STAFF PAPER

KANSAS CORN AND SORGHUM BASIS RELATIONSHIPS: HEDGING RISKS ASSOCIATED WITH CORN FUTURES

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Introduction

In 1986, Kansas produced about one-third of U.S. grain sorghum (over 311 million bushels), making it the largest grain sorghum producing state. In addition, Kansas corn production exceeded 181 million bushels in 1986, making it the eleventh ranked corn producing state (Kansas Agricultural Statistics, 1986). The combined value of these crops was over $680 million.

Kansas also produces a large percentage of total U.S. livestock creating a significant demand for feed grains. Kansas ranked third behind Texas and Nebraska in number of cattle on feed January 1, 1987, tenth in hogs on farms December 1, 1986, and seventh in sheep and lambs on feed January 1, 1987 (Kansas Agricultural Statistics, 1986).

Because of the large volumes of feed grain production and usage in Kansas, there is substantial interest amoung producers and grain merchandisers regarding marketing and procurement alternatives for feed grains, particularly corn and grain sorghum. Futures markets are one pricing mechanism that market participants may consider. The Chicago Board of Trade (CBT) corn futures contract is a well established market for pricing corn. However, no grain sorghum futures contract presently exists; thus, grain sorghum buyers and sellers can hedge only in the futures market of a different commodity (cross-hedging). Hedging grain sorghum in the corn futures market, however, will only reduce risk if the sorghum price and corn futures price move in predictable manners relative to one another. That is, a change in the corn futures price needs to be concurrent with a relatively redictable grain sorghum price change.

Since grain sorghum and corn are fairly good substitutes in livestock feed rations, it would seem logical that corn and sorghum prices in Kansas should move in some predictable pattern relative to each other. An increase in the price of corn, for example, would be expected to lead to more sorghum feeding as feedlots shift to lower cost rations, forcing the sorghum price up and/or the corn price down until they reach a stable differential reflecting their relative values. Thus, if corn in Kansas could be effectively hedged using corn futures, it seems logical to expect that grain sorghum could be cross-hedged in the corn futures market with similar levels of basis risk relative to corn. However, because feed grain production, merchandising, and feeding are not all occurring in the same locations or at the same volumes, it is necessary to examine several different local cash markets to determine more generally the levels of basis risk present for corn and grain sorghum with corn futures markets.

This paper first investigates absolute basis levels and variability between CBT corn futures and cash corn and grain sorghum for Kansas City and several Kansas locations. Next, the relative hedging risks between corn and sorghum in corn futures are examined. Then, the value of sorghum relative to corn, as reflected in the market prices, is addressed. Finally, the possible implications of these results are summarized.

Data

The data analyzed in this study are weekly, Wednesday, cash, corn prices ($/bu) and cash, grain sorghum prices (converted from $/cwt to

$/bu by multiplying by .56 lbs/bu) from Kansas City, Missouri, and 10 locations in Kansas including Cherryvale, Colby, Dodge City, Garden City, Great Bend, Hutchinson, Pratt, Salina, Scott City, and Topeka (Figure 1). The Kansas City data were collected from 1972 through 1987 and the prices from the Kansas markets were collected from 1982 through 1987. The Kansas City data were taken from the Kansas City Board of Trade (KCBOT) annual summaries, and the Kansas cash prices were obtained from the Wichita Eagle Beacon newspaper. Weekly, Wednesday, corn futures settlement prices ($/bu) were collected from the CBT annual summaries.

Basis

In this analysis, basis is defined as the difference between the local cash price and the nearby contract corn futures price (basis = cash price - corn futures price). The nearby contract period used in this study was from the 16th day of the previous contract month to the 15th day of the contract expiration month. The basis summaries provide an indication of relative cash and futures price levels near contract expiration. Basis risk, as defined in this section, does not necessarily provide an indication of the levels of hedging risk present; this issue will be addressed in the next section.

At this point, it is useful to define the statistics used to examine the basis. The average basis is an indicator of how different the cash and futures price levels have typically been near the futures contract expiration. A measure of the variability in the basis can be approximated by the standard deviation of the basis. Assuming that the

basis was approximately normally distributed over time, the actual basis would be expected to be between the average basis plus or minus one standard deviation of the basis roughly two-thirds of the time. Thus, with an average basis of $.10/bu and a standard deviation of $.08/bu, one would expect that roughly two-thirds of the time the actual basis was between $.18/bu and $.02/bu.

The averages and standard deviations of the nearby corn and sorghum bases for Kansas City are reported in table 1. The Kansas City cash corn price was typically greater than the nearby corn futures price by $.09/bu to $.14/bu on average during the 1972 through 1987 period. The cash grain sorghum price, however, averaged $.14/bu to $.21/bu below the nearby corn futures price. The standard deviation of the corn basis was typically less than that of the sorghum basis by about $.04/bu.

The December contract basis statistics for the selected Kansas cash markets are reported in table 2. The basis relationships for each contract month are reported in detail in appendix tables 1A through 10A. In general, the December corn basis was close to zero or slightly negative in these markets, and the sorghum cash price was typically at least $.30/bu lower than the December corn futures price. Clearly, differences in basis levels and basis variability existed across the different market locations. The December sorghum basis typically had a $.02/bu to $.03/bu larger standard deviation than corn and the other contract months had similar relations.

Hedging Risk

Hedging risk is often defined as the risk of an adverse ending

basis. Highly unpredictable basis levels make hedging a risky prospect. To the extent that basis can be reasonably predicted, hedging will be less risky. However, this argument assumes that hedgers take a futures quantity position the same as the cash quantity position that they are trying to protect. However, the size of the cash and futures positions that result in the least hedging risk may not be the same. This is particularly true when one considers potential cross hedging, such as hedging sorghum in the corn futures market. The quantity of the futures position per unit of cash quantity that should be taken to minimize basis risk is referred to as the "hedge ratio".

A standard model used to estimate hedge ratios can be formulated as follows. An anticipatory hedger is concerned with variance about an expected return from hedging. The expected return can be expressed as:

$$\text{Expected Return} = X_f F_1 - E[X_f F_2 - X_c C_2] \qquad (1)$$

where X_f is the size of the futures market position, F_1 is the futures market price at the time the hedge is placed, E refers to expectation, F_2 is the futures market price at the time a hedge is lifted, X_c is the size of the cash market position, and C_2 is the cash price at the time of the cash transaction. The variance of the expected return is:

$$\text{Variance Expected Return} = X_f^2 \sigma_{f2}^2 + X_c^2 \sigma_{c2}^2 + 2X_f X_c \sigma_{c2f2} \qquad (2)$$

where σ_{f2}^2, σ_{c2}^2, and σ_{c2f2} are the variances and covariance of ending futures and cash prices, respectively, at the time the cash transaction would be completed.

The hedger's objective is to choose the futures position (X_f) to minimize equation (2). This gives the optimal hedge ratio as:

$$\frac{X_f}{X_c} = \frac{\sigma_{c2f2}}{\sigma^2_{f2}} \qquad (3)$$

This relationship can be estimated by a regression of cash prices on futures prices during the period when the hedger would be closing the futures position and entering the cash market. For further details of this model and a comparison of this technique with other models frequently used for hedge ratio estimation, see Witt, Schroeder, and Hayenga.

In typical hedging relationships, a hedge ratio of 1.0 is assumed. That is, usual recommendations are to take a futures position the same size as the cash position being hedged. If the cash price typically changes by more than the futures price, the hedge ratio will be greater than 1, and a hedger should consider taking a futures position larger than the (anticipated or actual) cash position, in order to ensure that the values (price times quantity) of the futures and cash positions will move similarly. Likewise, if the cash price typically changes less than dollar for dollar with the futures price, the hedge ratio will be less than 1, and a hedger should consider taking a futures quantity position smaller than the cash quantity being hedged.

The hedge ratio can be estimated from the following equation:

$$C_2 = a + b\ F_2 \qquad (4)$$

where C_2 is the price of the cash commodity near the contract expiration, and F_2 is the nearby contract futures price, an estimate of b is the hedge ratio, and a is a constant term. This relationship can be estimated statistically by regressing historical cash prices on futures prices.

The amount of hedging risk present as determined by the estimated hedge ratio should be less than or equal to the basis risk presented previously. That is, the basis information presented in the previous section assumes a hedge ratio of 1. However, the risk-minimizing hedge ratio may be different from 1 particularly for hedging sorghum in corn futures, since this involves cross-hedging. A measure of the hedging risk is provided by the root mean squared error (RMSE) of the regression equation used to estimate the hedge ratio.

The interpretation of the RMSE is similar to the interpretation of standard deviation. Roughly two-thirds of the time, the actual price paid or received from hedging should be the expected price plus or minus one RMSE. An additional unitless measure of hedging risk is also examined, the root mean squared percentage error. This is the root mean squared error times 100, divided by the average cash price over the period for which the relationship was estimated. The root mean squared error provides a measure of the hedging risk as a percentage of the average cash price. It allows for direct comparisons between the corn and sorghum hedging risks, hedging risks across different contract months, and hedging risks across locations.

The Kansas City corn hedge ratios (table 3) were generally not significantly different from 1.0. This implies that hedging Kansas City

cash corn in the corn futures markets should be done one for one. The root mean squared errors imply that roughly two-thirds of the time, the net realized price from hedging Kansas City cash corn would have been within $.11/bu to $.17/bu of the expected price, depending on the time of year. The corn hedging risk ranged from 4% to 6.3% of the average cash corn price. The estimated corn and sorghum hedging relationships, and actual data for Kansas City for each contract month are plotted in figures 2 through 11. The fitted lines are the estimated hedging relationships and the actual data points are reported to provide a general view of the amount of variation present in the cash and futures price relationship during the 1972 through 1987 period.

The Kansas City sorghum hedge ratios were all significantly smaller than 1.0, indicating that a futures position smaller than the cash sorghum position should be taken in order to minimize hedging risk. A hedge ratio of 0.90, for example, implies that for each 5000 bushel corn futures position the hedger assumes, he is effectively hedging 5556 (5000/0.90) bushels of cash grain sorghum. The hedging risk for Kansas City grain sorghum ranged from $.12/bu to $.15/bu or 4.8% to 6.1% of the average sorghum price. Thus, the hedging risks for Kansas City cash corn and sorghum using CBT corn futures appeared to be very similar over the 1972 through 1987 period.

The local Kansas cash markets and the Kansas City market generally had similar results, although hedging risks were slightly larger in some instances and the hedge ratios were typically smaller at the local Kansas markets. The hedging relationships for the selected Kansas markets for the December corn futures contract are reported in table 4.

The hedging relationships for all the corn futures contracts at each market are reported in appendix tables 11A through 20A. For most of the Kansas locations, the December corn hedge ratios were around 0.95, and the sorghum hedge ratios averaged about 0.75. Hedging risks for both corn and grain sorghum typically ranged from 4% to 6% of the average cash price during non-harvest periods (see appendix) and 6% to 8% during harvest months (table 4). Differences between the corn and sorghum hedging risks were typically small either in absolute dollar amounts or in percentage terms.

Relative Values of Grain Sorghum and Corn

It is generally agreed that corn and grain sorghum are competing products and are good substitutes in production as well as in livestock feed rations. Church discusses National Research Council (NRC) studies, which indicate that grain sorghum has roughly 95% as much digestible protein as corn. In addition, grain sorghum has approximately 88% total digestible nutrients (TDN) relative to corn for cattle rations and 96% of corn TDN for swine. Thus, from nutrient and energy requirement perspectives, sorghum is slightly less valuable than corn, with the magnitude depending upon the relative weights applied to the NRC measurements. Sorghum also may need to be processed in slightly different ways or may require slightly different handling procedures which can affect the relative values. As a result, perhaps the most reasonable method for investigating the relative values of sorghum and corn is to examine what the relative market prices have been.

Assuming that the market is accurately pricing corn and sorghum in

relation to each other, the relative value of sorghum to corn should be reflected in market prices. The relative prices of Kansas City sorghum and corn are shown in figure 12. The line in figure 12 was estimated by regressing the weekly Wednesday cash sorghum price on the cash corn price for the same day over the 1972 through 1987 period. The estimated relationship is reported in table 5. The estimates imply that sorghum was typically priced ($/bu) at .84 times the price of corn ($/bu) plus $0.155/bu. The plot in figure 12 shows the stability of this relationship over the 1972 through 1987 period.

The value of sorghum relative to corn for selected locations in Kansas during 1982 through 1987 are reported in table 6. The value of sorghum relative to corn was fairly constant across these locations, ranging from 0.79 to 0.85 times the price of corn plus a constant.

Summary and Conclusions

Hedging risks for corn and sorghum using the CBT corn futures market appeared to be similar in Kansas City over the 1972 through 1987 period. In addition, corn and sorghum hedging risks were also similar in selected Kansas markets during the 1982 through 1987 period. In some markets, corn hedging risks were less than sorghum hedging risks, whereas, in other markets at certain times of the year, sorghum cash prices were more highly correlated with corn futures prices than were cash corn prices. Typical hedging risks for corn and sorghum ranged from around 4% to 8% of the underlying average cash commodity price.

This finding does not necessarily imply that corn futures served as a "good" hedging market for sorghum. That is, if the risks of hedging

corn or sorghum were greater than the unhedged price risk, the corn futures market would not be a good hedging mechanism for corn or sorghum. To examine the extent to which hedging either corn or sorghum in the corn futures market serves as a satisfactory risk reduction strategy would require some assumptions regarding hedgers' risk preferences.

Hedging risk appeared to be seasonal. In general, corn and sorghum hedging risks were greatest for hedging in the September and December corn futures contracts, likely reflecting the basis fluctuations during local harvest time. In the March and May corn futures contracts, hedging risks for both sorghum and corn were typically smaller than during harvest months.

Spatial differences in corn and sorghum price relationships were apparent. In general, the hedge ratios were higher in eastern Kansas locations, implying that the eastern markets' cash prices change more as futures prices change than do the prices in the western markets. Hedging risks, however, did not seem to have any systematic relationship with location.

Cash sorghum and corn prices have maintained very predictable differentials during recent years. Sorghum has typically been valued in the market at roughly 85 percent of corn value. There were very few significant differences in this relationship over the period examined.

References

Church, D. C. Livestock Feeds and Feeding. O & B Books, Corvallis, Oregon, 1977.

Kansas City Board of Trade. Annual Statistical Report, various issues 1972-1986.

Witt, H. J., T. C. Schroeder, and M. L. Hayenga. "Comparison of Analytical Approaches for Estimating Hedge Ratios for Agricultural Commodities." Journal of Futures Markets, 7(1987):135-46.

Table 1. Kansas City Corn and Sorghum Basis Relative to Nearby CBT Corn Futures, Weekly, Wednesday Data 1972-1987.

Corn Futures Contract[a]	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)[b]	Corn ($/bu)	Sorghum ($/bu)
March	0.09	-0.14	0.12	0.16
May	0.10	-0.18	0.11	0.16
July	0.14	-0.21	0.13	0.16
September	0.14	-0.17	0.17	0.14
December	0.06	-0.17	0.16	0.16

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month. Basis defined as cash price minus futures price.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 2. Kansas Corn and Sorghum Basis Relative to December Corn Futures, Selected Markets, Weekly, Wednesday Data 1982-1987.[a]

Location	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)[b]	Corn ($/bu)	Sorghum ($/bu)
Cherryvale	0.09	-0.45	0.22	0.13
Colby	-0.15	-0.51	0.18	0.21
Dodge City	0.01	-0.36	0.17	0.21
Garden City	-0.05	-0.36	0.17	0.21
Great Bend	-0.09	-0.46	0.18	0.20
Hutchinson	-0.07	-0.41	0.16	0.20
Pratt	-0.02	-0.43	0.18	0.18
Salina	-0.09	-0.37	0.18	0.19
Scott City	-0.01	-0.38	0.17	0.22
Topeka	-0.04	-0.40	0.13	0.19

[a] Includes data from September 16th through December 15th of each year.

[b] Assumes a test weight of 56 lbs/bu of sorghum.

Table 3. Kansas City Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1972-1987.

Corn Futures Contract	Hedge Ratio[a] Corn (bu. Futures/bu Cash)	Hedge Ratio[a] Sorghum (bu. Futures/bu Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	0.99	0.84*	0.12	0.13	4.6	5.3
May	1.02	0.83*	0.11	0.12	4.0	4.8
July	1.05*	0.87*	0.13	0.15	4.6	6.1
September	1.02	0.89*	0.17	0.12	6.3	5.1
December	0.97	0.90*	0.16	0.14	6.0	6.0

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 4. Kansas Corn and Sorghum Hedging Relationships with December Corn Futures, Selected Markets, Weekly, Wednesday Data 1982-1987.[a]

Location	Hedge Ratio Corn (bu. Futures/bu. Cash)	Hedge Ratio Sorghum (bu. Futures/bu. Cash)	Root Mean Squared Error Corn ($/bu)	Root Mean Squared Error Sorghum ($/bu)	Root Mean Squared Percentage Error Corn (%)	Root Mean Squared Percentage Error Sorghum (%)
Cherryvale	1.21*	0.93*	0.19	0.13	7.5	6.4
Colby	0.90*	0.74*	0.17	0.13	7.6	7.1
Dodge City	0.91*	0.74*	0.16	0.15	6.6	7.2
Garden City	0.92*	0.74*	0.17	0.14	7.1	7.0
Great Bend	0.91*	0.76*	0.17	0.14	7.6	7.4
Hutchinson	0.95	0.75*	0.16	0.13	6.9	6.6
Pratt	0.95	0.80*	0.18	0.14	7.6	7.1
Salina	0.95	0.75*	0.18	0.13	7.7	6.3
Scott City	0.91*	0.73*	0.16	0.15	6.9	7.3
Topeka	1.10*	0.81*	0.12	0.15	5.2	7.7

[a] Includes data from September 16th through December 15th of each year.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 5. Regression Estimates of Relative Value of Cash Sorghum to Cash Corn, Kansas City, Weekly, Wednesday Data 1972-1987.

Cash Sorghum Price ($/bu) = 0.155 + 0.840 Cash Corn Price ($/bu)
(0.021)[a] (0.008)

R^2 = 0.94 RMSE = $0.14/bu Number of Observations = 827

a Standard errors of respective coefficient in parentheses.

Table 6. Regression Estimates of Value of Cash Sorghum Relative to Cash Corn, Selected Kansas Locations, Weekly, Wednesday Data 1982-1987.

Dependent Variable: Cash Sorghum Price					
Location	Intercept ($/bu)	Corn Price Coefficient	R^2	RMSE ($/bu)	Number of Observation
Cherryvale	0.02 (0.02)[a]	0.80 (0.01)	0.96	0.11	306
Colby	0.04 (0.02)	0.83 (0.01)	0.96	0.09	311
Dodge City	0.00 (0.02)	0.85 (0.01)	0.97	0.08	311
Garden City	0.07 (0.02)	0.84 (0.01)	0.97	0.08	304
Great Bend	0.04 (0.02)	0.84 (0.01)	0.96	0.09	305
Hutchinson	0.10 (0.03)	0.82 (0.01)	0.95	0.10	311
Pratt	0.02 (0.03)	0.84 (0.01)	0.94	0.12	306
Salina	0.24 (0.03)	0.79 (0.01)	0.94	0.11	308
Scott City	0.06 (0.23)	0.83 (0.01)	0.97	0.09	306
Topeka	0.18 (0.03)	0.79 (0.01)	0.96	0.11	304

[a] Standard errors are in parentheses below the respective coefficients.

Figure 1. Cash Grain Market Locations Analyzed

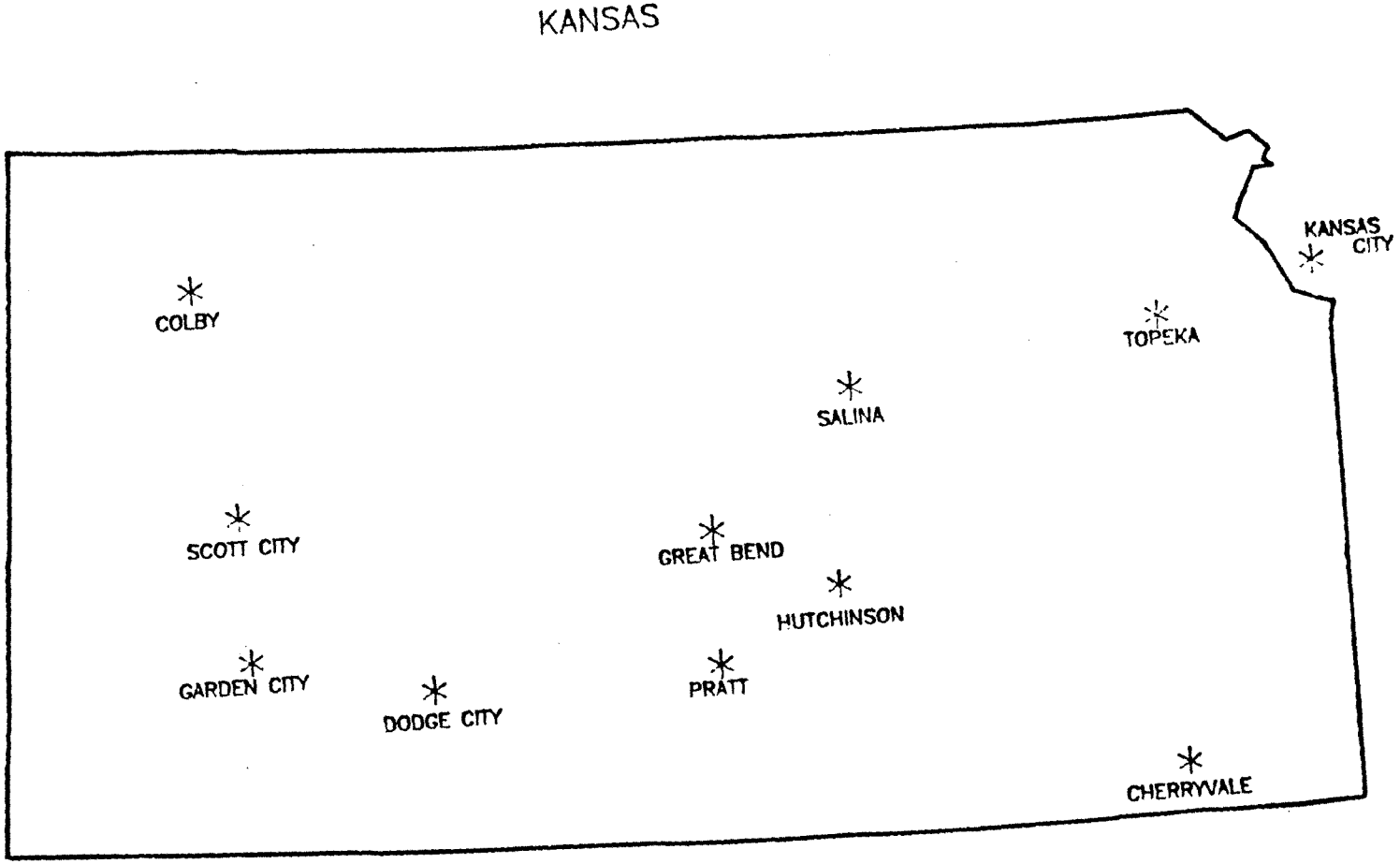


Figure 2. Kansas City Cash Sorghum vs. March Corn Futures

Dec.16 – Mar.15, Weekly 1972 through 1987

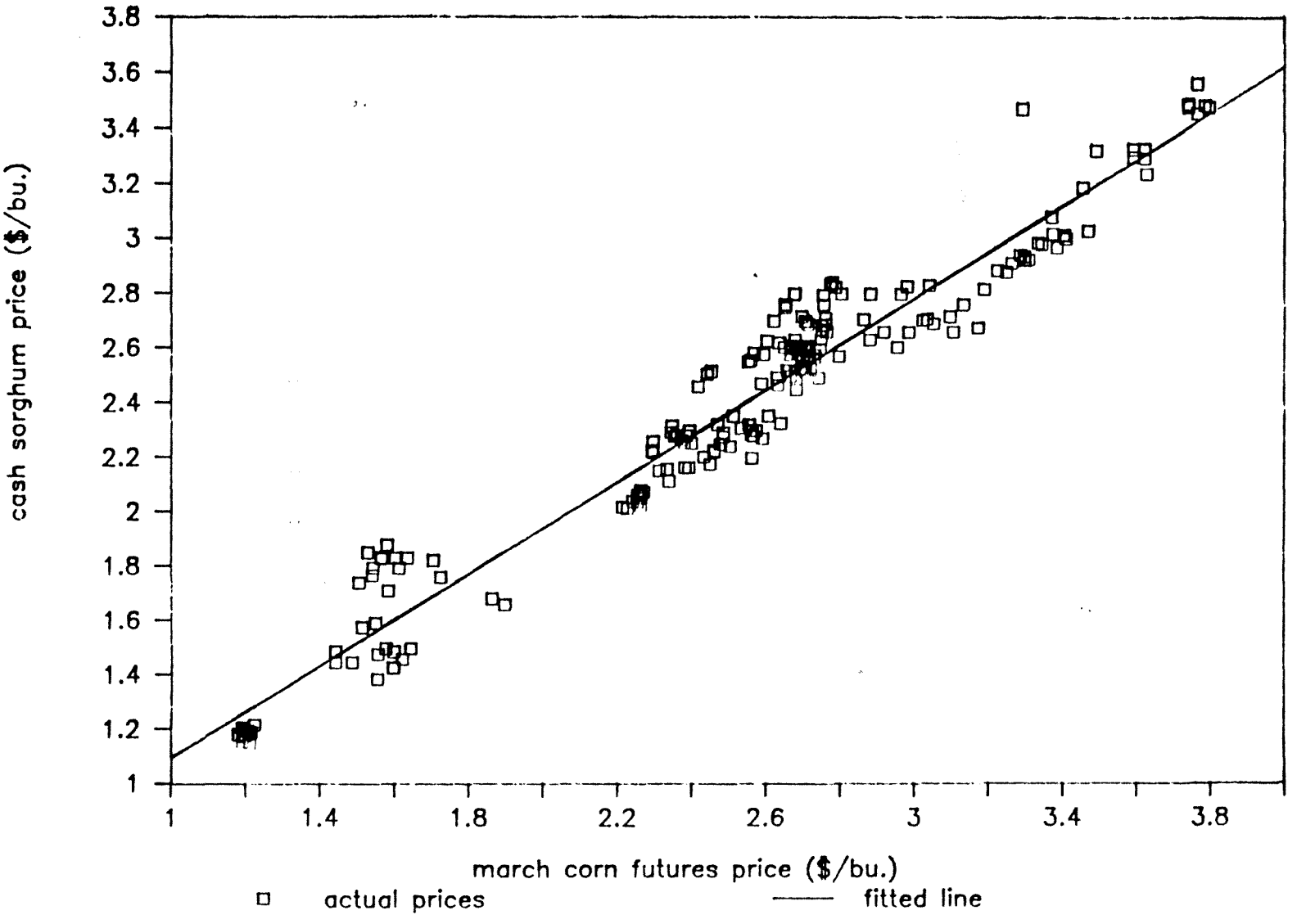


Figure 3. Kansas City Cash Corn vs. March Corn Futures
Dec.16 – Mar.15, Weekly 1972 through 1987

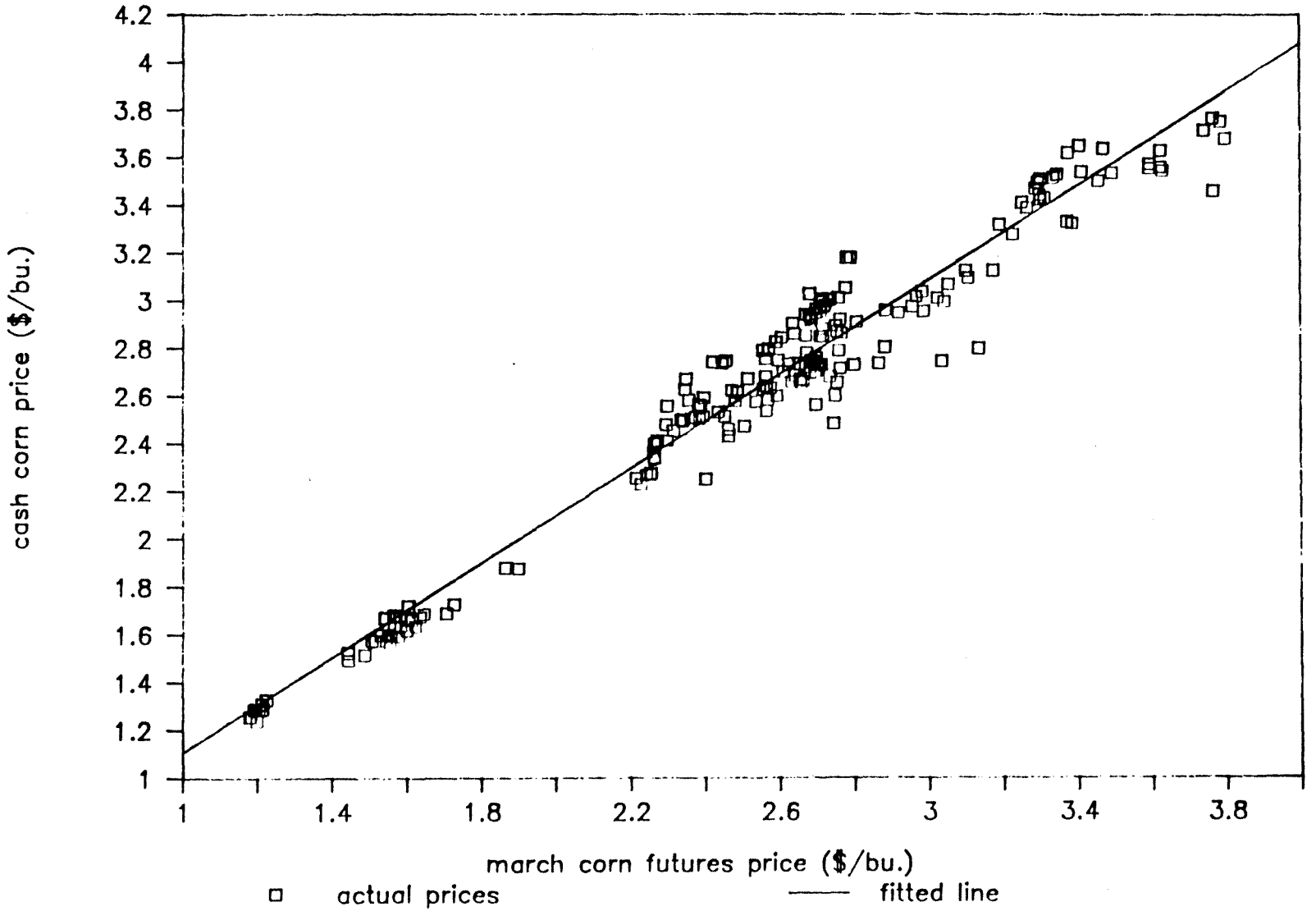


Figure 4. Kansas City Cash Sorghum Price vs. May Corn Futures

March 16 – May 15, Weekly 1972 through 1987

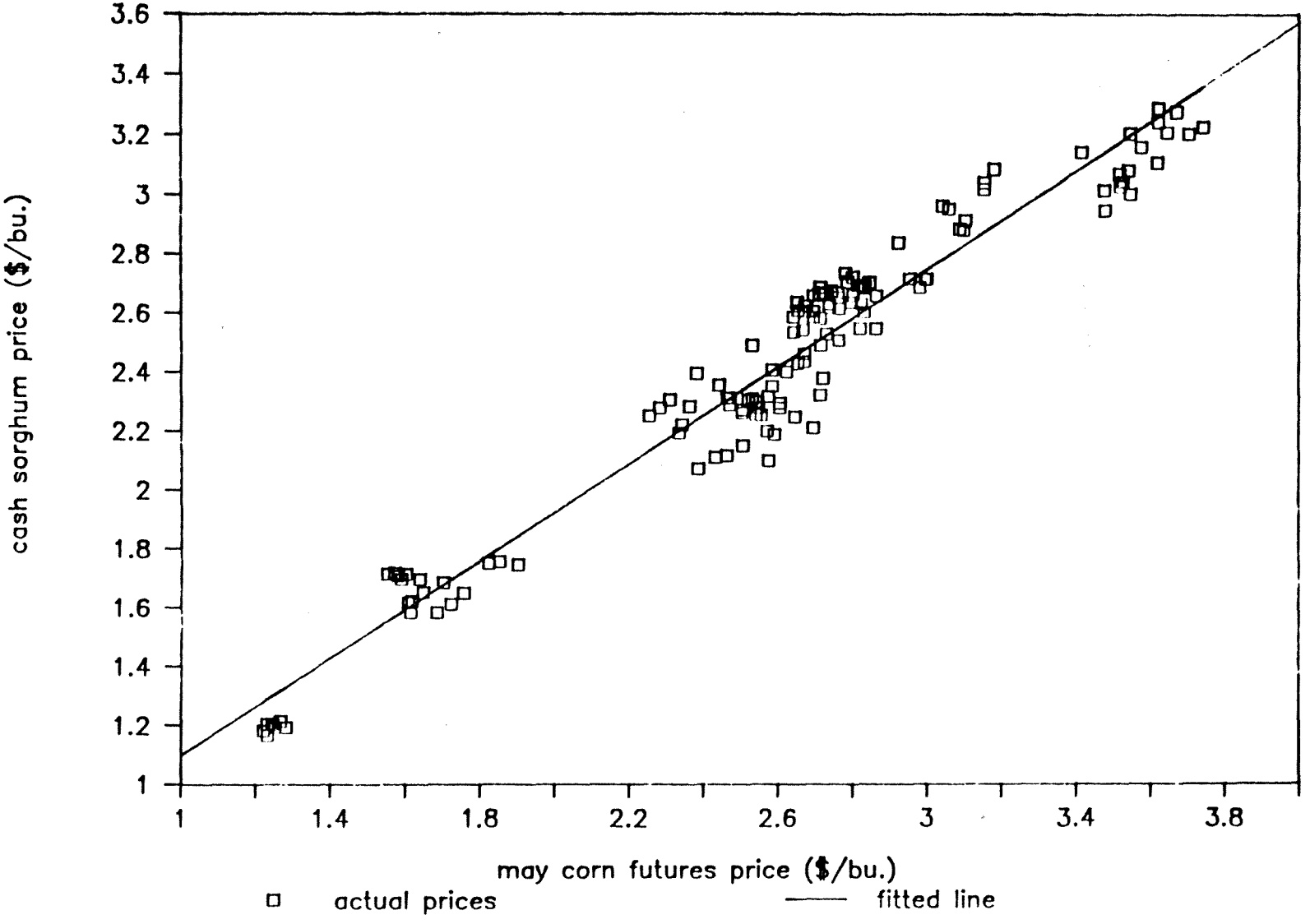


Figure 5. Kansas City Cash Corn vs. May Corn Futures

March 16 – May 15, Weekly 1972 through 1987

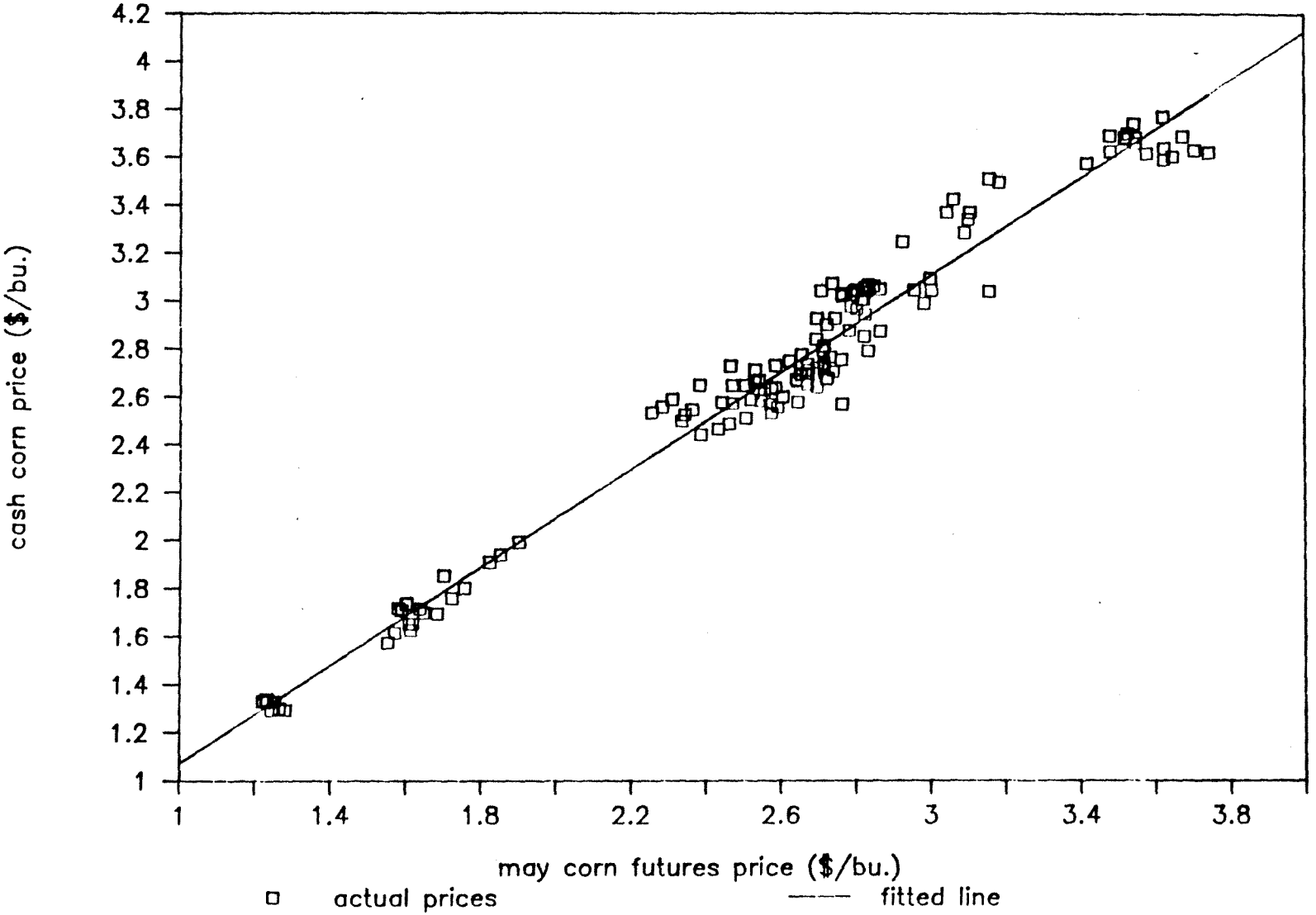


Figure 6. Kansas City Cash Sorghum vs. July Corn Futures

May 16 – July 15, Weekly 1972 through 1987

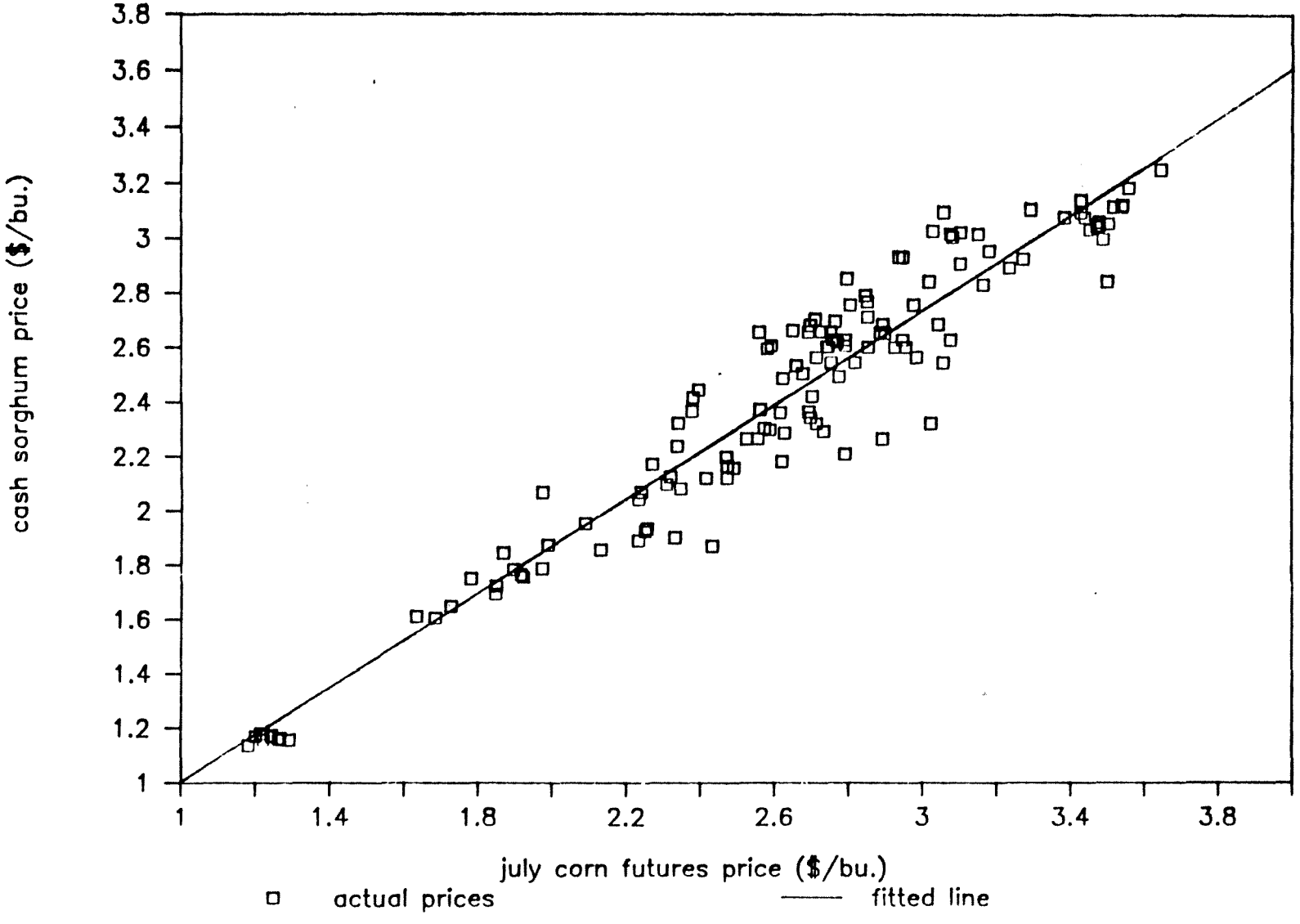


Figure 7. Kansas City Cash Corn vs. July Corn Futures

May 16 – July 15, Weekly 1972 through 1987

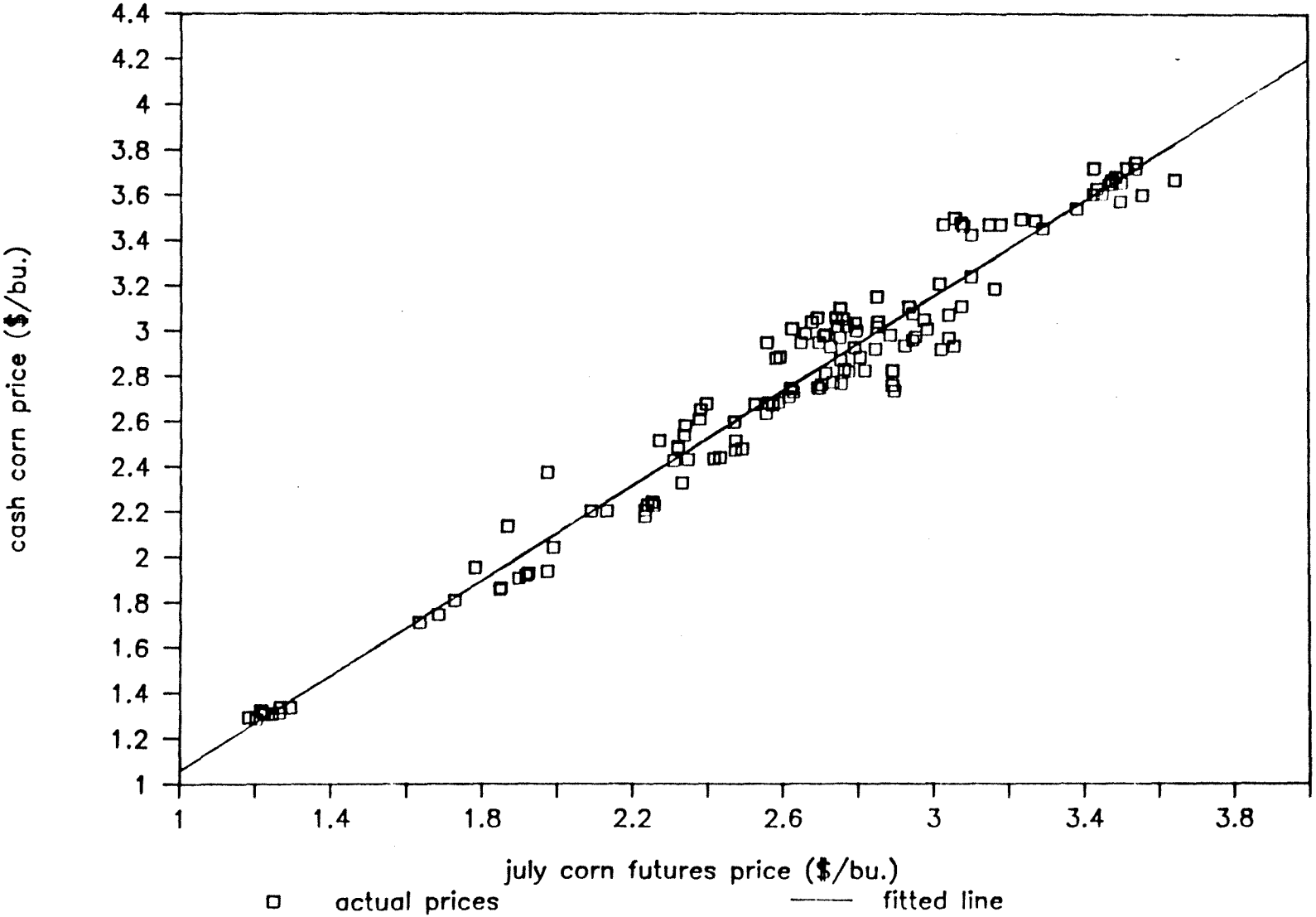


Figure 8. Kansas City Cash Sorghum vs. September Corn Futures

July 16 – Sept. 15, Weekly 1972 through 1987

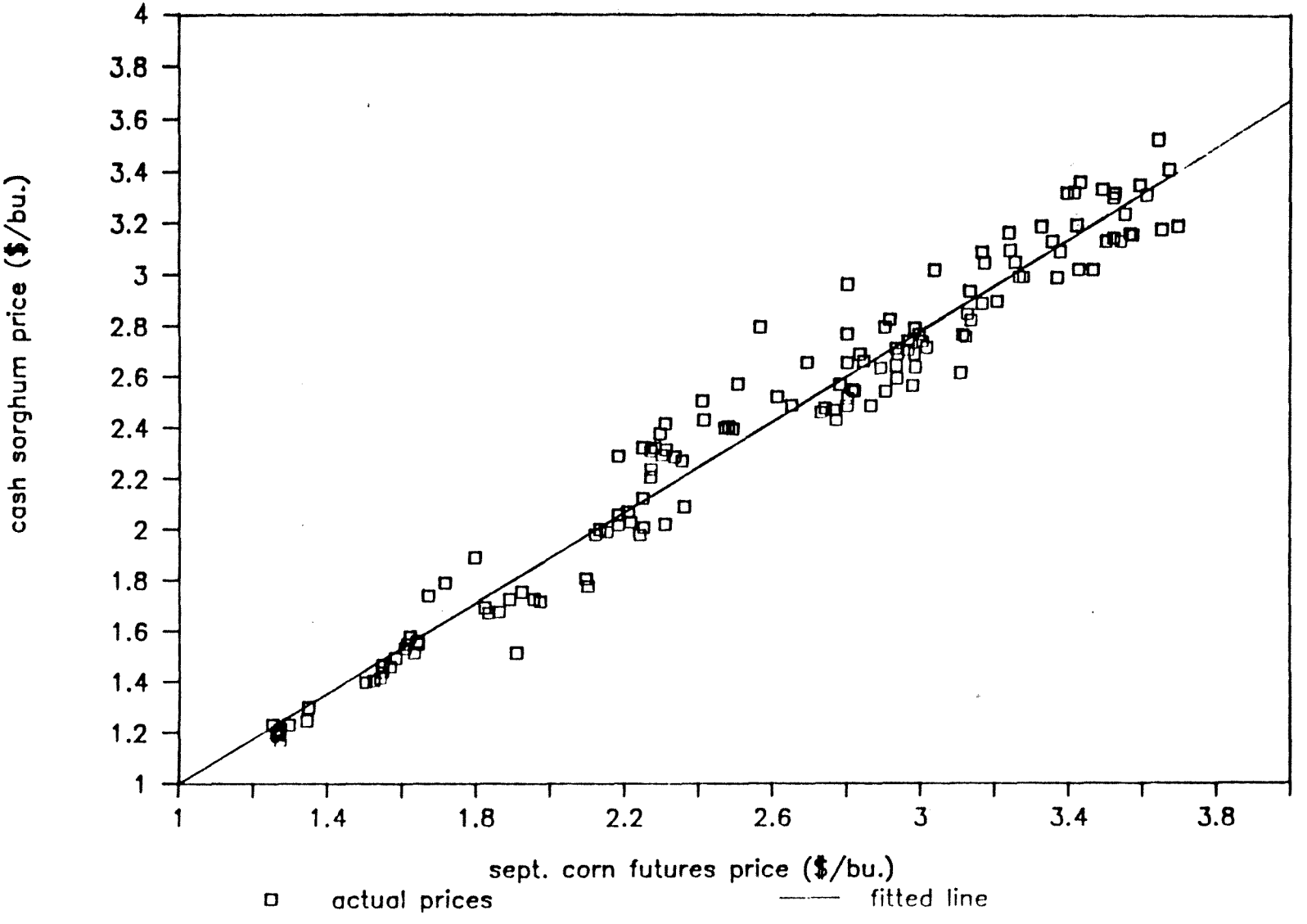


Figure 9. Kansas City Cash Corn vs. September Corn Futures

July 16 – Sept. 15, Weekly 1972 through 1987

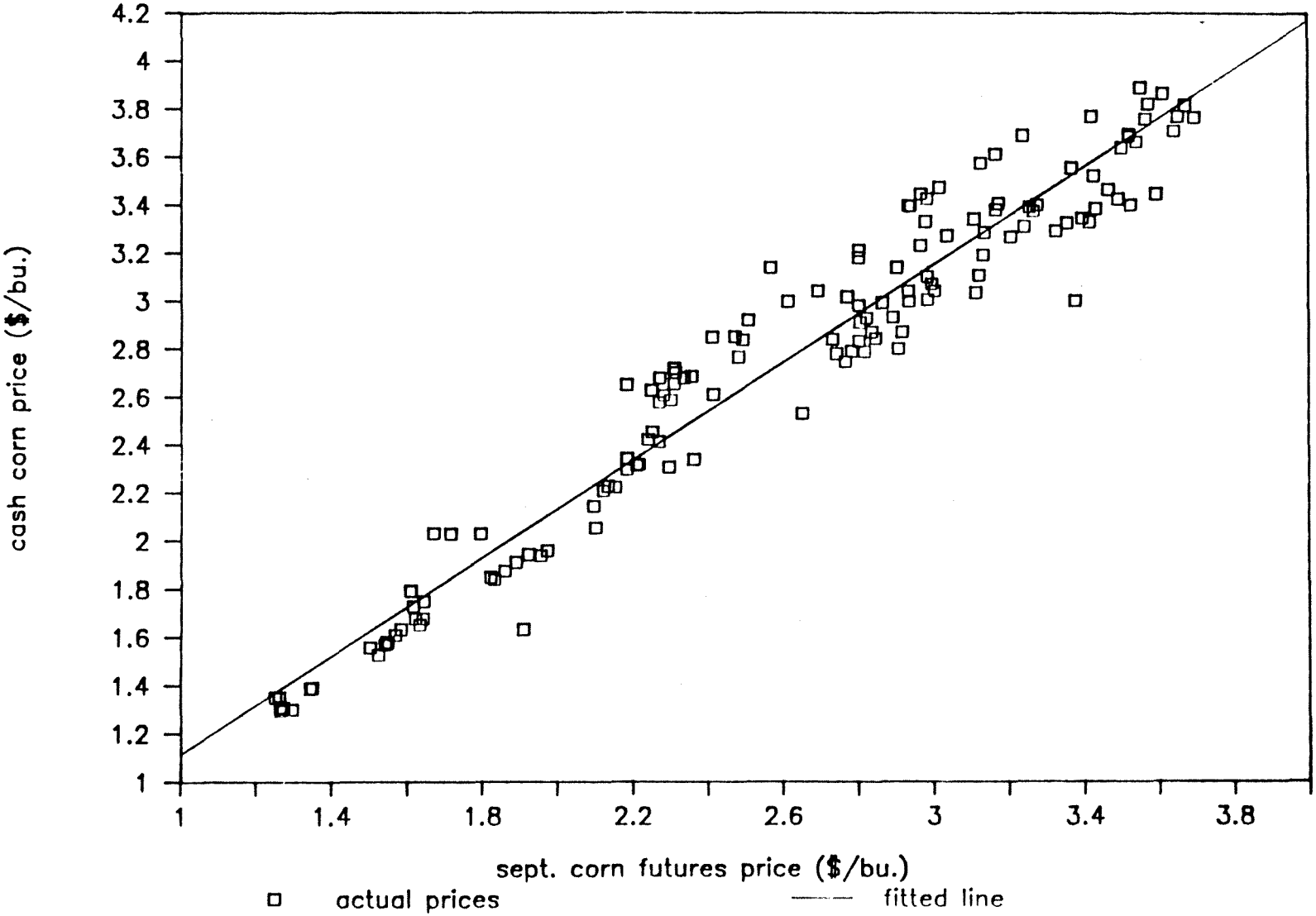


Figure 10. Kansas City Cash Sorghum vs. December Corn Futures

Sept. 16 – Dec. 15, Weekly 1972 through 1987

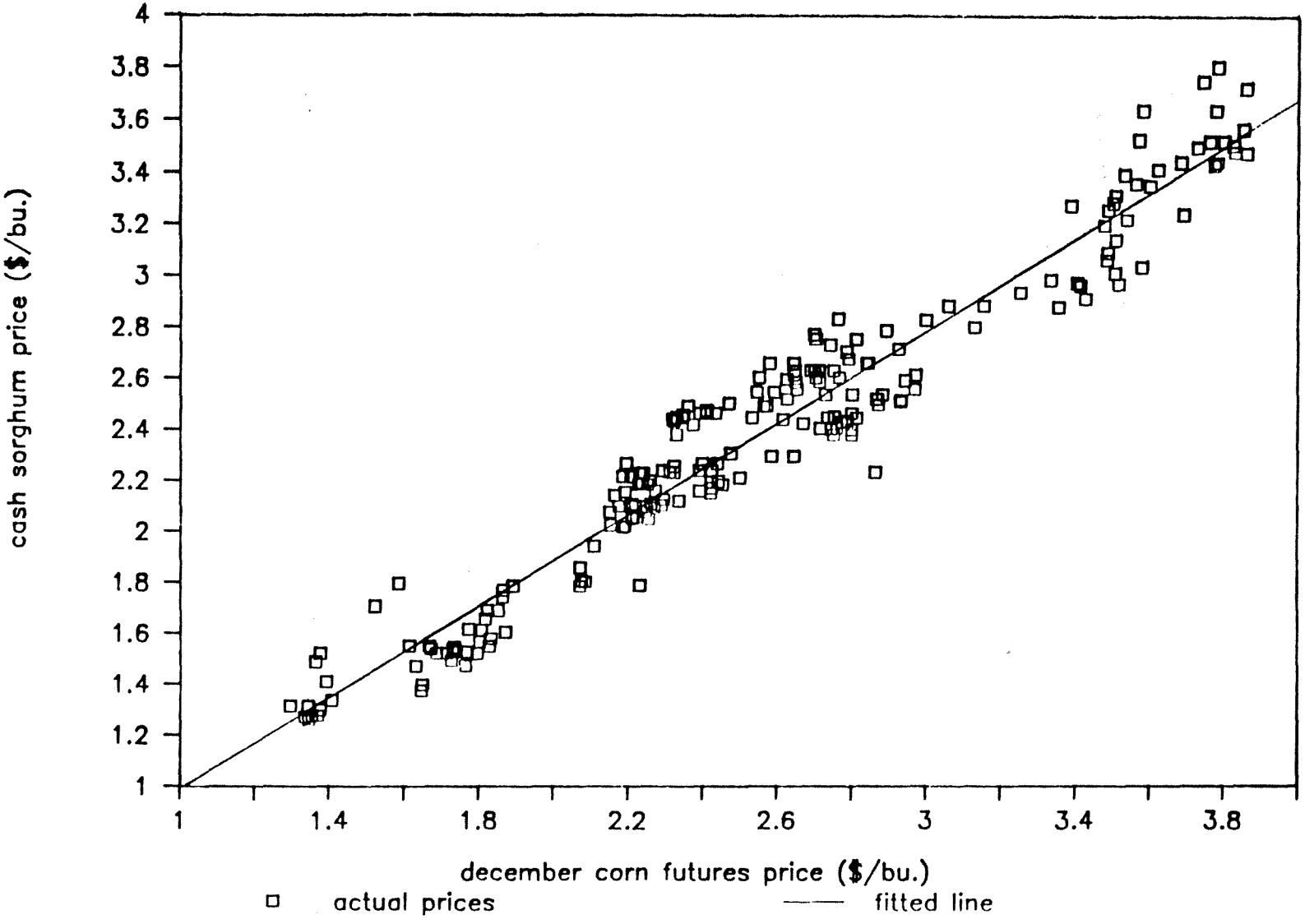


Figure 11. Kansas City Cash Corn vs. December Corn Futures

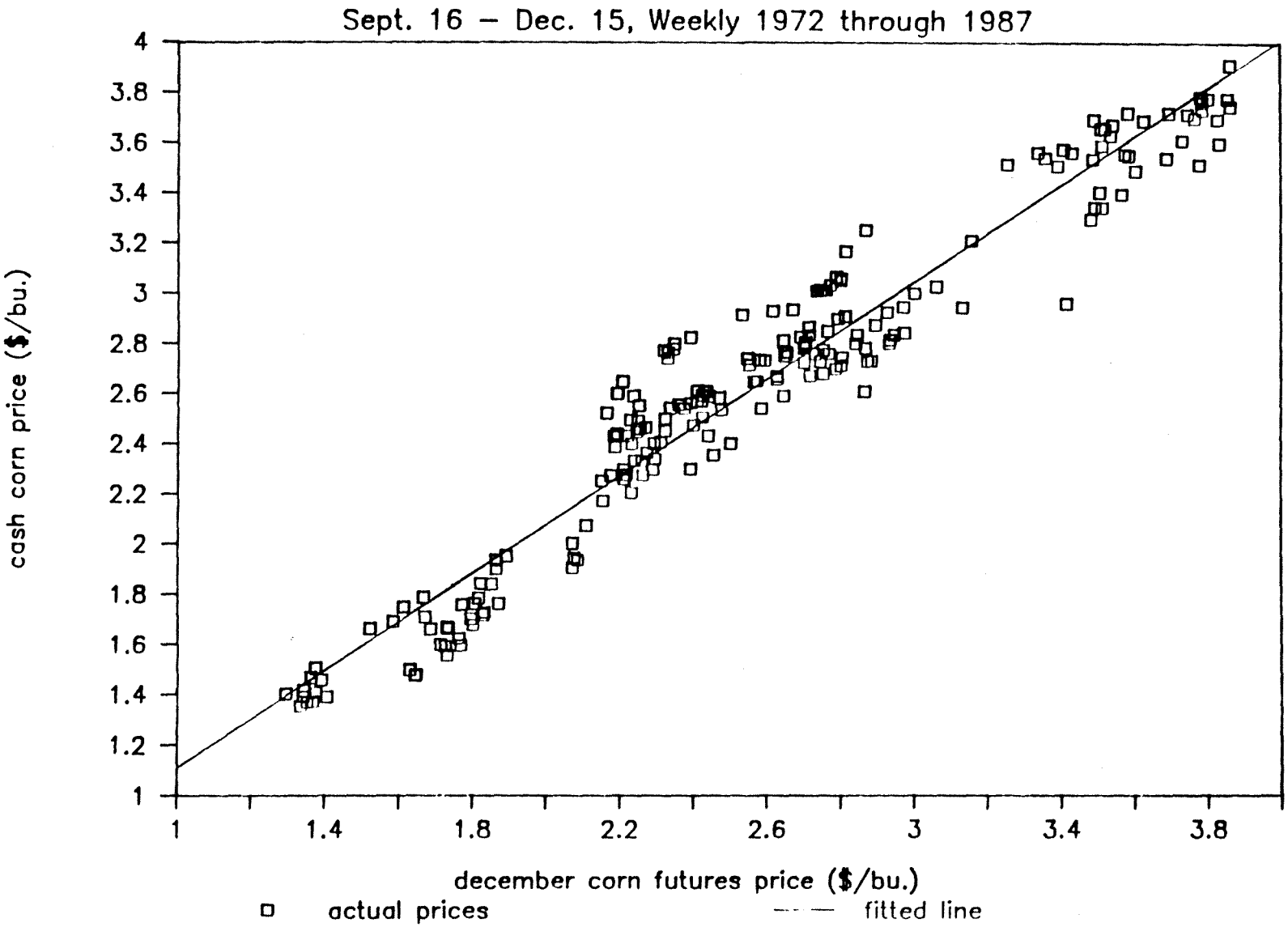
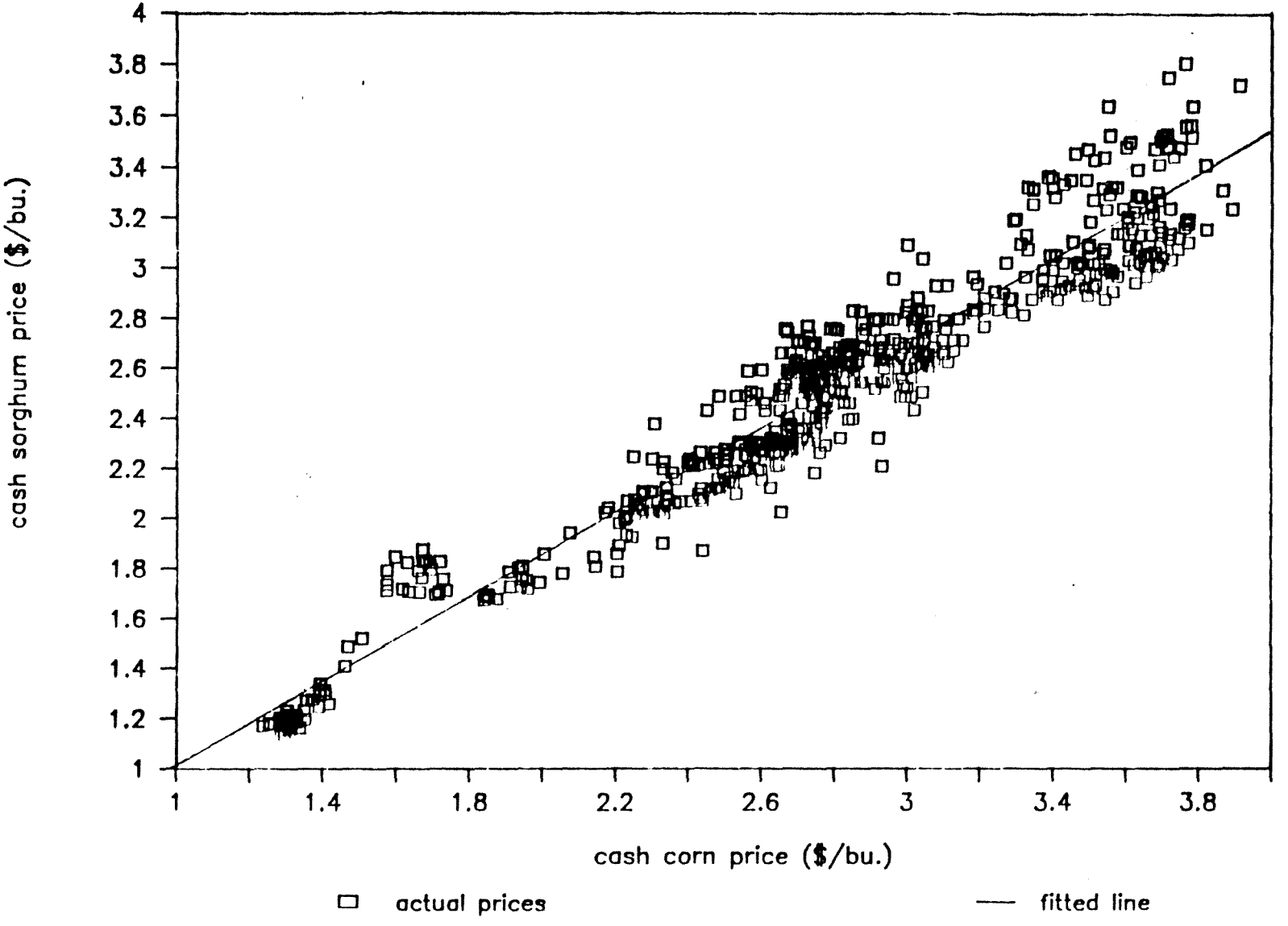


Figure 12. Kansas City Cash Sorghum vs. Kansas City Cash Corn

Weekly 1972 through 1987



APPENDIX

Detailed summaries of basis and hedging risks for selected local Kansas markets, 1982-1987.

Table 1A. Cherryvale, Kansas Corn and Sorghum Basis Relative to Nearby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)[b]	Corn ($/bu)	Sorghum ($/bu)
March	0.19	-0.38	0.19	0.11
May	0.15	-0.41	0.15	0.15
July	0.22	-0.29	0.18	0.19
September	0.25	-0.21	0.28	0.23
December	0.09	-0.42	0.22	0.13

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 2A. Colby, Kansas Corn and Sorghum Basis Relative to Neaby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)[b]	Corn ($/bu)	Sorghum ($/bu)
March	-0.14	-0.54	0.12	0.17
May	-0.19	-0.54	0.16	0.21
July	-0.06	-0.45	0.16	0.22
September	-0.01	-0.34	0.25	0.27
December	-0.15	-0.51	0.18	0.21

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 3A. Dodge City, Kansas Corn and Sorghum Basis Relative to Nearby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis Corn ($/bu)	Average Basis Sorghum ($/bu)	Standard Deviation Corn ($/bu)	Standard Deviation Sorghum ($/bu)
March	0.00	-0.45	0.15	0.19
May	-0.01	-0.39	0.15	0.22
July	0.11	-0.28	0.15	0.19
September	0.18	-0.18	0.23	0.23
December	0.01	-0.36	0.17	0.21

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 4A. Garden City, Kansas Corn and Sorghum Basis Relative to Nearby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis Corn ($/bu)	Average Basis Sorghum ($/bu)	Standard Deviation Corn ($/bu)	Standard Deviation Sorghum ($/bu)
March	-0.07	-0.43	0.13	0.18
May	-0.09	-0.39	0.16	0.22
July	0.06	-0.29	0.16	0.19
September	0.11	-0.19	0.22	0.23
December	-0.05	-.36	0.17	0.21

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 5A. Great Bend, Kansas Corn and Sorghum Basis Relative to Nearby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)	Corn ($/bu)	Sorghum ($/bu)
March	-0.12	-0.50	0.11	0.19
May	-0.11	-0.48	0.13	0.20
July	-0.02	-0.39	0.17	0.20
September	0.02	-0.29	0.20	0.24
December	-0.09	-0.46	0.18	0.20

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 6A. Hutchinson, Kansas Corn and Sorghum Basis Relative to Neaby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)	Corn ($/bu)	Sorghum ($/bu)
March	-0.04	-0.45	0.12	0.18
May	-0.10	-0.42	0.14	0.21
July	-0.01	-0.35	0.15	0.19
September	0.06	-0.22	0.22	0.23
December	-0.07	-0.41	0.16	0.20

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 7A. Pratt, Kansas Corn and Sorghum Basis Relative to Nearby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)	Corn ($/bu)	Sorghum ($/bu)
March	-0.04	-0.46	0.12	0.16
May	-0.03	-0.44	0.12	0.18
July	0.09	-0.33	0.14	0.19
September	0.11	-0.17	0.22	0.29
December	-0.02	-0.43	0.18	0.18

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 8A. Salina, Kansas Corn and Sorghum Basis Relative to Nearby CBT Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis		Standard Deviation	
	Corn ($/bu)	Sorghum ($/bu)	Corn ($/bu)	Sorghum ($/bu)
March	-0.12	-0.35	0.15	0.18
May	-0.14	-0.36	0.14	0.22
July	-0.09	-0.35	0.16	0.20
September	-0.03	-0.35	0.16	0.25
December	-0.09	-0.37	0.18	0.19

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 9A. Scott City, Kansas Corn and Sorghum Basis Relative to Nearby CBT Futures, Weekly, Wednesday 1982-1987.

Corn Futures Contract[a]	Average Basis Corn ($/bu)	Average Basis Sorghum ($/bu)	Standard Deviation Corn ($/bu)	Standard Deviation Sorghum ($/bu)
March	-0.03	-0.45	0.12	0.18
May	-0.05	-0.40	0.14	0.22
July	0.11	-0.28	0.25	0.22
September	0.14	-0.23	0.21	0.23
December	-0.01	-0.38	0.17	0.22

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 10A. Topeka, Kansas Corn and Sorghum Basis Relative to Nearby CBT Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract[a]	Average Basis Corn ($/bu)	Average Basis Sorghum ($/bu)	Standard Deviation Corn ($/bu)	Standard Deviation Sorghum ($/bu)
March	-0.04	-0.38	0.11	0.15
May	0.00	-0.37	0.09	0.17
July	0.04	-0.30	0.12	0.20
September	0.09	-0.23	0.16	0.22
December	-0.04	-0.40	0.13	0.19

[a] Includes data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

[b] Assumes a test weight of 56 lbs/bu of sorghum, i.e., sorghum price was converted to $/bu by multiplying $/cwt sorghum price by 0.56.

Table 11A. Cherryvale, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987

Corn Futures Contract	Hedge Ratio[a] Corn (bu.Futures/bu.Cash)	Hedge Ratio[a] Sorghum (bu.Futures/bu.Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	1.02	0.87*	0.19	0.08	6.9	3.6
May	1.03	0.84*	0.15	0.12	5.3	5.1
July	1.06	0.89*	0.18	0.18	6.1	7.7
September	1.13*	0.90*	0.27	0.22	10.2	10.0
December	1.21*	0.93*	0.19	0.13	7.52	6.4

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 12A. Colby, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] (bu.Futures/bu.Cash)		Root Mean Squared Error[b]		Root Mean Squared Percentage Error[c]	
	Corn	Sorghum	Corn ($/bu)	Sorghum ($/bu)	Corn (%)	Sorghum (%)
March	0.89*	0.73*	0.10	0.09	4.3	4.7
May	0.85*	0.72*	0.13	0.14	5.4	6.6
July	0.85*	0.72*	0.14	0.15	5.1	6.8
September	0.85*	0.70*	0.23	0.17	9.4	8.2
December	0.90*	0.74*	0.17	0.13	7.6	7.1

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 13A. Dodge City, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] Corn (bu.Futures/bu.Cash)	Hedge Ratio[a] Sorghum (bu.Futures/bu.Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	0.89*	0.74*	0.14	0.13	5.6	6.4
May	0.88*	0.72*	0.13	0.15	4.9	6.4
July	0.89*	0.77*	0.14	0.14	4.9	5.9
September	0.84*	0.75*	0.20	0.15	7.8	6.8
December	0.91*	0.74*	0.16	0.15	6.6	7.2

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 14A. Garden City, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] Corn (bu.Futures/bu.Cash)	Hedge Ratio[a] Sorghum (bu.Futures/bu.Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	0.90*	0.74*	0.12	0.11	4.7	5.4
May	0.87*	0.73*	0.14	0.15	5.4	6.5
July	0.87*	0.79*	0.15	0.15	5.5	6.4
September	0.86*	0.75*	0.20	0.15	7.8	6.9
December	0.92*	0.74*	0.17	0.14	7.1	7.0

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 15A. Great Bend, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] Corn (bu.Futures/bu.Cash)	Hedge Ratio[a] Sorghum (bu.Futures/bu.Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	0.92*	0.75*	0.11	0.13	4.4	6.6
May	0.92*	0.75*	0.12	0.14	4.7	6.1
July	0.87*	0.77*	0.16	0.15	5.8	6.4
September	0.87*	0.73*	0.18	0.15	7.3	7.1
December	0.91*	0.76*	0.17	0.14	7.6	7.4

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 16A. Hutchinson, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] (bu.Futures/bu.Cash)		Root Mean Squared Error[b]		Root Mean Squared Percentage Error[c]	
	Corn	Sorghum	Corn ($/bu)	Sorghum ($/bu)	Corn (%)	Sorghum (%)
March	0.91*	0.75*	0.11	0.11	4.5	5.3
May	0.86*	0.71*	0.11	0.13	4.3	5.7
July	0.97	0.77*	0.15	0.14	5.8	6.0
September	0.86*	0.75*	0.20	0.15	8.1	6.7
December	0.95	0.75*	0.16	0.13	6.9	6.6

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 17A. Pratt, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] Corn (bu.Futures/bu.Cash)	Hedge Ratio[a] Sorghum (bu.Futures/bu.Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	0.92*	0.78*	0.11	0.10	4.5	4.6
May	0.90*	0.77*	0.10	0.12	3.9	5.1
July	0.92*	0.77*	0.13	0.15	4.7	6.3
September	0.88*	0.73*	0.20	0.23	7.9	10.2
December	0.95	0.80*	0.18	0.14	7.6	7.1

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 18A. Salina, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a]		Root Mean Squared Error[b]		Root Mean Squared Percentage Error[c]	
	Corn (bu.Futures/bu.Cash)	Sorghum	Corn ($/bu)	Sorghum ($/bu)	Corn (%)	Sorghum (%)
March	0.95	0.75*	0.15	0.11	6.4	5.0
May	0.89*	0.69*	0.12	0.13	4.7	5.4
July	0.96	0.74*	0.16	0.14	6.0	5.9
September	0.94	0.76*	0.16	0.18	6.5	8.9
December	0.95	0.75*	0.18	0.13	7.7	6.3

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 19A. Scott City, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] Corn (bu.Futures/bu.Cash)	Hedge Ratio[a] Sorghum (bu.Futures/bu.Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	0.92*	0.72*	0.11	0.12	4.5	5.8
May	0.87*	0.70*	0.12	0.14	4.5	6.1
July	0.86*	0.75*	0.24	0.17	8.7	7.2
September	0.84*	0.73*	0.18	0.14	7.1	6.2
December	0.91*	0.73*	0.16	0.15	6.9	7.3

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]1/2$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.

Table 20A. Topeka, Kansas Corn and Sorghum Hedging Relationships with Corn Futures, Weekly, Wednesday Data 1982-1987.

Corn Futures Contract	Hedge Ratio[a] Corn (bu.Futures/bu.Cash)	Hedge Ratio[a] Sorghum (bu.Futures/bu.Cash)	Root Mean Squared Error[b] Corn ($/bu)	Root Mean Squared Error[b] Sorghum ($/bu)	Root Mean Squared Percentage Error[c] Corn (%)	Root Mean Squared Percentage Error[c] Sorghum (%)
March	1.04	0.85*	0.11	0.12	4.3	5.7
May	1.03	0.80*	0.09	0.13	3.3	5.4
July	1.06*	0.84*	0.12	0.17	4.4	7.2
September	1.06*	0.86*	0.16	0.20	6.3	9.3
December	1.10*	0.81*	0.12	0.15	5.2	7.7

[a] Estimated using data from the 16th day of the previous contract month through the 15th day of the nearby contract month.

Estimated by regressing cash price on corn futures price.

[b] Root mean squared error (RMSE) = $\left[\frac{\Sigma e_i^2}{n-2}\right]^{1/2}$

Where e_i's are the errors from regressing cash price on futures price.

[c] Root Mean Squared percentage error = $\frac{RMSE}{ACP} \times 100$

where ACP is the average cash price.

* Indicates significantly different from 1.0 at the .05 level of significance.