NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

Forecasting the Storage-Season Wisconsin Basis for Corn

by

Nicholas Powers and Aaron Johnson, Jr.

Suggested citation format:

Powers, N., and A. Johnson, Jr. 1983. "Forecasting the Storage-Season Wisconsin Basis for Corn." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Des Moines, IA. [http://www.farmdoc.uiuc.edu/nccc134].

FORECASTING THE STORAGE-SEASON WISCONSIN BASIS FOR CORN

by

Nicholas Powers and Aaron Johnson, Jr.*

In January of 1978, the Agricultural Marketing Service began reporting cash grain prices for each of the crop reporting districts in Wisconsin. For the first time farmers, grain merchants, extension economists, and researchers had available a reliable set of cash prices for the emerging Wisconsin cash grain industry. It was, of course, too early to begin any kind of analysis--a historical price series had to be accumulated. About two years ago, after four years of cash prices were available, we began some preliminary analyses to see if the expected basis patterns were emerging.

---

* The authors are, respectively, a research assistant and a professor in the Department of Agricultural Economics, University of Wisconsin-Madison.

Research reported herein was supported by Hatch Project #2671, Experiment Station, University of Wisconsin-Madison.

Following this preliminary work, which indicated that indeed the patterns were there, we began estimating regression equations with the two-fold objective of determining what factors were responsible for explaining Wisconsin basis changes over the storage season and determining whether we could develop a simple equation for basis forecasting that could easily be used by Wisconsin farmers, merchants, and extension personnel. The results of this preliminary work are presented in this paper. The statistical results must be interpreted with a great deal of caution, as the lack of adequate data forced us to take a number of shortcuts. (This work will be updated as more price data become available.) Nevertheless, we feel that the preliminary results are of some value and interest.

A monthly basis model is specified to explain the effect of spatial, temporal, and local market conditions on the Wisconsin basis during the storage season. For this study, the basis is defined as the difference between the Wisconsin South Central crop reporting district (SCD) cash corn price and the Chicago Board of Trade (CBT) July corn futures price. The SCD was selected to represent Wisconsin because the SCD is a surplus producing market, a relatively high portion of Wisconsin is produced in the SCD, and the vast majority of Wisconsin corn sold-for-cash originates from the SCD. Probably the single most important reason for selecting the SCD is that it is a highly developed market in Wisconsin; hence, prices in the SCD may provide the "best" indication available of the "true" Wisconsin basis.

Simple Theory of the Basis

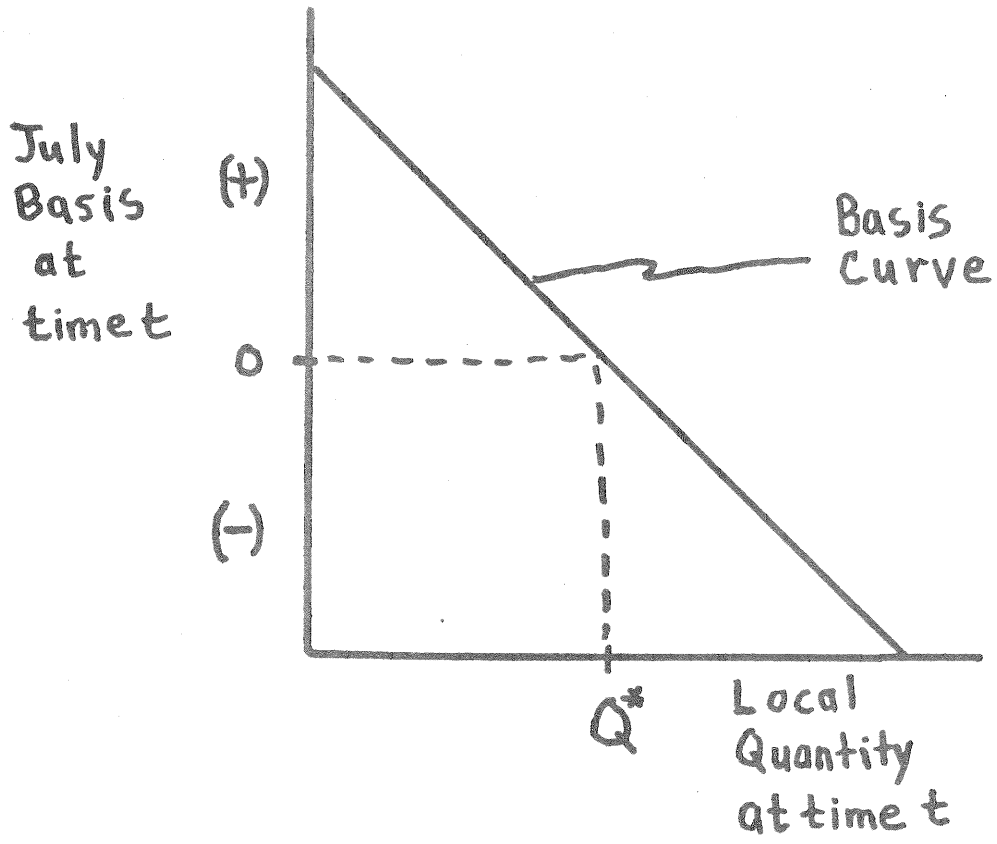
To avoid confusion, a preliminary remark is useful. When analyzing price relationships between any two markets, the researcher must decide if conditions in one market influence price in the other market without itself being influenced by the first market. In the present case, we use the (CBT) July corn futures price to represent the national market and the SCD cash corn price to represent the Wisconsin market. Given this representation, we assume that changes in national market conditions will affect the SCD cash price but that changes in the SCD market conditions, being of relatively minor importance in the national market, will have no effect on the CBT July futures price. Changes in the SCD market conditions are, of course, assumed to affect the SCD cash price.

In a competitive market system four main economic factors explain the difference between prices in two separate markets: 1) differences in product form, 2) spatial price relationships, 3) local market conditions, and 4) temporal factors. The SCD cash price and the CBT July corn futures price are for No. 2 quality corn. Consequently, product form difference is not an issue in this analysis.

Spatial price relationships pertain to the cost involved in transporting corn between two markets. If the national market and local market conditions are in "some" sense identical then the July basis will equal zero. If the local market is in either a surplus or a deficit position relative to national market conditions, then the local basis will equal the cost incurred in transporting the corn between the two

markets--in the case of a surplus, the local price will be under the July futures. In a competitive market, an increase in the local surplus means that the local price will decrease relative to the national price, that is, the local July basis will weaken. Since the SCD is strictly a surplus market, the July basis is expected to be the weakest when the SCD surplus is the greatest and to strengthen as the SCD surplus is reduced.

Temporal factors are the cost of storage per month and the storage cost for the entire period. Under competitive conditions in a surplus local market, the basis will be such as to encourage storers to carry stocks over time. The following diagram may be useful in providing an understanding of the basis phenomena.



The above diagram shows the relationship between the local market quantity to the July basis at time t, where t is a point in time during the storage season. Assume that the spatial factor and storage cost equal zero; the basis curve then indicates that if the local supply is Q* then the July basis equals zero. Any quantity to the left of Q* indicates that the local price is above the July futures price, therefore, the local market is in a deficit position. By a similar line of reasoning, any quantity to the right of Q* indicates the local market is in a surplus.

An increase in transportation costs constitutes an inward shift in the basis curve - the basis is weaker at each corresponding local quantity level. Likewise, an increase in the cost of storage constitutes an inward shift of the basis curve - the basis weakens at each quantity level.

A Discussion of Relevant Economic Variables

Using the preceding discussion as a guide, the July basis is expressed as a function of the following variables:

1. Transportation Cost--Movement of corn from the SCD to Chicago is solely by truck. Unfortunately, data on transportation costs for corn from the SCD to Chicago were unavailable. Consequently, on the not unreasonable assumption that transportation costs in general were increasing during the period of interest to this study due to rising fuel prices, insurance fees, and maintenance costs, a trend variable was used as a proxy for transportation costs.

2. Cost of Storage Per Month--Cost of storage per month includes the cost of placing and removing the corn from storage facilities, managerial fees, depreciation of storage facilities, and corn deterioration. As in the case of transportation costs, virtually no data exist on Wisconsin cost of storage; the data that do exist indicate that the cost of storage per month varies greatly across corn holders because of a diversity in storage facilities and of managerial practices. However, it was felt that the cost of storage per month, like transportation costs, was increasing during the period of interest because of rising material and labor cost directly related to storage activities. Thus, the trend variable introduced above plays the double, and therefore ambiguous, role of picking up the effects of trends in both storage and transportation costs.

3. Storage Cost - Storage cost equals the cost of storage per month multiplied by the length of the storage period. Changes in storage cost can result from either a change in the cost of storage per month or a change in the length of the storage period. Suppose the cost of storage is fixed, then the storage cost becomes smaller as we approach the end of the storage period; in fact, the cost of storage equals the storage cost in the last month of the storage period. Now suppose we are at time t during a storage period: if the cost of storage changes then the storage cost also changes--the magnitude of the change in storage cost depends on the size of the change in the cost of storage and how near to the end of the storage we are positioned, the further from the end of the storage

period the greater will be the influence of a change in the cost of storage on storage cost.

A component of storage cost, not mentioned in the discussion of cost of storage, is the opportunity cost of holding corn, measured as the current cash price multiplied by the appropriate interest rate. To avoid the problem of having to make a cash price forecast in an ex ante basis forecast, we decided to simply use the interest rate as a proxy variable to measure the opportunity cost of holding corn. This study uses interest rates adjusted to account for the length of the storage season as an attempt to measure the influence of changes in the cost of storage and in the length of the storage period.

4. Local Old-Crop Market Conditions--Local market old-crop conditions are defined as the availability of and demand for local corn from the preceding harvest. A large local supply relative to demand indicates that the local market is experiencing a surplus; thus, the July basis is weak. As the local supply decreases during the storage period the July basis strengthens.

No data are available to directly measure the SCD demand for corn; however, by using stocks data and by making an assumption regarding local demand, we have indirectly measured local market conditions. SCD stock levels are reported quarterly by the Wisconsin Department of Agriculture, Trade and Consumer Protection. Based on a constant daily decumulation rate between these reports, mid-month stock levels were derived. We use these mid-month stock levels as a proxy for local market conditions and

assume that local demand remained constant over the time period of the study, this assumption being based on the observation that livestock numbers in the SCD have remained relatively constant.

5. Local Storage Capacity--Local storage capacity for corn measures the availability of storage and is, therefore, a measure of the local market to adequately store various quantities of local corn supplies. If the local market has adequate storage capacity then additional storage demand will have no effect on the July basis. However, if the local market has a shortage of storage, then under competitive conditions, the local cost of storage will increase. In this case, in line with the discussion above, the increase in the cost of storage is manifested by a weakening of the basis--the local cash price decreases relative to the futures.

Off-farm storage capacity data for SCD were obtained from published reports; estimates of on-farm storage were provided by personnel of the Wisconsin Department of Agriculture, Trade and Consumer Protection. Preliminary econometric modeling using the combined off-farm and estimated on-farm storage indicated possible measurement errors in the on-farm data. Thus, the on-farm data were eliminated from the data set, and the off-farm data were used to indicate the relative magnitude and the changes in the size of the local storage industry.

6. New-Crop Expectations--The new local crop is defined as the expected production of the crop that is planted or intented for planting but not yet harvested. Expectations regarding the size of the new local

corn crop may affect the July basis in the following way: a decrease in the size of the expected new local crop may indicate a possible local shortage for the following market year, so the local price would increase as the market attempts to restrict current local consumption to ensure that a greater local supply is available for the following market year.

Estimates of corn planting intentions are released in January and April. Estimates of the size of the new crop become available beginning in July. These estimates were used as a measure of expected corn production for the SCD.

7. Rate of Local Harvest-- The rate at which the local harvest is proceeding may provide an indication of the supply and demand situation of local market services. If the local harvest is progressing at a "high rate" then a relatively large amount of corn is being dried, stored, and transported; if the harvest proceeds "too fast" then the drying, storage, and transportation facilities will operate additional hours at higher costs in order to accommodate the increased demand for market services. In this case, the July basis weakens, signaling a strain on the system. Data on mid-month percent of harvest completed were obtained from the Wisconsin Department of Agriculture, Trade and Consumer Protection.

Functional Form and Variable Specification

Economic theory provides little guidance in functional form selection and, in the present case, graphic analysis revealed little. Consequently, we used a linear and additive model estimated by ordinary least squares.

Based on the discussion above, the following model was used to analyze the variables affecting the Wisconsin basis.

$$JB_{i,t} = f(MTRD_{i,t}; \frac{EPROD_{i,t}}{OFSC_{i,t}}; \frac{STB_{i,t}}{OFSC_{i,t}}; \frac{AHC_{i,t}}{OFSC_{i,t}}; \frac{AHC_{i,t}}{OFSC_{i,t}}; INTRAT_{i,t})$$

where

i = subscript for month: Oct=1, Nov=2,...,Jul=10.

t = subscript for storage year; i.e., 1977/78-1980/81, where storage year is the October-July period.

$JB_{i,t}$ = the monthly average SCD basis, defined as the SCD Cash price minus the CBT July corn futures price. Prices were calculated as average of second and third mid-week prices or of second and fourth mid-week prices if the month had five mid-week prices (cents per bushel).

$MTRD_{i,t}$ = monthly trend variable: Jan 1978=1,...,Dec 1980=48.

$INTRAT_{i,t}$ = interest cost for carrying corn from time i until July. Monthly average bankers acceptances in New York City (%/year) were used to make the necessary computations.

$\frac{EPROD_{i,t}}{OFSC_{i,t}}$ = SCD expected corn production in month i expressed as a percent of SCD off-farm storage capacity.

$\frac{AHC_{i,t}}{OFSC_{i,t}}$ = SCD corn harvested in month i expressed as a percent of SCD off-farm storage capacity.

$\frac{STA_{i,t}}{OFSC_{i,t}}$ = SCD corn stocks in month i (assumes expected corn production at beginning of harvest as part of stocks) expressed as a percent of off-farm storage capacity.

$\frac{STB_{i,t}}{OFSC_{i,t}}$ = SCD corn stocks in month i (assumes expected corn production becomes a part of stocks when harvested) expressed as a percent of off-farm storage capacity.

This model expresses the local supply variables in terms of availability of storage space; this is analogous to expressing demand on a per capita basis to account for shifts in demand caused by changes in population. Thus, this model specification accounts for shifts in the basis caused by changes in local storage availability. Table 1, equation #1, reports the estimated regression for the preceding model; the estimated coefficient for (AHC/OFSC) has the wrong sign and only two of the five estimated coefficients have large t - ratios.

The variable (STA/OFSC) was substituted in place of (STB/OFSC) and (AHC/OFSC) and the July basis model was re-estimated. The variable

TABLE #1: REGRESSION RESULTS OF JULY BASIS

Regression Number and Time Period	n	S.E.	R^2	D.W.	EXPLANATORY VARIABLES							
					Inter-cept	Inter-cept Shift 79/80	Inter-cept Shift 80/81	MTRD	$(\frac{EPROD}{OFSC})$	$(\frac{STA}{OFSC})$	$(\frac{STB}{OFSC})$	$(\frac{AHC}{OFSC})$	INT-RAT
#1 (Complete Data)[b]	40	7.76	86.5	1.97	-15.4 (19.9)[a]			-.407 (.139)	-.879 (4.87)		-.386 (1.29)	1.04 (.993)	-4.50 (.455)
#2 (Complete Data)	40	7.21	88.0	2.17	-18.9 (17.0)			-.669 (.156)	3.39 (4.33)	-6.76 (2.83)			-2.12 (.984)
#3 (Complete Data)	40	7.17	87.8	2.24	- 6.85 (6.57)			-.589 (.116)		-6.23 (2.73)			-2.21 (.971)
#4 (78-80 Storage Seasons)[c]	30	7.82	80.0	2.17	- 8.31 (8.77)			-.550 (1.68)		-6.32 (3.32)			-2.03 (1.15)
#5 (78-80 Storage Seasons)	30	7.85	81.3	2.33	-41.2 (77.5)	-22.7 (49.9)	-32.6 (91.1)	.841 (3.64)		-1.05 (7.40)			-2.60 (1.72)
#6 (1978 Storage Season)	10	5.58	75.4	1.08	-256. (122.)			11.1 (5.99)		2.09 (10.6)			9.38 (7.86)
#7 (1979 Storage Season)	10	6.62	86.6	2.54	78.6 (184.)			-2.92 (5.36)		-12.6 (10.3)			-2.37 (3.13)
#8 (1980 Storage Season)	10	7.44	88.7	2.76	-1894. (673.)			46.9 (14.7)		66.6 (26.6)			5.64 (3.47)

a Standard errors of estimated coefficients are in parenthesis. Results have been rounded.
b Complete data for the period January 1978 - December 1981, excluding the period August - September across years.
c A storage season is defined as the October - July period.

(STA/OFSC) assumes that carryin and expected production at the beginning of the harvest season are stocks, whereas (STB/OFSC) considers only corn in storage facilities as stocks. The estimated regression is presented as equation #2 in Table 1; the estimated coefficients for three of the independent variables have correct signs and are significant, the estimated coefficient for (EPROD/OFSC) is incorrect and insignificant. A possible explanation for the incorrect sign for (EPROD/OFSC) is that the SCD cash prices incorporates relatively little information regarding the expected new crop. Consequently, this variable was dropped and the equation reestimated. Equation #3 shows that the estimated coefficients for all the independent variables are correct and significant.

Covariance Analysis

Covariance analysis was used to test whether structural changes have occurred over time. The concern being that a specification error caused by omitted relevant variables may be biasing the coefficient estimates. To provide adequate degrees of freedom, equation #3 was re-estimated using only data for the three storage (not calendar) years for which there were complete data. The results are shown as equation #4. The estimated coefficients and standard errors are very similar to the results using the four calendar years of data.

Equation #5 in Table 1 permits intercept shifts to occur across the three storage years. The F-test indicated that the intercept is not significantly different across the three storage years (F=0.92, Table F.05=3.40). Equations #6-#8 permit all parameters to shift over time. Again, the F-Test indicated no significant shift over time (F=2.66, Table F.01=4.01). Consequently, we return to discussing Equation #3.

Analysis of Results

For convenience, the results of Equation 3 are reproduced below:

Variable	Coefficient	Standard Error
Constant	-6.85	6.57
MTRDi,t	-0.59	0.11
INTRATi,t	-2.21	0.97
(STA/OFSC)i,t	-6.23	2.73

D.W. = 2.24 R^2 = 87.8

Standard Error of Regression = 7.17 cents per bushel

The Durbin-Watson statistic indicates that the OLS residuals do not follow a first order auto-regressive scheme.

Approximately 88 percent of the variation in the Wisconsin basis is associated with transportation and storage costs (measured by the trend variable), opportunity costs, and the SCD supply and demand variables. Over the period of analysis, the basis weakened by 0.59 cent/bushel/month due to increasing transportation cost and increasing cost of storage, as measured by the trend variable. Given off-farm storage capacity, a one million bushel increase in stocks resulted in a 6.23 cents per bushel increase (basis weakening) in the July basis. Similarly, a 1% increase in the opportunity cost of holding the corn until July resulted in a 0.23% weakening in the July basis (flexibility computed at the means).

The estimated model is consistent with the theory of basis discovery, but data limitations imposed severe restrictions on estimating the influence of specific economic variables on the July basis. This study resorted to using proxy and aggregate variables to measure the level and magnitude of several economic variables. As more market years become available, it will be of interest to test if the coefficients for the basis relationship remain time-invariant. It will also be important to evaluate the model in actual forecasting situations.