On predicting the price of corn, 1963-2002

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In an economic environment in which price is determined by relative scarcity, the year ending stocks-to-use ratio for field crops like corn has often been seen as an important predictor of the season average price received by farmers. Because it reflects the net results of numerous transactions between suppliers and demanders, the stocks-to-use ratio is seen as a proxy for the Marshallian supply/demand price cross. The relationship between the season average price and the stocks-to-use ratio is held to be an inverse relationship in which as the stocks-to-use ratio falls, prices increase and vice versa. However, in the 1963-2002 period one can find years with high or relatively high stocks-to-use ratios and high prices and other years with relatively low stocks-to-use ratios and low prices.

In developing a price model one must account for the variations from what would be expected in a simple model. Why do some years with relatively large stocks-to-use ratio have high prices paid to farmers? Does weather make a difference and if so, how? Given the large amount of political capital that is expended in the debates surrounding each new farm bill, what, if any, are the impacts of various policy regimens?

The purpose of this study is to look at the part the corn stocks-to-use ratio plays in the determination of the season average price paid to farmers and at the same time identify other factors, both policy changes and discrete psychological/behavioral responses, that play a significant role in the process. The time period covered in this analysis is the 40 year period from 1963 through 2002.

Several previous models have been published that cover shorter time periods. Westcott and Hoffman's 1975-1996 corn price model, with an R^2 of 0.908, used the log of the price, the log of the total stocks-to-use ratio, the CCC stocks-to-use ratio, and the log of a policy dummy for the 1978-1985 period. They also dummied out 1986 in their corn price model for the 1975-

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1996 period (Westcott, 1999). Van Meir's first 1967-1981 corn price model, with an R^2 of 0.900, used the log of the deflated price, and the log of the year ending total stocks-to-use ratio (Van Meir, 1983). Van Meir's second model, with an R^2 of 0.915, used the log of the differential between deflated farm prices and deflated loan rate, and the commercial year ending stocks-to-use ratio.

The present study results in a model for the 1963-2002 period that explains more than 98 percent of the variation in the price of corn for the 40 year period between 1963 and 2002, excluding 1985 and 1986 when, because of the PIK program, the season average price paid to farmers was below the CCC Loan Rate.

Price determination for corn, 1963-2001

Most reduced-form, single-equation price prediction models are based on composite measures like the total, commercial or CCC year-ending stocks-to-use ratio for the United States or the natural log of these measures. In addition researchers often factor in U.S. farm policy mechanisms like loan rates (Westcott, 1999)) and macroeconomic influences like inflation to construct their models (Van Meir, 1983)). No psychological/behavioral response factors are included even though the weekly literature of commodity marketing services is replete with language like "with futures probing resistance at \$x," "steep uptrending support crosses psychological resistance at \$x," "uptrend channel," and "established support[1]."

Akerlof has documented the importance of taking psychological/behavioral factors into account in macroeconomic analysis (Akerloff, 2002). He identifies six macroeconomic phenomena for which New Classical economic theory is unable to provide adequate, consistent explanations. By using insights into human behavior provided by sociologists and psychologists,

Akerlof challenges the Procrustean application of utility maximization and provides cogent descriptions of the causes of these six macro-economic phenomena.

In developing a corn pricing model for the 1963-2002 period this study examines several behavioral factors (discrete behavioral responses to measurable and/or identifiable events) and their relevance for explaining variation in the season average U.S. corn price received by farmers. The starting point for this analysis is the year ending stocks-to-use ratio used by USDA modelers like Van Meier, and Westcott and Hoffman. The behavioral response factors that are examined in this paper include the market's response to: 1) weather events that significantly reduce crop production in the United States, 2) the shift in price expectations brought about by the expanding export markets of the 1970s followed by a significant increase in the loan rate, and 3) policy changes brought about by the adoption of the 1996 Farm Bill.

The 1985-1986 crop years were eliminated from this study. These were years when PIK certificates were an important part of the government program to protect the farmer against sub-loan prices. As a result, unlike other years in the 1963-2002 period when the government held significant CCC stocks, the season average price paid to farmers for these two years was lower than the loan rate. The policy conditions for price determination in these two years were not duplicated at any other time during the 1963-2002 period.

Preliminary examination of the raw data

A look at a scattergram (Figure 1) of the corn season average price paid to farmers plotted against the U.S. commercial corn stocks-to-use ratio for the 1965-2001 period (excluding 1985 and 1986) provides some valuable information that can be used to identify years in which the behavioral factors considered in this portion of the study may have had a significant impact on the season average price of corn. The commercial stocks-to-use ratio was used because CCC

stocks and FOR stocks are effectively isolated from the commercial marketplace until the open

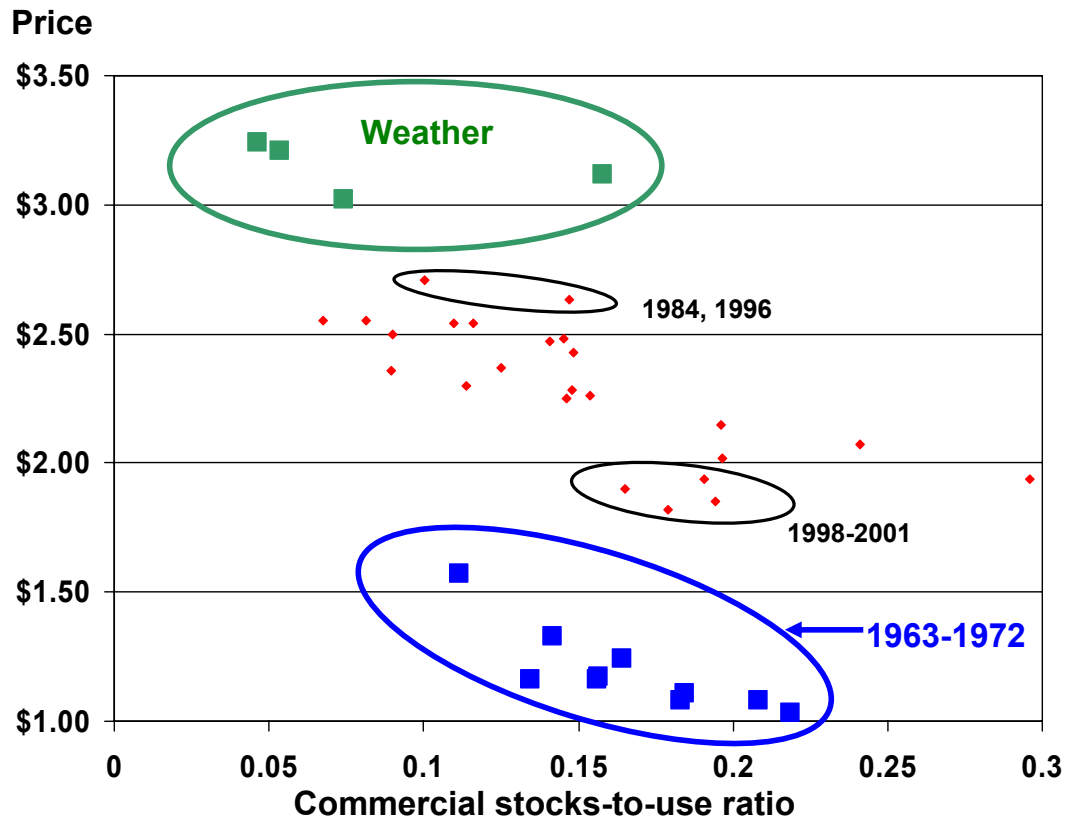market price rises above a predetermined release price.

Figure 1. Scattergram of U.S. season average corn prices paid to farmers and year ending commercial stocks-to-use ratios for the years 1963-2002. The years 1985 and 1986 have been eliminated because of unique policy provisions that were in place in those two years.

Weather

The four highest price years (1995, 1983, 1980, and 1974) are all years in which corn

yields dropped by more than 15 percent from the previous year suggesting that a psychological

response to adverse-weather-induced reductions in corn production is a potential factor in a corn

price model (Figure 1). If these four high price years were also the four low stocks-to-use ratio

years one could easily develop a model in which as the stocks-to-use ratio approaches zero the

price begins to accelerate with the curve asymptotically approaching the y-axis. This is in fact

the graphic representation that Van Meir, and Westcott and Hoffman provide in their corn price models. The problem is that 1980, with a year ending commercial stocks-to-use ratio of 0.1579, is not among the years with the lowest commercial stocks-to-use ratio. In fact for the 40 year period, 1963-2002, 24 years had a lower year ending commercial stocks-to-use ratio than 1980. At the other extreme, 1982 had the third lowest year ending commercial stocks-to-use ratio (0.0675) but its price was only seven cents higher than 1979 with a year ending commercial stocks-to-use ratio of 0.1451.[2]

While economists, eschewing a discontinuous, knife's edge solution, have accepted continuity as one of the axioms of rational choice, the data suggests that in years where both yield and production decline by more than 15 percent from the previous year and certain other conditions are met, the market adds a premium to the per bushel price of corn. The continuity assumption for rational behavior in the corn market is consistent with the first quadrant hyperbolic-like function but it is inconsistent with the data. Using a behavioral approach one is not limited by the continuity assumption and can look at discrete instances where a psychological response to identifiable events might better explain the data[3].

Faced with a corn crop that is well below the market's expectations, based on last year's harvest, one can posit a behavioral hypothesis in which buyers exhibit a willingness to pay a premium over and above the price that would be expected based on the commercial stocks-to-use ratio. A dummy variable will be used to test this hypothesis.

The fifth and sixth highest price years in the study period were 1984 and 1996, the years following the two highest price years in the last century. Given the extent of the reduced production/high price shock of 1983 and 1995, one can hypothesize a carry in the market that extends the high prices of those years into the following year.

1963-1972 period

The eight lowest price crop years are those from 1965-1972. All but the 1972 crop year are the years immediately preceding the Russian Wheat Deal. While the 1972 corn crop was not harvested until after the Russian Wheat Deal, the extent of the price impact of that event was not apparent until well into 1973 with the highest corn prices not being reached until August 1973 (Luttrell, 1973), at the end of the 1972 crop marketing year. It is apparent from Figure 1 that the season average price paid to farmers in the 1963-1972 period was lower than it was in the years that follow.

Freedom to Farm Period

In figure 1, the years 1998, 1999, 2000, and 2001 are clustered together above the data points for the 1963-1972 period. A casual look at that figure might suggest that the season average price paid to farmers for a given commercial stocks-to-use ratio during that period was lower than in the previous 25 years.

Research methodology

The methodology used in this research was to begin with the most basic model of regressing price against the commercial stocks to use ratio, using an examination of the studentized residuals to look at outliers that would identify a systematic component in the price determination model. The outliers were compared with the potential factors identified during the preliminary examination of the data. Outliers that had nothing in common with the others were not identified as being a part of the systematic component. A dummy variable was then assigned to that potential systematic component and the regression was run including the dummy variable to see if it was significant. This process was repeated three additional times. Following are the variables that were used in this study:

CNCDRPRI – the corn season average price paid to farmers[4];

CNCOMSTU – the year ending commercial stocks-to-use ratio computed by dividing the year-ending commercial stock level by total disappearance for that crop year;

CNCDPPIN – a dummy variable of 1 for the years 1963-1972, representing 0 for all other years;

CNCDPFTF – a dummy variable of 1 for the years 1998-2002 representing 0 for all other years;

CNCDPWEA – A dummy variable of 2 for 1980; 1 for the years 1974, 1983, and 1995; representing 0 for all other years; and

CNCDPWEB – a dummy variable of 1 for the years 1984, 1996, and 2002 representing 0 for all other years.

Models under test

1) $CNCDRPRI = \beta_1 + \beta_2 COCOMSTU$

2) $CNCDRPRI = \beta_1 + \beta_2 COCOMSTU + \beta_3 CNCDPPIN$

3) $CNCDRPRI = \beta_1 + \beta_2 COCOMSTU + \beta_3 CNCDPPIN + \beta_4 CNCDPFTF$

4) $CNCDRPRI = \beta_1 + \beta_2 COCOMSTU + \beta_3 CNCDPPIN + \beta_4 CNCDPFTF + \beta_5 CNCDPWEA$

5) $CNCDRPRI = \beta_1 + \beta_2 COCOMSTU + \beta_3 CNCDPPIN + \beta_4 CNCDPFTF + \beta_5 CNCDPWEA + \beta_5 CNCDPWEB$

$H_0 : \beta = 0$ vs. $H_a : \beta \neq 0$ at $\alpha = 0.001$

Table of results

Corn 1963-2002	F	R^2	RMSE	CNCOMSTU	CNCDPPIN	CNCDPFTF	CNCDPWEA	CNCDPWEB
Model 1	17.6022	0.3284	0.5354	-7.0130 (-4.2)				
Model 2	115.5075	0.8684	0.2403	-4.9766 (-6.47)	-1.0880 (-11.99)			
Model 3	111.0555	0.9074	0.2046	-4.3982 (-6.45)	-1.1732 (-14.56)	-0.3921 (-3.78)		
Model 4	308.9877	0.9740	0.1100	-3.5760 (-9.60)	-1.1065 (-25.21)	-0.3278 (-5.83)	0.4285 (9.19)	
Model 5	364.8476	0.9828	0.9100	-3.3430 (-10.67)	-1.0887 (-29.78)	-0.3568 (-7.59)	0.4526 (11.60)	0.2318 (4.03)

Examination of model 1

Model 1 tested the hypothesis that the season average price is dependent upon the year-ending stocks-to-use ratio. Model 1 resulted in an R^2 of 0.33. An overall F of 17.6 provided sufficient evidence to accept the hypothesis that the price paid to farmers is partly determined by

the commercial stocks-to-use ratio. The Durbin-Watson score of 0.4457 indicated that first order autocorrelation was a problem with this model. An examination of the studentized residuals indicated that part of the autocorrelation problem was to be found in the years 1963-1972. The residuals for these years were all negative and greater than one standard deviation away from the mean of the residuals. The ending of this period coincides with the Russian Wheat Deal in July and August of 1972 and the increasing dependence of U.S. grain trade on exports.

Examination of model 2

Model 1 was then modified to add an intercept dummy variable of 1 for the years 1963-1972, recognizing 0 for all other years. This regression resulted in an R^2 of 0.87. An overall F ratio of 115.5 along with the t-tests for the two independent variables provided sufficient evidence to accept the model[5]. The Durbin-Watson score of 1.40 indicated there was still some first order autocorrelation. The studentized residuals for the model were examined to see if the source of the autocorrelation could be identified. The residuals were all negative and between -0.93 and -1.69 standard deviation from the mean of the residuals for the period from 1998 through 2002. The 1998 crop year was the first year of the large emergency payments that were authorized by Congress. The large emergency payments continued through the 2001 crop year. Critics of the 1996 Farm Bill, also known as Freedom to Farm, blamed that legislation with its lack of a safety net and production controls for the lower prices. Supporters of the Freedom to Farm legislation attribute the low prices on the Asian Crisis and an alleged drop in world demand for corn and other grains. In either case, there is general recognition that the 1998-2002 period is distinct from the preceding years.

Examination of model 3

To correct for the potential source of the autocorrelation in model 2, a dummy variable of 1 was introduced for the years 1998-2002, recognizing 0 for all other years. The results of this regression showed that the dependence of the season average price on the commercial stocks-to-use ratio, an intercept dummy for the 1963-1972 period, and an intercept dummy for the 1998-2002 period resulted in an R^2 of 0.91. The p-value of <0.0001 for the whole model and each parameter provided sufficient evidence to reject the null hypothesis and accept the alternate hypothesis. The Durbin-Watson score of 1.90 indicates that the null hypothesis of no autocorrelation is not rejected. A regression was run using a slope dummy for the 1998-2002 period. The results did not provide sufficient evidence to prefer a slope dummy over the intercept dummy, so the intercept dummy was retained in the model.

With the decision to use an intercept dummy for the 1998-2002 period solving the autocorrelation problem, the next step was to examine the studentized residuals for model 3 to identify any possible outliers. The four years with studentized residuals in excess of 1.0 were 1974, 1980, 1983, and 1995. These are the four years identified in the examination of figure 1 as being related to significant adverse-weather-induced production drops. The studentized residual for 1980 of 3.607 corresponded to a residual of $0.72. The residuals for 1983 (studentized residual: 1.818) and 1995 (1.821) were both $0.35 and the residual for 1974 (1.279) was $0.25. Giving 1980 a dummy variable of 2 and assigning the other three years a dummy variable of 1 prevented 1980 from leveraging the other years and overestimating the psychologically induced price impact of a weather influenced short crop. All other years were assigned a dummy variable of 0. Alternately, 1980 could have been assigned a dummy variable of its own with the other

three years being assigned a separate dummy variable. It was felt that using a dummy value of 2 was preferable to, in essence, dummying out 1980 by assigning it a dummy variable of its own.

Following is a set of criteria that can distinguish the years in which a weather dummy is established. In the years prior to the adoption of the 1985 Farm Bill, the years with higher prices were those years with both a yield and a production drop of greater than 15 percent. In the period since the adoption of the 1985 Farm Bill, the high price years were those with a yield and production drop of greater than 15 percent, a carryin of less than 20 percent and a carryout of less than 10 percent. Years in this recent period with a yield and production drop of greater than 15 percent that paid no weather premium had carryin stocks in excess of 20 percent.

There are also five years (1977, 1978, 1982, 1989 and 1993) in which the studentized residuals were less than -1.0. No common set of factors could be identified that would justify establishing a dummy variable for these years. Interestingly 1993 was a short crop year, caused by excessive rain in the Midwest, in which one would expect a higher price. One reason for the lower price for 1983 may have been the fact that the total stocks-to-use ratio at the beginning of the crop year stood at 25 percent so even with a short crop there were sufficient supplies of good quality corn to meet both domestic and foreign demand. Another potential explanation for the lower price in 1993 was the poor quality of the corn crop. The spring rains delayed the planting of much of the corn that was put in the ground. A cool summer prevented both early and late planted corn from catching up to the usual pattern, and an early frost killed the corn stalks before the kernels reached the black layer stage (AgriEnergy, 1993). For much of the upper Midwest corn belt, the result was a poor quality crop with a light test weight. Farmers had to take a dock on the poor quality corn they delivered to country elevators (Hurburgh, 1993).

Examination of model 4

To account for years with a weather induced drop in production an additional dummy variable was added to model 3 using 2 for 1980, 1 for the years 1974, 1983, and 1995, recognizing 0 for all other years. The results of this regression showed that the dependence of the season average price on the commercial stocks-to-use ratio, an intercept dummy for the 1963-1972 period, an intercept dummy for the 1888-2002 period, and an intercept dummy for weather years A resulted in an R^2 of 0.97. The total model and each of the parameters were significant at the 99.9 percent confidence level. The Durbin-Watson score of 1.62 indicates the null hypothesis of no autocorrelation is not rejected.

The usual expectation of modelers is that the market responds to changes in the stocks-to-use ratio and that response accounts for the higher prices in low production years. That is precisely what happened in 1970 and 1988. The price response in 1974, 1980, 1983, and 1995, however, are greater than would be expected if the market were simply responding to a reduction in available stocks, opening up the consideration that psychological factors are at work.[6]

The next step was to examine the studentized residuals from model 4 to identify any outliers. Four years had positive studentized residuals greater than 1 (1972, 1984, 1996 and 2002). The 1972 crop year was the last year of the 1963-1972 period and the Russian Wheat Deal was completed just months before the 1972 corn crop was harvested. The market's reaction to the wheat deal was not immediate, but by the end of the crop year prices had increased dramatically. Thus it is not surprising that the season average price for the 1972 crop year was above the predicted value as 1972 served as a transition year between the 1963-1972 period and the years that followed. The remaining three years are all years with an adverse weather connection. 1984 and 1996 are years following the two highest price, years in the last century. In

the summer of 2002 there was considerable concern in the market about the size of the corn crop especially given the fact that there were no government stocks to cushion any production shortfall. Early in the summer, the Chicago Board of Trade futures prices for new crop corn were significantly above levels seen by corn farmers since 1997. If a number of farmers locked in their price on the futures market or contracted out their production before harvest that would account for an adverse-weather-induced price premium in 2002. Given the recent emphasis on marketing, that type of behavior would not be unexpected. Again no pattern can be seen in the years with negative studentized residuals in excess of 1.

Examination of model 5

To account for the weather related years 1984, 1996, and 2002 an additional dummy variable (weather B) was added to model 4 using 1 for the years 1984, 1996, and 2002, recognizing 0 for all other years. The results of this regression showed the dependence of the season average price on the commercial stocks-to-use ratio, an intercept dummy for the 1963-1972 period, an intercept dummy for the 1888-2002 period, an intercept dummy for weather years A, and an intercept dummy for weather years B. The regression resulted in an R^2 of 0.98. The p-value of the F test of <0.0001 provided sufficient evidence to reject the null hypothesis and accept the alternate hypothesis. All coefficients were significant at the 0.001 level. The Durbin-Watson score of 2.12 does not indicate an autocorrelation problem.

The estimated regression for the corn price in the 1963-2002 period is:

(5a) $p = 2.836 - 3.343$ CNCOMSTU $- 1.089$ CNCDPPIN $- 0.357$ CNCDPFTF
         (56.91)   (-10.67)   (-29.78)   (-7.59)

         $+ 0.453$ CNCDPWEA $+ 0.232$ CNCDPWEB
            (11.60)   (4.03)

$R^2 = 0.983$
F-value = 364.85

Root Mean Square Error = 0.091
Durbin-Watson statistic = 2.117
Estimation period: 1963-2002, eliminating 1985 and 1986.
t-values are in parentheses

Over 98 percent of the variation in the season average corn price for the years from 1963 to 2002, excluding 1985 and 1986, is explained by the estimated equation 5a. Each coefficient has the expected sign, with a negative sign for the commercial stocks-to-use ratio, the 1963-1972 dummy variable, and the 1998-2002 dummy variable; and a positive sign for both price premiums paid in reaction to adverse-weather-induces reduction in crop production (weather years A and B). Each coefficient is significant at the 0.1-percent level. The p-value of the F test of the whole model is less than 0.0001. The Durbin-Watson statistic of 2.117 indicates the null hypothesis of no autocorrelation is not rejected.

INTERPRETATION

Discrete shifts in pricing function

This research identified four discrete price shifters that trigger discontinuous changes in the pricing mechanism. In each case the shifts result in a change in the intercept. Two of these shifters are policy driven covering a range of years and two are year specific, relating to the market's psychological reaction to weather induced drops in production. This author would argue that the discrete shifts identified in this research are a systematic component of the price determination model and not part of the random variability. The factors represented by these dummy variables are clearly identifiable and not unexplainable or random.

1963-1972 Period

This period began with the institution of supply control measures under the Kennedy administration for the 1961 crop year and a change in the loan rate mechanism. In the prior period, the corn price was dependent on the both the year ending total stocks-to-use ratio and the

loan rate.[7] The usefulness of the loan rate as an explanatory factor ended in 1963 when the loan rate was set at $1.07, in the following year it was set at $1.10. For the rest of the 1963-1972 period the loan rate was invariant at $1.05.

Beginning with the 1963 crop year the season average corn price paid to farmers was dependent on the commercial stocks-to-use ratio. This period ended with the Russian Wheat deal in 1972 and the beginning of a period of the rapid expansion of corn exports. In 1971 corn exports were 796 million bushels. By the end of the decade corn exports stood at 2,402 million bushels, triple the 1972 level. The loan rate lagged significantly behind corn prices, but by 1977 it had been increased to $2.00. A dummy variable of 1 was used to distinguish the 1963-1972 period from the subsequent period. The coefficient of this dummy variable indicates a price jump of $1.089 between the two periods for a given commercial stocks-to-use ratio. The increase in the loan rate in effect set a new floor under corn prices and, with the exception of 1986, they never returned to their pre-1973 levels. This shift was brought about by an external change in agricultural policy. In the face of a crop shortfall, the Soviets decided to import grain rather than slaughter their livestock herd. And then, the shift was locked in by an internal U.S. agricultural policy change, the increase in the loan rate to $2.00 and above.

Post 1996 Farm Bill Period

Conventional wisdom has variously blamed overproduction by farmers, the Asian Crisis and the strong dollar for the loss of exports and lower prices. Following the logic of these arguments one would expect to see a significant increase in the stocks-to-use ratio with lower prices a function of the increased stock levels. For a given commercial stocks-to-use ratio one would expect to find the same price as in the earlier period.

This is not what one finds when one looks at the data. Instead, beginning with the 1998 crop year, the season average corn price paid to farmers is 35.7¢ per bushel less than they would have received for the same commercial stocks-to-use ratio in the previous 26 years. In the Freedom to Farm era, for the first time since 1963, there was no floor under the corn price. Given the fact that 1995 was a short-crop/high-price year, it is not surprising that it took two crop years before the full impact of the new policies came into effect. Relative to their respective stocks-to-use ratios, both 1996 and 1997 experienced successive price drops. There was no effective non-recourse loan which would guarantee a minimum price while removing excess crops from the commercial marketplace. Instead farmers were given Loan Deficiency Payments (LDPs) and allowed to keep their corn and market it at a price below the loan rate.

This author concurs with the suggestions of Ray[8] that the other factor that brought this price drop about is the lack of the threat of a set-aside in the next production year, if the price drops too low. Just the presence of the threat of a set-aside reminds the market that there is a floor on prices. The 1996 Farm Bill removed the two mechanisms that worked together to provide both an upper and a lower bound to corn prices. It is this elimination of these price stability mechanisms that brought about a worldwide drop in corn prices.

This author would argue that, contrary to the argument of many, it is not high U.S. subsidies that are responsible for the low world crop prices, rather the low prices have been brought about by the elimination of the two mechanisms that brought stability to the determination of crop prices. If this is true, the negotiating away of agricultural subsidies during the Doha Round will do little to restore prosperity to farmers in either the developed or the developing countries. On the other hand, if the top two or three countries with the largest exports of each major agricultural crop were to adopt a floor price mechanism coupled with modest

production controls, this author would expect higher prices to return to crop markets to the benefit of farmers around the world. Given the cost of these programs from 1963-1995, one would even expect that the cost would be significantly less than the current program.

Weather premium

Changes in the stocks-to-use ratio are insufficient to account for the price changes that took place in years like 1974, 1980, 1983, 1995, and 1996. The premium that was paid in those years was greater than can be accounted for by putting a curve on the ends of the price function. When the weather dummy variable that was used in this model is introduced into the Westcott and Hoffman model, it is significant at the 95 percent confidence level and in addition it raises the R^2 of their loglinear model by two points.

It certainly would make for easier modeling if price changes in low production years were to respond to some continuous variable like the stocks-to-use ratio, but that is not the situation that presents itself in the corn data from 1963-2002. Instead, it appears that pricing models may need to take into account what sociologists and historians call agency, and theologians call free will. Agency is the ability of human beings to make choices that are not solely determined by external factors.

The fact that the 45.3 cents price premium, its double and its half are stable over time is clear from examining the residuals of this model. What is not so clear, and will need input from psychologists is why the premium is not 10 cents this time 25 cents next time and 18 cents some other time. There seems to be the need for bidders in the market to provide a distinctly recognizable gap between the normal price function with its random variability and the price premium with its random variability. What is clear is that there is a distinct gap between the two.

Effect of loan rate

One of the other expectations this researcher had at the beginning of this study was that changes in loan rates would significantly affect the season average price paid to farmers. One would be led to think that given the amount of political capital that both opponents and proponents of increased loan rates expend in the legislative battles surrounding this issue. This research suggests that small changes in the loan rate have no measurable impact on the price farmers receive. Large changes like the change from $1.05 in 1973 to $2.00 in 1977 do have an impact on prices by establishing a new price floor. It would appear that both sides of the loan rate argument have misunderstood the relationship of the loan rate to the pricing mechanism as it has operated since 1963.

Conclusions

The slope of the pricing model for the season average price paid to farmers has been extremely stable over the last forty years. The shifts that have taken place have all shifted the intercept while the slope and the basic functional form have remained constant. It also shows that the basic shifts happen in response only to major trade and policy shifts and not to the yearly meddling with loan rates to the extent that loan rates do not affect the stocks-to-use ratio.

Two insights stand out. First, the market oriented reforms of the 1995 Farm Bill cost corn farmers in the U.S. and around the world 45.3¢ for every bushel they have produced since 1998. This cost continues under the 2002 Farm Bill. It is not the level of U.S. subsidies that have hurt corn farmers around the world. It is not that these subsidies have induced farmers to expand their corn production driving the stocks-to-use ratio ever upwards and prices downward. Rather it is the elimination of a price floor and the threat of production controls that have allowed purchasers of corn to reduce the amount they are willing to pay for each bushel of corn. Changes in policies and trade regulations that do not effect price floors and production management are not likely to

increase the corn prices received by farmers in the U.S., Argentina, South Africa or anywhere else in the world. The low prices of today are caused not by subsidies but rather by policy changes embodied in the 1996 Farm Bill and continued in the 2002 Farm Bill. It should be noted that the stock levels since 1998 have been such that they would most likely not have triggered very significant set-asides or large accumulations of government stocks. It is the potential use of these mechanisms that is important for the pricing model.

The second insight this model provides is to change the perception of the shape of the pricing model for corn. The basic model is rectilinear and does not asymptotically approach either axis. Policy and non-policy events affect the season average price paid to farmers through positive or negative price premium of a distinct amount.

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Endnotes

[1] The weekly newsletters like ProFarmer provides a good example of the use of this language.

[2] The other issue that has to be considered is the fact that three years (1970, 1988 and 1993) experienced yield declines of more than 15 percent and yet those years do not appear among the high corn price years. The question that needs to be answered is, are there factors in those three years which distinguish them from the four high price years. In the years prior to the adoption of the 1985 Farm Bill, 1970 is the only year in which yield dropped by more than 15 percent but total production dropped by less than that. In the years following the adoption of the 1985 Farm Bill, both 1988 and 1993 started the year with carryin commercial stocks-to-use levels in excess of 29 percent while in 1995 the commercial carryin stocks-to-use ratio was less than 17 percent.

[3] Knife edge situations can be understood in terms of the old proverb about "the straw that broke the camel's back." In geologic terms one can understand knife edge situations by examining Periodic Spring in Wyoming's Bridger-Teton National Forest. Periodic Spring is an intermittent spring that is fed by a pool connected to a natural siphon. The spring only flows after the reservoir is filled to the point that the siphon is triggered emptying the reservoir. Periodic Spring is then dry until the reservoir fills again, starting the process all over.

[4] Data on price and stocks-to-use ratio were obtained from USDA-ERS.

[5] Model 2 was run again using a slope dummy. Both models provided sufficient evidence to reject the null hypothesis. When the PRESS test was run, the score for the model using the intercept dummy was 2.386, and the score for the model using the slope dummy was 3.023. When two regressions with the same number of variables have similar results, the model with the lower PRESS score is to be preferred. The model using the intercept dummy is to be preferred over the one using the slope dummy.

[6] A psychological response is exactly what one would expect from reading the weekly reports of analytical crop advisory marketing services that talk about uptrending lines breaking resistance at $X.xx and running up to the next resistance level $Y.yy. In 1974, 1983, and 1995, the psychological resistance was broken, with farmers receiving a premium above what would be expected from a simple supply/demand function. In 1980 the price also broke resistance at $Y.yy and ran up to the next resistance at $Z.zz.

[7] Harwood Schaffer, unpublished research.

[8] Personal communication with Darryl E. Ray, Director of the Agricultural Policy Analysis Center at the University of Tennessee.