The Widening Corn Basis in South Dakota: Factors Affecting and the Impact of the Loan Deficiency Payment

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The Federal Agricultural Improvement and Reform (FAIR) Act of 1996 introduced an alternate price support program to the nonrecourse commodity loan program, the loan deficiency payment (LDP). Under Title I: The Agricultural Market Transition Act (AMTA), eligible producers may choose to receive an LDP payment rather than obtain a loan from the Commodity Credit Corporation (CCC). Although there was a similar target price deficiency payment program set up under the Agricultural Act of 1973, the current LDP did not play a role in farmer's marketing plans until 1998 when market prices dropped below loan rates. The introduction of the direct payment LDP was an attempt to decouple government payments from market prices and move toward a free market commodity pricing system with limited government involvement. The focus of this study was to examine whether the introduction of the LDP has had an impact on local basis, as well as what other factors may be impacting the local basis in South Dakota.

Basis is the difference between local cash price and the futures contract price. Local basis is determined by such factors as transportation costs, local supply and demand conditions, and local storage availability. Because South Dakota (SD) is located far from terminal commodity markets, the basis is wider here (i.e., the difference between cash and futures price is larger) than in states closer to terminal markets.

Because the basis is so wide in SD, good marketing strategies become very important to a producer's profitability. Efficient grain markets provide a profit to individuals who are willing

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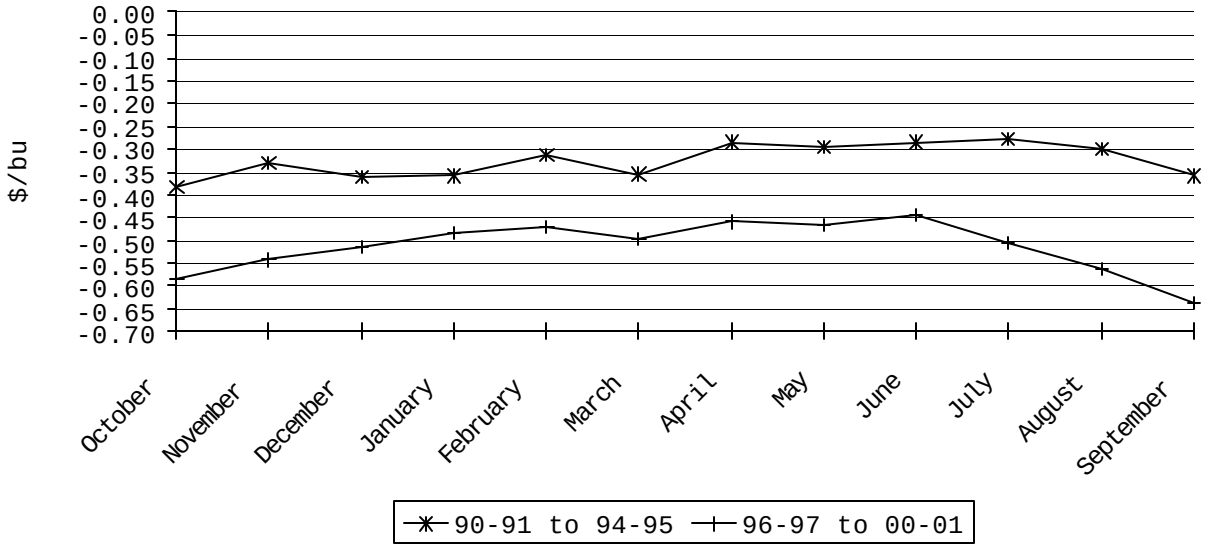
to store corn during times of excess supply and implement a storage hedge marketing strategy. Predicting future basis is less risky than predicting future cash price and correct basis estimates are important to hedge successfully.

In additional to the historically wide basis in South Dakota, recent data shows the local corn basis is approximately twelve to twenty-eight cents wider on average after the 1996 FAIR Act than before. The widening of the SD corn basis is depicted in Figure 1.

Figure 1 South Dakota Corn Basis: Marketing Year Five Year Average, Excluding The 95-96 Marketing Year



If local corn basis in SD is affected by LDPs, this would require a change in marketing strategies for producers. Under previous loan programs, producers would put their grain under loan when the market price was below the loan rate. The producer received cash from the loan to cover immediate cash flow needs. If the market price increased the producer would pay back the loan and sell the grain on the market. However, if the market price stayed below the loan rate, the producer would forfeit the grain to the government as payment of the loan. This insured that farmers received the loan rate as a floor price and still had the opportunity to benefit from

market price increases. The government became a grain dealer under this strategy.

In an attempt to limit the amount of grain forfeited to the government, the LDP was adopted in the 1996 FAIR Act. With the LDP there is still a market floor price at the loan rate, but now the producer doesn't have to put the grain under loan in order to receive a cash payment. This resulted in a reduction in the amount of grain handling the government was involved in and producers began to store more of their own grain. The producer receives a cash payment to meet immediate cash flow needs while still retaining ownership and control of the grain to market when conditions are perceived to be optimal.

Many producers use local basis estimates in their marketing strategies. For example, a successful storage hedge would result from the correct prediction of local basis movement toward maturity of the futures contract.

Under FAIR, producers based their decisions to plant on what program commodity has the best loan rate and will provide the largest marketing loan gain or LDP, not on harvest time market price signals. The LDP may also have an impact on the timing of producers' marketings, which could have a further impact on basis.

Producers and extension economists feel that LDPs may be affecting local corn basis and don't feel comfortable developing marketing plans using historical basis information that may not accurately reflect current conditions. Despite this, there has been very little research investigating the widening of the SD corn basis.

Overview of Factors Affecting Basis

Keynes' theory of normal backwardation or the risk premium theory argues that basis consists of a risk premium paid by producer hedgers to speculators to accept the risk of an adverse price change. Keynes believed hedgers participated in the market only as a means of

shifting risk. This theory has been debated and most studies have been inconclusive. Naik and Leuthold found that corn basis often includes a risk premium, a speculative component, and an expected maturity basis which could be predicted two or three months before maturity of the contract.

Working's theory of price of storage looked at differences between cash and futures prices (basis) and differences in price of futures contracts of different maturity months. It was thought that the differences in price were due wholly to production expectations, but Working's theory added the price of storage to the relationship. He argued that the efficient market provided a profit (the "price of storage") to producers who were willing to hedge the grain and store it during times of adequate supply and this was the reason producers participated in the futures market. During times of tight supply, the "price of storage" was negative and although storage occurred during these times, the decision to store was not based on futures price relationships.

Benirschka and Binkley took the theory of the price of storage further by examining the amount of storage provided (grain storage capacity) at varying distances from terminal markets and adding a study of transportation costs. Transportation costs lead to lower prices in markets further from terminal markets. If the market is efficient, regions further away (such as SD) will provide longer-term storage and thus grain storage capacity increases with distance from terminal markets.

During their discussion on the cash-futures price relationships, Karlson, Anderson, and Dahl point out the effect of storage availability on basis. Upward pressure on storage occurs during times of high supply. This causes the cost of storage to increase. Because the cost of

storage is a part of local basis, this will cause a widening of the basis, indicating a favorable return to storage.

Martin, Groenewegen, and Pidgeon brought into the discussion the impact of local market conditions on basis, such as production (demand for storage), local demand in respect to amount of production, and availability of transportation to export markets. Most of these factors are seasonal as production exceeds local demand during harvest time and demand for storage is higher at that time.

Another useful study on forecasting basis is Dhuyvetter and Kastens. They found that the risk of forecasting basis during critical production time periods is high. They also found that complex models forecast basis more accurately than naïve models, but noted that producers would have problems predicting basis with a complex model that requires more information and difficult computations.

Parcell did an analysis of the possible impact of loan deficiency payments (LDP) on corn and soybean basis in Missouri. He pointed out that the LDP would only have an effect on basis if it caused producers to stray from "normal" marketing patterns. He found the LDP program did have an affect on basis, but at most it accounted for a $0.023/bushel weaker corn basis. The largest impact on corn basis was observed during harvest time and decreased as the marketing year progressed.

Research Design

For this analysis, the area of study is South Dakota. Eastern SD has accounted for approximately 95.8% of production on average over the past 11 years (see Table 1). The South East (SE) region accounts for the largest percentage of corn production in the state on average with 29.8% of the state's corn production. The East Central (EC) region is next with an average

of 28.1%. These two regions account for over 50% of corn production in SD, followed by the North East region (NE) at 14.5%, the North Central region (NC) with 12.1%, and finally the Central region (C) with 11.3% of corn production on average. All other regions in SD account for the remaining 4.2%, therefore, the focus of the study will be on eastern SD.

Table 1: Eastern South Dakota Regions, % of Corn Production October 1990 to September 2001

Marketing Year	SE	C	EC	NC	NE	Eastern SD
1990	28.4	10.2	31.3	10.3	16.2	96.4
1991	24.7	9.7	32.8	11.7	18.3	97.2
1992	35.4	9.6	31.8	8.1	11.8	96.7
1993	36.0	15.0	22.0	12.5	9.1	94.6
1994	31.5	10.6	30.2	10.7	13.3	96.3
1995	27.9	9.7	27.9	13.3	18.8	97.6
1996	34.0	11.0	27.0	10.1	13.0	95.1
1997	27.5	14.1	25.1	12.4	14.4	93.5
1998	29.6	11.5	27.0	12.6	13.7	94.4
1999	27.0	12.3	26.0	14.0	15.8	95.1
2000	25.8	10.3	28.1	17.1	15.6	96.9
Ave.	29.8	11.3	28.1	12.1	14.5	95.8

Source: South Dakota Agricultural Statistics Service

The general objective of this research is to examine local basis before and after the implementation of the loan deficiency payment to determine if there is an effect on local basis. This will be accomplished through the construction of a basis model, regression of the model, and analysis of the results. Based upon the literature review, some of the factors thought to have an impact on the widening of local basis include but are not limited to:

Basis = f(futures price, local corn usage, transportation cost, local storage availability, yearly local corn production, LDP, seasonality)

An ordinary least squares (OLS) model was estimated using monthly data from the corn-marketing year beginning October 1990 and ending September 2001. The following is a brief description of relevant data collected for the OLS regression model analysis.

Weekly regional South Dakota cash corn prices and Chicago nearby futures price from October 1990 to September 2001 have been collected by Alan May, Extension Grain Marketing Specialist at South Dakota State University Economics Department. The cash price data series is based on an average of regional local elevator prices as reported on the DTN on Thursday of every week. Because of limited data on western SD corn prices and because eastern South Dakota accounts for 95.8% of corn grain production, the data was then averaged to a monthly price and weighted by regional production to create an Eastern South Dakota price which is used as a representative price for the whole state of South Dakota.

Local corn basis is rarely positive in South Dakota. However, local cash prices soared to $4.54 in May of 1996. This caused abnormal basis during that time period so four observations were removed from the basis calculations.

The loan deficiency payment is included in the model as a dummy variable of one as an indication of when the LDP was available and a value of zero otherwise. This variable was assigned a one for observations when the loan rate was above the local cash price, indicating that there would have been an LDP available the majority of the month.

South Dakota corn usage is not measured by any statistical agency so it was estimated based on the two primary uses for corn in SD: livestock feed and ethanol processing. Cattle on feed and hog inventory numbers were collected from the South Dakota Agricultural Statistics Service in Sioux Falls, SD and ethanol corn usage was estimated based upon information on the South Dakota Corn Growers Association and Broin and Associates, Inc. internet sites.

Storage availability was calculated using yearly South Dakota storage capacity numbers and quarterly corn, soybean, wheat, and oat stock numbers, also from SD Agricultural Statistics Service. Other grain stocks accounted for a very small portion of grain stocks and were not reported consistently and therefore were not included as part of the storage availability calculation. The quarterly data was then interpolated into monthly data.

The Producer Price Index for Intermediate Energy Goods, obtained from the United States Department of Labor, Bureau of Labor Statistics, was used as a proxy for transportation costs. This index includes the price of gasoline and diesel fuel.

Annual corn production was obtained from the SD Agricultural Statistics Service and was included in the data set as corn production in millions of bushels. This variable remains constant at the current year's production for the marketing year October through September.

A quarterly seasonality dummy variable was included to represent the changes that occur during the corn-marketing year. The harvest quarter, or October, November, and December, is the default. Quarter 1 is the quarter immediately following harvest, which includes January, February, and March.

Model and Data

An ordinary least squares regression model was used to estimate the effects of these factors on basis. The functional form used to estimate the affect on basis was the double-log model. This functional form provided the best-fit basis and represents the fact that the relationships between these variables are not strictly linear.

The model was estimated using monthly data from October 1990 to September 2001. Four outlier observations were removed (June 96 through September 96) during the 1995-1996 marketing year because of the large deviation from the price pattern. The following is the basis

model used in the analysis for this study:

$$\ln(B) = a + ß_1 \ln(FP) + ß_2 \ln(USE) + ß_3 \ln(TRAN) + ß_4 \ln(SA) + ß_5 \ln(PROD) + ß_6 (LDP) + ß_7 (Q1) + ß_8 (Q2) + ß_9 (Q3)$$

Variable definitions are summarized in Table 2, which also includes the means and standard deviations of the unlogged variables. The variable B is the dependent variable and is equal to the average basis during that month. Because basis is normally negative in South Dakota and a negative number cannot be logged, the basis numbers were changed to positive to allow for logging. Conceptually this changes the sign of all of the coefficients, but does not change the value of the estimates.

Table 2: Summary of variable definitions

Variable name	Definition	Mean	Standard Deviation
B	South Dakota corn basis	-0.42	0.12
FP	Futures price	2.48	0.46
USE	South Dakota corn usage estimate (million bushels)	7.59	0.95
PROD	South Dakota yearly corn production (million bushels)	311.50	87.60
TRAN	Producer Price Index for Intermediate Energy Goods, Seasonally Adjusted		
LDP	Loan deficiency payment dummy variable = 1 when LDP present, 0 otherwise		
Q1	Quarter 1 dummy variable = 1 in the months January through March		
Q2	Quarter 2 dummy variable = 1 in the months April through June		
Q3	Quarter 3 dummy variable = 1 in the months July through September		

Expected relationships. Variable FP is the nearby futures price as reported for the Chicago Board of Trade on the DTN. All other variables held constant, we would expect a negative relationship between B and FP. An increase in FP will cause the basis to widen (become more negative) if cash price does not change. As the cost of business increases (FP increases), businesses will charge a higher percent margin, i.e., basis will widen. In the model, this would mean that the coefficient would be positive because of the inverse sign on basis.

Local demand for corn is included in the model with the variable USE, which is an estimate of local corn use. With all other variables held constant, we would expect an increase in local demand to cause the basis to strengthen (narrow). This is a positive relationship, which would be displayed as a negative coefficient in the results.

Local transportation costs are estimated using the seasonally adjusted Producer Price Index for Intermediate Energy Goods. An increase in transportation costs would be expected to widen basis, therefore a positive coefficient is expected.

The variable SA is the storage availability estimate, which is included as an indicator of local storage costs. As storage becomes more available, all other variables unchanged, we would expect the basis to narrow as the market attempts to bring grain out of storage and into market channels. This is a positive relationship and we would expect a negative coefficient in the results.

Local supply of grain is included in the model with the variable PROD, which is the yearly SD production estimate obtained from the SD Agricultural Statistics Service. All other variables unchanged, we would expect basis to widen if supply (production) increases. The coefficient is expected to be positive.

The loan deficiency payment dummy variable is LDP. Local cash price and the loan rate were used to determine if there was an LDP for the majority of the month. If the loan rate was above the local cash price level a value of 1 is included for that month to represent the presence of an LDP. A value of 0 is included otherwise. It is hypothesized that the LDP will cause basis to widen, so we expect to find a positive sign on the coefficient, $ß_{6.}$

The quarterly dummies included are Q1 (January, February, March), Q2 (April, May, June), and Q3 (July, August, September). The harvest quarter (October, November, December) is the default. The dummy variable is defined as 1 during the months of that quarter and zero otherwise. During the harvest quarter, the basis is typically widest. It is expected that during all other quarters the basis will be narrower so the coefficients should be negative.

Results

The estimated logarithmic regression equation for corn basis using ordinary least squares regression in SAS is:

$$\ln(B) = 4.2000 + \underset{(3.28)}{0.3972}\ln(FP) - \underset{(4.58)}{0.7350}\ln(USE)$$

$$- \underset{(1.36)}{0.2283}\ln(TRAN) + \underset{(0.93)}{0.0853}\ln(SA)$$

$$+ \underset{(4.25)}{0.3132}\ln(PROD) + \underset{(7.07)}{0.3206}\,LDP$$

$$- \underset{(1.19)}{0.0493}\,Q1 - \underset{(4.24)}{0.2155}\,Q2 - \underset{(2.70)}{0.1431}\,Q3$$

The numbers shown in parenthesis under each coefficient are t-statistics. Variable definitions are summarized in Table 2 and the results of the model testing are summarized in Table 3. The model is significant with an F-value of 40.80.

The measure of "goodness of fit" is R^2. An R^2 of 1.0 would indicate that the model

explains 100% of the variation in the dependent variable. The R^2 for this model is 0.7568. This means approximately 76% of the variation in basis is explained by the independent variables included in the model. However, this also indicates that there may be other factors affecting the local corn basis that are unaccounted for in this model. Included in these factors may be qualitative factors such as weather and individual producer decisions to store and sell. All coefficients except TRAN and SA are significant and have the expected sign. The futures price is positive, the local use variable is negative, the local production variable is positive, the LDP was expected to be positive and it is, and the quarterly dummy variables are negative as expected.

Table 3 Summary of regression results

Variable	Parameter Estimate	t-statistic	VIF
Intercept	4.2000	1.94	0
LN (FP)	0.3972	3.28****	2.3560
LN (USE)	-0.7350	-4.58****	2.5102
LN (TRAN)	-0.2283	-1.36	1.3165
LN (SA)	0.0853	0.93	3.4132
LN (PROD)	0.3132	4.25****	3.1155
LDP	0.3206	7.07****	2.5014
Q1	-0.0493	-1.19	1.9720
Q2	-0.2155	-4.24****	2.9124
Q3	-0.1431	-2.70****	3.0440

**** significant at 0.99

Observations = 128, R^2 = 0.7568, F-value = 40.80

Transportation has a negative coefficient and storage availability is positive. It was expected that these two variables would have the opposite sign. However, these two factors are

not significant with t-statistic values of 1.36 for transportation and 0.93 for storage availability. Any t-statistic lower than a 1.65 is considered insignificant at the 0.90 level and the coefficients, therefore, are not statistically different than zero. For this reason, the unexpected sign of transportation and storage availability will be noted, but regarded as insignificant factors affecting basis in this model.

All other variables were significant except Q1. This was unexpected, but the quarterly dummy variables are not critical to the analysis.

The variance inflation factors (VIF) were estimated to check for collinearity, which if present will cause the regression coefficients to no longer be reliable indicators of the change in the dependent variable (B). A VIF of 10 or higher would be considered a problem. As can be seen in Table 3, all variables, VIFs are well below 10, indicating no obvious problem with collinearity.

Of particular interest in Table 3 is the significance of the LDP variable with a t-statistic of 7.07. This clearly shows that the LDP is having an impact on local corn basis. Other significant factors impacting local corn basis are local yearly production with a t-statistic of 4.25 and local usage with a t-statistic of 4.58. Futures price also has a significant impact with a t-statistic of 3.28, as would be expected because basis is directly determined by the difference between local cash price and futures price. Since a double-log model was estimated, these coefficients are elasticity measures. This means that the coefficient is a measure of the relative responsiveness of basis to a change in that other factor.

To illustrate the basis model, in September the average basis of 96-97 to 00-01 was -64 cents and the average futures price was $2.21. A $ß_1$ value of 0.3972 implies that, holding all other variables in the model constant, a 10% increase in FP would cause the basis to widen by

3.972% or 2.54 cents. If FP increases by 10% to $2.43, basis will widen by approximately three cents (2.54 cents) to –67 cents. Basis would not change the full 23 cents that futures price changes because cash price is not included in the model and would move as futures price moves.

A 10% increase in local corn usage will narrow the basis by 7.350%. For example, in September of 2000, average usage was 5,735,000 bushels and basis was –64 cents. Holding all other variables in the model constant and increasing usage 10% to 6,308,500 (or, for instance, feeding 12,536 more head of cattle a year) will cause the basis to narrow by 4.7 cents to –59 cents according to the model.

An increase of 10% in local production will widen the basis by 3.132%. For example in September 2000, production is 367,250,000 bushels and basis is –64 cents. Increasing production by 10% to 403,975,000 bushels would cause basis to widen by 2.00 cents from –64 cents to –66 cents, all else held constant.

The estimated $ß_6$ coefficient of 0.3206 shows that the presence of the LDP causes basis to widen by 32.06%. For example, the September 2000 basis of –64 cents is 28 cents wider than the average September basis in the 1990-1991 to 1994-1995 marketing year period of –36 cents (See Figure 1). According to this basis model, the presence of the LDP was represented by a local cash price below the loan rate, and can account for approximately 9.0 cents of the widening.

All three quarter dummy variables are expected to have negative coefficients. As described earlier, the harvest quarter should be the widest due to the increased supply during this time. According to the model, Q2 (April, May, June) will be 21.5% narrower than the average harvest basis and Q3 (July, August, September) will be 14.3% narrower. Using Figure 1 as an example again, average basis in the harvest quarter for the years 90-91 to 94-95 is –36 cents. In

Q2 we would expect basis to narrow by 8 cents (-36 x 21.5%) to –28 cents. The average basis in Q2 is actually –29 cents. In Q3, basis should narrow by 5 cents (-36 x 14.3%) to –31 cents and the actual average basis is indeed –31 cents. Although the coefficient on Q1 is insignificant, the equivalent illustration holds true.

Summary

Results of the OLS model estimation show that the futures price, local supply and demand, the LDP, and seasonality have a significant effect on local corn basis, all with the expected signs.

This research shows that the LDP does have an effect on basis. It is estimated that the presence of an LDP will have the impact of widening the basis by approximately 32%, all else equal. Producers should take this into account when developing marketing plans if the marketing situation changes and there is no longer an LDP available. In the absence of LDPs, according to the results of this study, the basis would narrow considerably from the five-year average.

This study also discovered that increasing usage by 10% results in a 7.3% narrowing of the local corn basis, which is useful information for proponents of keeping livestock in South Dakota and feeding South Dakota corn to these animals.

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