main objectives, we also explore whether the accuracy of futures forecasts improves when futures markets gain access to new information from the most recent WASDE report. That is, are forecasts based on futures prices immediately following the release of WASDE more accurate than those made just prior to the WASDE release. Intuitively, this makes sense. WASDE SAFP projections represent the sum of all publicly available market-related information, but some of this information, such as USDA's National Agricultural Statistics Service (NASS) survey-based data on crop yields, are not made available to the public until the WASDE's release. Although market participants may anticipate this information, futures forecasts following the release of the WASDE should represent the most up-to-date composite of public and privately held information. To test this conjecture, we develop two separate forecasts of SAFP using the futures method – one based on futures price data available prior to the release of WASDE, and the other based on futures price data immediately following the release of WASDE.

The following section describes the method used to develop monthly forecasts of annual season-average soybean prices with futures, and illustrates the method with a November 1999 forecast for the 1999/2000 crop year. We then compare the historical accuracy of the futures forecasts with WASDE

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forecasts by calculating the mean absolute percentage error (MAPE) of the forecasts during crop years 1981/82 to 1998/99. Next, the average (1981/82 to 1998/99) absolute percentage error for each forecast month is examined separately to see if there is any pattern to differences between the alternative forecasts over the course of the crop year. We conclude with a brief summary.

Overview of Futures Forecasting Method

Using the futures method, forecasts of monthly average prices received by U.S. farmers are made for each month of the crop year starting with September. Price forecasts for each month of the crop year are initially based on the current month's futures price for the nearest contract maturing after the month being forecast (referred to as the "nearby futures contract").

Most market participants understand that the futures market is a composite indicator of anticipated supplies and demands and that current futures prices therefore provide important information about cash prices on future dates. However, participants also need to be able to forecast a price at the location and time when they plan to buy or sell. Thus, they need to predict the "basis," the difference between the futures price and the local price.

The futures method employed here uses an historical monthly average basis (historical monthly farm price received minus historical monthly average futures price for the nearby contract) that is subtracted from the current nearby futures prices to yield a monthly U.S. average farm price forecast for each month of the crop year. The 12 monthly price forecasts are then multiplied by their 5-year historic share of annual marketings and summed to produce a weighted season-average farm price forecast. As estimated monthly farm prices become available, the predicted season-average farm price becomes a composite of actual and forecasted prices.

Basis

The difference between a farm (henceforth "cash") price received at a specific location and the price of a particular futures contract is known as the basis. The basis tends to be more stable or predictable than either the farm price or futures price. Factors that can affect the basis include local supply and demand conditions for the commodity and its substitutes, handling costs, transportation and storage costs, and market expectations. The basis used in this analysis is a composite of these factors and represents an average of U.S. conditions.

The basis in this study is defined as the difference between the monthly U.S. average cash price received by producers and the monthly average settlement price for the nearby futures contract. For example, the September basis is the difference between the September average cash price received by producers less September's average settlement price of the November futures contract. A 5-year moving average of these bases, used to eliminate distortions that may occur in any given year, is updated at the end of each crop year. Thus, data for the 1976 through 1980 crop years establish the historical basis used to develop the 1981 crop year futures forecast.

Data

Historical daily soybean futures settlement prices for crop years 1976 to 1999 are obtained from *TechTools* data service. Historical cash prices were acquired from USDA's (NASS) *Agricultural Prices*, and weights for monthly marketings were obtained from USDA's (NASS) December issues of *Crop Production* (prior to 1998) and November issues of *Agricultural Prices* (1998 to present).

Procedure and Illustration Of futures method

Table 1 illustrates the method used to forecast the 1999/2000 crop year season-average soybean price in November 1999. Although the futures method forecast for 1999/2000 has been updated through August 2000, we present the November 1999 forecast to more clearly illustrate that SAFP forecasts are, in general, a composite of actual and forecasted monthly prices. It should be noted that our assessment of the accuracy of the futures method for crop years 1981/82 to 1998/99 is based on all 12 monthly forecasts for each year. Recall that we use the futures method to produce two alternative forecasts of the SAFP – one using a 2-day average futures settlement price available just prior to the release of that month's WASDE, and one using a 2-day average settlement price following the WASDE release. For simplicity of presentation, only the first (pre-WASDE) forecasts are shown in table 1.

Seven steps are involved in the forecast process, illustrated here with the November 1999 forecast of the 1999/2000 crop year SAFP:

- Futures settlement prices are gathered for the contracts that will mature during the forthcoming year (line 1). When pre-WASDE settlement prices are used, the 2-day average futures price for the January, March, May, July, and September (2000) contracts available on November 8th and 9th were selected (WASDE was released on November 10). Estimates of actual monthly prices received are available from NASS and used for September and October 1999. The October 1999 price represents a mid-month estimate published in that month's issue of *Agricultural Prices* (the price is updated the following month). The November 1999 contract is not used for reasons discussed below.
- The monthly futures prices are based on the settlement prices of the nearby contracts. For example, the futures

Table A-1--Futures forecast of U.S. soybean season-average farm price, 1999/2000 crop year (November 1999)

Item	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.
							Dollars/bu						
1. Current futures price 1/ by contract					4.81		4.87		4.93		4.98	4.97	5.03
2. Monthly futures price based on nearby contract			4.81	4.81	4.87	4.87	4.93	4.93	4.98	4.98	4.97	5.03	
3. Plus the historical basis (cash less futures) 2/	-0.07	-0.25	-0.30	-0.23	0.18	-0.19	-0.26	-0.26	-0.26	-0.20	-0.11	-0.04	
4. Forecast of monthly average farm price			4.51	4.58	4.69	4.68	4.67	4.67	4.72	4.78	4.86	5.06	
5. Actual monthly farm price	4.57	4.49											
6. Spliced actual/forecast monthly farm price	4.57	4.49	4.51	4.58	4.69	4.68	4.67	4.67	4.72	4.78	4.86	5.06	
Annual price projection													
7. Marketing weights (percent)	6.90	22.80	9.20	7.40	13.60	7.20	7.40	5.60	4.70	4.80	5.40	5.10	
8. Weighted average forecast ($/bushel)			4.64										

1/ Contract months for soybeans include: September, November, January, March, May, July, and August.
2/ Data shown here are the 5-year average for crop years 1994-1998.
Source: Economic Research Service, USDA.

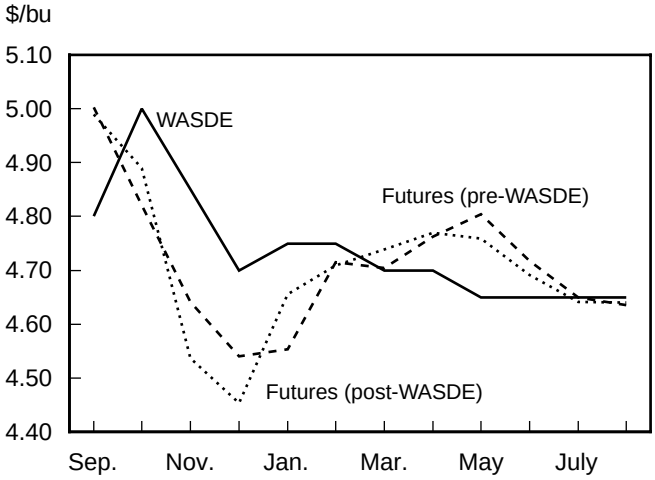
prices for November and December represent the November (8th and 9th) average settlement price of the nearby January contract. The futures prices for January and February are based on the November settlement prices for the nearby contract for those months (March). During months in which a futures contract matures, the next contract month is used because futures contracts are affected by a decline in liquidity during the month of maturity. Although the September 2000 futures contract falls outside of the current crop year, this contract is used to establish the monthly futures price for August 2000.

- A 5-year moving average of the basis (cash prices minus the monthly average settlement price for the nearby futures contract) for each month is entered (on line 3).
- A forecast of the monthly average farm price (line 4) is computed by adding the basis (line 3) to the monthly futures prices (line 2), except when NASS monthly or mid-month price estimates are known.
- The NASS monthly average farm price is entered on line 5 as it becomes available. In this example, the September price is for the entire month and the October price is a mid-month estimate. In December, the estimate for October would be updated and a mid-month estimate for November would be included.
- The NASS price estimates and forecast farm prices are spliced together in line 6. The November 1999 forecast of SAFP for crop year 1999/2000 will be based on actual price data for September and October, and forecasts for the remaining 10 months.
- A 5-year average of monthly marketing shares (in percents) by soybean producers (line 7) is used to weight the monthly farm prices (forecast or actual), yielding the final November 1999 forecast of the 1999/2000 soybean SAFP (line 8).

The November 1999 forecast of the 1999/2000 SAFP based on pre-WASDE futures information was $4.64/bushel. Although the actual 1999/2000 SAFP for soybeans is not yet available, this figure compares very favorably with the most recent (August 2000) WASDE point estimate of $4.65/bushel for the current crop year. In the months following the November forecast, the (pre-WASDE) futures forecast fell to about $4.55/bushel before climbing to a peak of just over $4.80/bushel in May 2000. The futures forecast then began to converge towards the WASDE estimate in June, July, and August (fig. A-1).

The futures forecasts based on post-WASDE release futures data were all within about 10 cents per bushel of the pre-WASDE forecasts and the difference averaged about 4 cents/bushel. In November, the post-WASDE forecast was about 10 cents per bushel lower (at $4.54/bushel) than the pre-WASDE forecast. The difference is probably due to new

Figure A-1
Forecasts of U.S. soybean prices, 1999/2000 crop year



Source: Economic Research Service, USDA.

information conveyed by the November WASDE report. USDA lowered its mid-point forecast of soybean SAFP by 15 cents per bushel due in part to diminished export prospects. The result was a less accurate forecast of the probable 1999/2000 soybean SAFP, but one still more accurate than the November WASDE mid-point projection of $4.85/bushel.

Compared with the WASDE price estimates, the futures price forecasts ranged from as much as 20 cents a bushel above the WASDE mid-point forecast in September 1999 to 31 cents a bushel below the WASDE projection in November 1999. Since the actual season-average farm price for soybeans has not yet been established and just one year's worth of projections are represented here, these comparisons are somewhat less meaningful than the historical analysis of forecast accuracy for the crop years 1981/82 to 1998/99 presented in the next section.

Forecast accuracy of the futures method and WASDE (1981/82 to 1998/99)

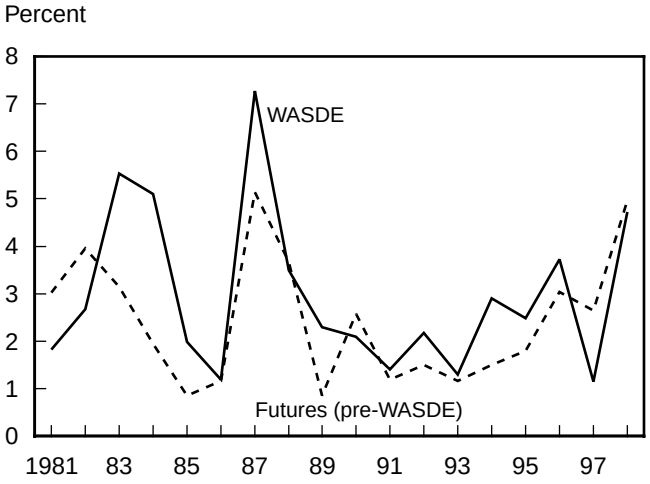
In this section, we examine the historical (1981/82 to 1998/99) accuracy of soybean SAFP forecasts published in USDA's WASDE reports as well as the accuracy of the two alternative forecasts developed using the futures method. This analysis is designed to help us gauge the general accuracy of the WASDE projections, and to judge whether the futures method represents a reasonable alternative approach for developing such forecasts. Initially, forecast accuracy is assessed by calculating the mean absolute percentage error (MAPE) for each forecast (WASDE or futures) over the entire crop year. That is, for a given crop year, the MAPE gives the average percentage difference between each month's (September through August) forecast of SAFP and the actual SAFP. We then examine the average absolute percentage error of the monthly forecasts. For instance, the average absolute percentage error for the September WASDE report is the average of the September forecast errors over the 18 years examined. It should be remembered that the WASDE and futures forecasts of SAFP are composites of projected and actual (NASS estimates of) monthly cash prices as they become known.

Yearly forecast errors (1981/82—1998/99)

Figure A-2 and the accompanying table present the mean absolute percentage errors for the WASDE and the futures method for crop years 1981/82 to 1998/99. The MAPE is a summary of monthly errors during each crop year and therefore masks fluctuations of the errors over the course of the crop year. Nevertheless, it provides a general sense of the overall accuracy of the alternative forecasts as well as a basis for comparison between the forecast methods. Since the results for the pre-WASDE and post-WASDE futures method were similar, figure A-2 compares only the pre-WASDE futures forecasts with the WASDE. The accompanying table provides the results for all three methods.

The MAPE for each of the three forecasts ranged from a low of 0.56 percent for the 1985/86 post-WASDE release futures method to a high of over 7 percent for the 1987/88 WASDE projections. By the MAPE criteria, it appears that the futures method holds a slight advantage over the WASDE in forecasting soybean SAFP. The average MAPE over the eighteen observations was 2.96 percent for the WASDE, 2.45 percent for the pre-WASDE release futures method, and 2.38 percent for the post-WASDE release futures method. The WASDE projection out-performed one or both futures forecasts in 8 out of 18 years, but in the other years, the WASDE errors tended to exceed those of the

Figure A-2
Mean absolute percentage error (WASDE vs. Futures method), 1981/82-98/99



Source: Economic Research Service, USDA.

Table A-2--Mean absolute percentage error (1981/82–1998/99)

Crop year	1981	1982	1983	1984	1985	1986	1987	1988	1989	
WASDE	1.82	2.67	5.53	5.09	1.98	1.19	7.27	3.49	2.29	
Futures (pre)	3.03	3.95	3.14	1.95	0.86	1.17	5.14	3.67	0.85	
Futures (post)	2.95	3.88	3.06	1.51	0.56	1.25	4.80	3.27	0.68	
Crop year	1990	1991	1992	1993	1994	1995	1996	1997	1998	Mean
WASDE	2.09	1.40	2.17	1.30	2.90	2.48	3.72	1.15	4.72	2.96
Futures (pre)	2.58	1.19	1.51	1.16	1.50	1.80	3.04	2.65	4.97	2.45
Futures (post)	2.26	1.38	1.43	1.44	1.42	1.82	2.95	2.86	5.33	2.38

Source: Economic Research Service, USDA.

futures method by a fairly large margin – particularly in 1983, 1984, and 1987.

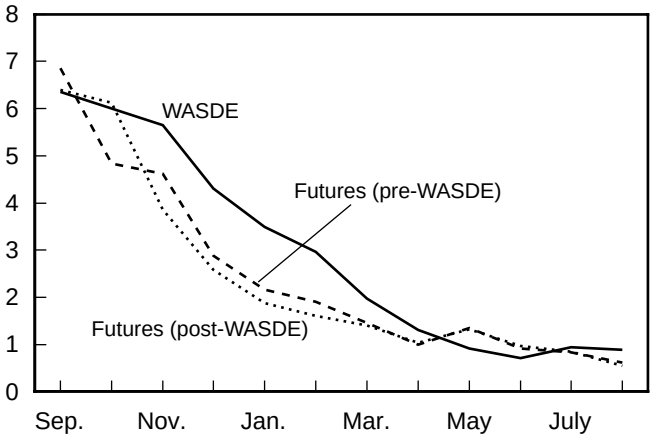
As indicated in figure A-2, the SAFP forecast errors for the WASDE and futures method tend to be highly correlated, generally falling or rising from previous year's errors in tandem. In addition, the tendency of all three forecasts was to somewhat over-estimate the soybean season-average farm price. For each method, about 55 percent of the 216 monthly forecasts over-estimated the final SAFP, but the simple mean error of all monthly forecasts was lowest for the WASDE (0.17 percent versus 0.36 percent for the pre-WASDE futures forecasts and 0.30 percent for the post-WASDE futures forecasts).

Monthly forecast errors (September—August)

Not surprisingly, the accuracy of SAFP forecasts for each method tends to improve over the course of the crop year, as actual monthly prices are incorporated into the forecasts. Interestingly, as shown in figure A-3 and the accompanying table, the WASDE and futures method forecasts perform similarly during the first monthly projection (September) of the crop year SAFP. The 18-year average (of absolute) September forecast errors ranged from a low of 6.35 percent for the WASDE projection to a high of 6.85 percent for the pre-WASDE futures forecast. In the following months, particularly November through March, however, the WASDE projection errors consistently exceeded the futures forecast errors. Between November and February, the difference averaged more than 1 percentage point per month.

Figure A-3

Average forecast error, by month of forecast, 1981/82-1998/99



Source: Economic Research Service, USDA.

Why the WASDE forecast errors exceed the futures forecasts during these months is difficult to determine. One suggestion is that over the time period examined (1981/82 – 1998/99), WASDE projections of (U.S.) domestic use tended to be under-estimated while ending stocks were over-estimated. A look at statistics on the reliability of monthly WASDE projections between November and March (1981/82 to 1998/99) confirm this impression. The expected impact would be a consistent under-estimation of the SAFP, but a closer look at monthly WASDE forecast errors does not support this conclusion. The simple average of errors for November, December, and January were positive, meaning price forecasts were slightly over-estimated during these months. In any event, this suggestion does not explain differing magnitudes of WASDE and futures method forecast errors, only a potential pattern to WASDE forecast errors (which is not apparent).

Another suggestion is that the difference between WASDE and futures method forecast errors from November to February may be related to uncertainties about South American soybean production. Soybean planting in South America typically occurs in October, with harvest beginning in March. Less accurate or timely information on these crops could contribute to forecasting errors, but again, it is unclear that this would have a greater impact on WASDE forecasts than those based on the futures method.

It should be pointed out that, regardless of the source of the WASDE forecast errors, the accuracy of WASDE forecasts made during November through March have improved significantly during the 1990's, while those of the futures method have actually worsened slightly. Compared with the 1980's (1981/82-1989/90) period, the average November-March WASDE forecast error decreased by more than 1 percentage point in the 1990's

Table A-3--Average absolute forecast error, by month of forecast (1981/82–1998/99)

Month	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
WASDE	6.35	6.01	5.65	4.31	3.49	2.96	1.98	1.31	0.91	0.71	0.94	0.89
Futures (pre)	6.85	4.84	4.62	2.89	2.16	1.90	1.46	0.99	1.35	0.92	0.83	0.62
Futures (post)	6.39	6.13	3.86	2.59	1.88	1.61	1.40	1.03	1.32	0.96	0.85	0.54

Source: Economic Research Service, USDA.

(1990/91-1998/99), whereas futures forecast errors increased by a little more than 0.1 percentage point during the same interval. This may reflect improved information, analysis, or modeling efforts by the USDA.

Summary and Conclusion

The goals of this analysis were twofold: to develop and illustrate the use of the futures method model for forecasting the season-average farm price for soybeans, and to assess and compare the historical accuracy of this method with USDA's farm price forecasts published monthly in WASDE. Our findings suggest that both the WASDE and futures method provide reasonable and generally accurate price forecasts. By the mean absolute percentage error (MAPE) criteria, the futures method slightly outperformed the WASDE projections, but a simple average of all (216) monthly forecast errors indicates that the WASDE does not overestimate the SAFP as much as the futures method forecasts. In addition, there is little to distinguish the WASDE from the futures method in terms of beginning-of-the-crop-year accuracy. The futures method is typically more accurate between November and March of the crop year, but the differences are narrowing. Finally, the MAPE of futures forecasts based on post-WASDE release futures prices are on average lower than pre-WASDE futures forecasts – indicating that information conveyed by WASDE reports improve futures method forecasts–but the difference is minor.

In conclusion, the futures method of forecasting the season-average-farm-price of agricultural commodities represents a useful tool for analysts and market participants seeking a cross-check to USDA projections. Future research on the method could examine alternative methods of estimating the basis and marketing weights, such as using a 5-year moving olympic average (omitting the high and low figures) rather than a simple moving average. Improved estimates of these variables should enhance the overall accuracy of price forecasts. Another avenue would be to examine the historical accuracy of other forecasting tools that have been used to project commodity prices, such as time series autoregressive-integrated-moving-average (ARIMA) models. Using the ARIMA method, Vroomen and Douvelis (1993) developed forecasts of soybean SAFP for crop years 1989/90 to 1991/92 with results similar to WASDE and futures method forecasts, but it is unclear whether the accuracy of this method would be sustained over the longer run.

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