FEASIBILITY OF CROSS-HEDGING GRAIN SORGHUM PRODUCED IN THE TEXAS HIGH PLAINS USING CHICAGO BOARD OF TRADE CORN FUTURES CONTRACTS 1971-1979

by

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ABSTRACT

Purpose: The purpose of this study was to determine if cross-hedging grain sorghum on corn futures contracts could reduce price variation to an individual grain sorghum producer.

Methodology: Weekly cash grain sorghum prices and cash corn prices for the Texas High Plains and closing corn futures prices were collected for the years 1971-1979. The relationship between cash corn prices and cash grain sorghum prices was statistically estimated. Nine arbitrary cross-hedging strategies were formulated for grain sorghum. The hedging strategies were evaluated using a mean/variance analysis, hedging performance, the concept of the minimum risk hedge, and risk shifting effectiveness of the minimum risk hedge.

Significant Findings: A strong relationship existed between cash grain sorghum prices and cash corn prices during 1971-1979. Some significant seasonality effects were found in grain sorghum prices. One cross-hedging strategy was more successful than the other eight strategies. The same strategy was found to be at least equal to or better than a postharvest cash sale.

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Introduction

Grain sorghum[1] is a principal crop in Texas and composed 29.8 percent of total U.S. grain sorghum production in 1979. From 1971 through 1975 grain sorghum was the state's leading crop in terms of total crop value (table 1). Since 1976, grain sorghum has been second only to cotton lint in total value, exceeding wheat, corn, rice, and soybeans. The location of grain sorghum production in Texas is shown in figure 1. This report deals specifically with crop reporting district 1-N which supplied 27.1 percent of Texas' crop in 1978.

Milo producers have historically faced yield risk along with price risk. Aside from yield risk, producers have faced an absolute increase in price variation since 1971 (figure 2). Prior to 1971 grain sorghum prices were relatively stable. The range of intraseasonal price variation was from 8.4 cents per bushel in 1966 to 22.4 cents per bushel in 1967 with an average of 16.8 cents per bushel during the 1960-1970 period. Since 1971, intraseasonal and interseasonal price variation has increased. Sorghum's mean cash prices and standard deviations for 1971 through 1979 are listed in table 2. The standard deviation is a measure of price risk associated with grain sorghum. The larger the standard deviation, the more price risk is involved. The costs of selected inputs used in sorghum production have generally trended upward (table 3), while grain sorghum prices have moved up through 1974 and trended downward since.

To summarize, producers have always faced both yield risk and price risk. Setting yield risk aside, the price risk faced by producers since

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[1]Grain sorghum, sorghum, and milo are different names for the same crop and are used interchangably herein.

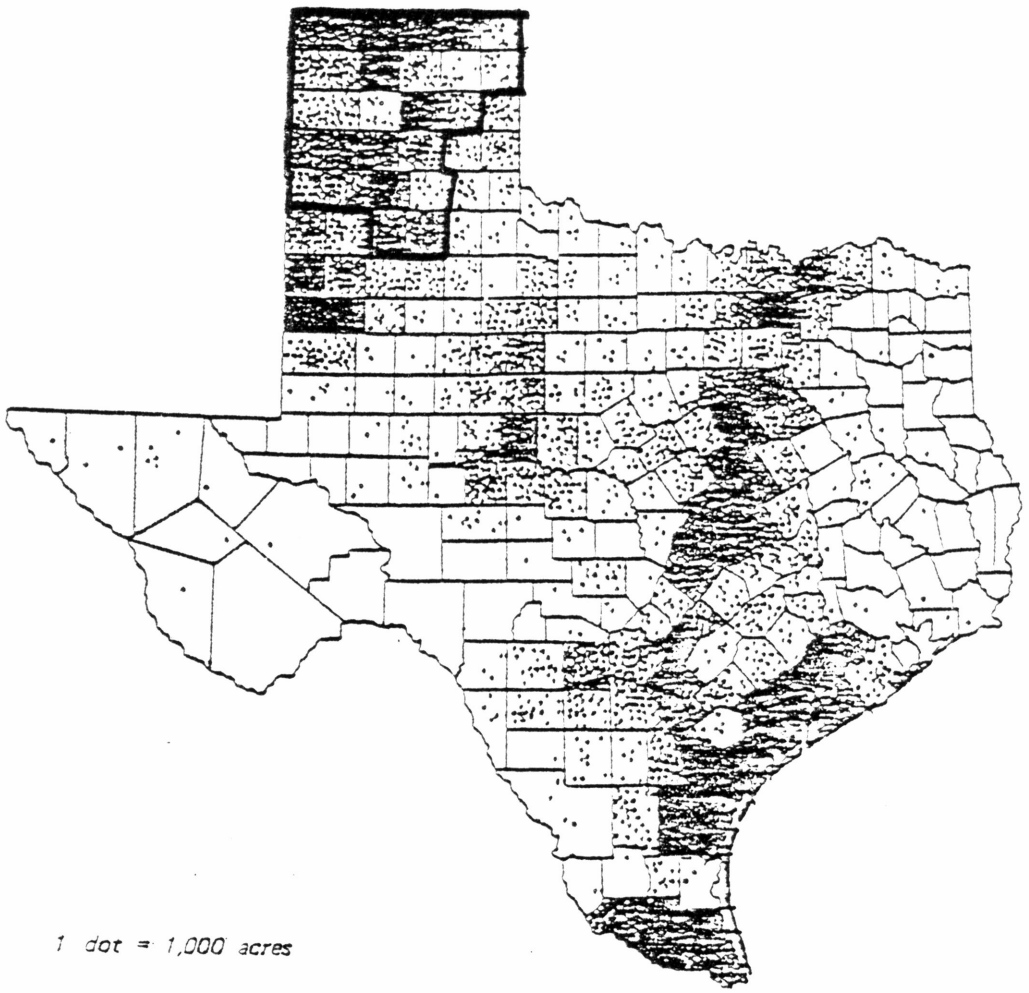

FIGURE 1 AREAS OF TEXAS GRAIN SORGHUM PRODUCTION, 1978

Table 1. Value of Texas Grain Sorghum, 1971-1978

Year	Farm Value	Proportion of Total Texas Crop Receipts
	(1000 dollars)	(percent)
1971	314,235	26.7
1972	357,813	24.5
1973	751,133	26.6
1974	721,076	26.7
1975	677,888	24.3
1976	596,026	19.3
1977	339,983	10.8
1978	278,162	9.6

Source: Texas Department of Agriculture, Texas Agricultural Cash Receipts Statistics, selected issues, Austin, Texas.

FIGURE 2 AVERAGE MONTHLY GRAIN SORGHUM PRICES RECEIVED BY TEXAS FARMERS
JANUARY 1965 - 1979

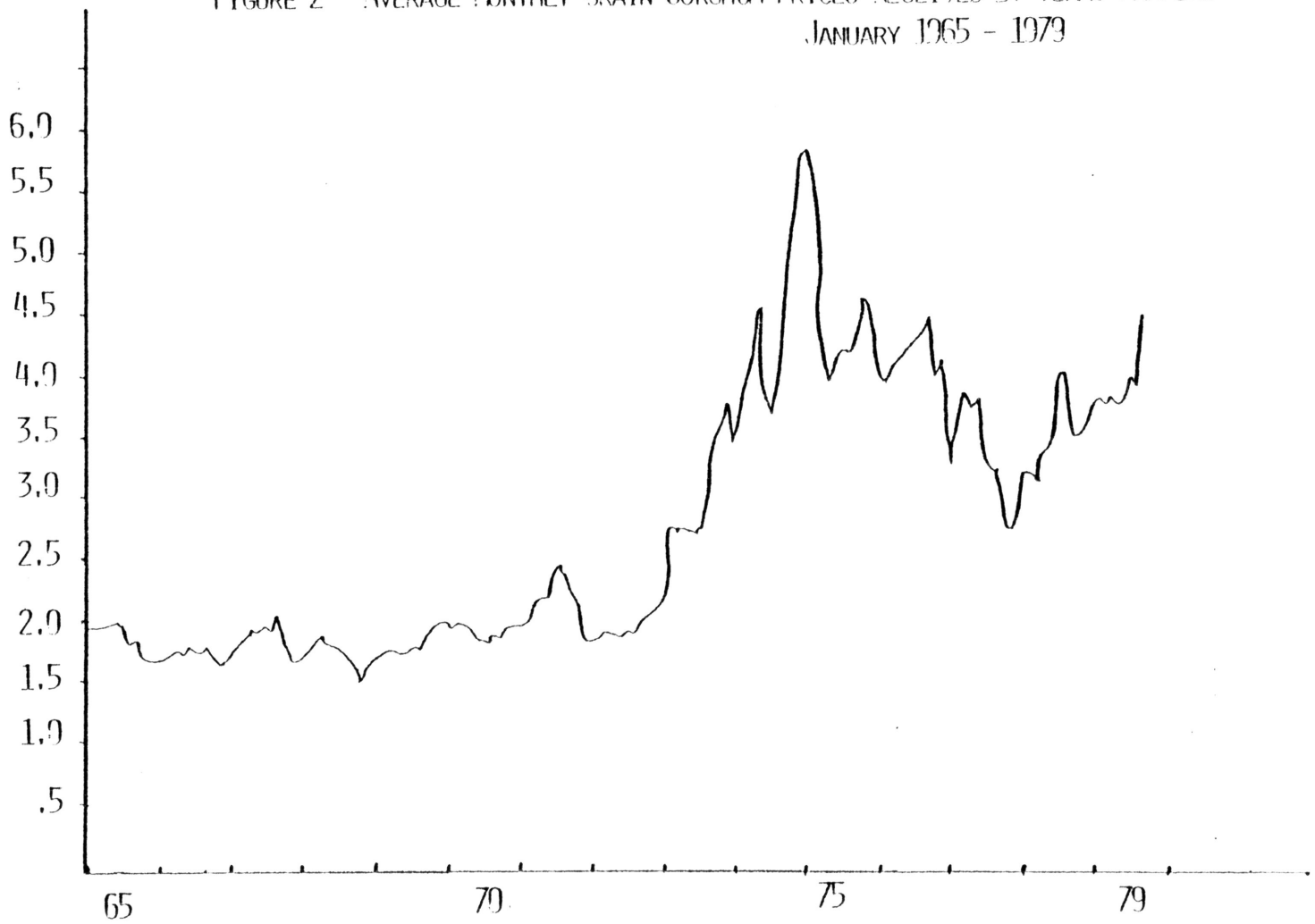

Table 2. Mean, Standard Deviation, and Range of Weekly Farm Prices for Texas Sorghum, 1971-1979

Year	Mean Weekly Price[a]	Standard Deviation	Price Range	
			Minimum	Maximum
		$/bushel		
1971	1.20	.1599	.98	1.46
1972	1.15	.1358	1.05	1.57
1973	1.96	.3837	1.51	2.80
1974	2.61	.4221	1.99	3.36
1975	2.39	.1487	2.13	2.83
1976	2.24	.1907	1.83	2.58
1977	1.76	.1436	1.48	1.95
1978	2.02	.1253	1.78	2.21
1979	2.29	.2370	2.02	2.80

Source: Texas Crop Reporting Service, Texas Livestock Market News, Austin, Texas.

[a]Based on 52 weekly prices each year. Assuming that prices were normally distributed at least two-thirds of the year's prices would fall plus or minus one standard deviation from the mean.

Table 3. Costs of Selected Grain Sorghum Production Inputs, 1971-1979

Year	Annhydroos Ammonia	Diesel Fuel	Hybrid Seed	Parathion Insecticide
	($/ton)	($/gallon)	($/cwt)	($/gallon)
1971	75.00	.16	21.50	3.80
1972	76.00	.16	22.50	5.00
1973	82.00	.19	23.50	4.30
1974	210.00	.32	27.50	6.00
1975	232.50	.35	36.50	9.30
1976	172.50	.37	37.00	8.70
1977	162.50	.41	43.00	8.51
1978	150.00	.43	40.00	8.54
1979	200.00	.90	60.00	9.90

Source: 1971-1978 Texas Department of Agriculture, Texas Prices Received and Paid by Farmers, selected issues, Austin, Texas; 1979 Prices in production area obtained directly by author.

1971 has substantially increased with year-to-year mean price change of 21.4 percent.

Research Problem

The purpose of this paper was to determine whether cross-hedging provides a grain sorghum producer with a feasible means of forward pricing his crop and increasing income while reducing price variation.

Objectives

I. Determine the relationship between corn and grain sorghum prices.

II. Formulate simple cross-hedging strategies for grain sorghum.

III. Evaluate hedging strategies to determine effectiveness for forward pricing a crop.

Proposed Solution

The proposed means of forward pricing a crop, reducing price variation, and increasing producer's income is to cross-hedge grain sorghum using Chicago Board of Trade corn futures contracts. The Chicago Board of Trade is an organized futures market where futures contracts to deliver or take delivery of a precise quantity and quality commodity are traded. Price risk may be reduced through the futures market with hedging. Hedging entails simultaneously holding opposite positions in the cash and futures market. For example, a corn producer commits resources (i.e., labor, fertilizer, seed, herbicides, etc.) to corn production. When a producer commits resources to the production process, he sells corn futures contracts to protect against a price drop. Thus, he is growing a crop and at the same time holding a short (sold) position in corn futures.

After a producer harvests and sells the corn, he buys back the corn futures contracts, thereby closing the hedge. Selling in the futures market while buying in the cash market is known as a short hedge. Cross-hedging is used to forward price a crop when no usable future contract exists for the particular cash commodity being produced. Cross-hedging is simultaneously holding opposite positions in the cash and futures market; however, a related commodity's futures contract is used.[2] For example, a grain sorghum producer cross-hedges by selling corn futures. Should a producer sell futures without an opposite simultaneous action in the cash market (i.e., production), he is speculating. Speculation occurs when the futures market transaction has no simultaneous opposite transaction in the cash market.

How effective a hedge performs in protecting a target price depends on the basis behavior. A target price is the price a hedge tries to procure through hedging. Basis is the difference between the cash price and the futures price. An illustration of the short hedging procedure follows:

Opening date	Closing date	Gain/Loss
Buy C_1	Sell C_2	$C_2 - C_1$
Sell F_1	Buy F_2	$F_1 - F_2$
BS_1	BS_2	$BS_2 - BS_1$

where: C = cash price

F = futures price

BS = basis or C - F.

[2] A major disadvantage of cross-hedging is that the producer cannot actually deliver against the sold futures contracts, i.e., he cannot deliver milo against the corn futures contracts.

The net or final price from a short hedge can be determined using any of three methods.

(1) $NP = C_2 + (F_1 - F_2)$

(2) $NP = F_1 + BS_2$

(3) $NP = C_1 + (BS_2 - BS_1)$

Examples of hedges with different basis behaviors are shown in table 4. The target prices are the opening cash prices. If the basis at the close of a hedge is the same as it was when the hedge was opened, the net price and the target price will be equal, resulting in a "perfect" hedge. Example I's target price and net price were the same because the basis was the same at the open and close of the hedge. However, should the basis change from the opening of a hedge to the close of hedge the net price and target price will be different. When a basis increase occurs in a short hedge, the net price will exceed the target price. The producer gains from the increase in basis. Example II's net price was .0364 dollars per bushel higher than the target price due to a basis increase of .0364 dollars per bushel. Should a basis decrease occur, the net price will be less than the target price by the amount of the decrease. Example III's net price was .1012 dollars per bushel lower than the target price because the basis decreased .1012 dollars per bushel.

When a producer hedges, he trades price risk for basis risk. The second method for calculating net price illustrates the importance of the closing basis. Accurate closing basis knowledge would allow a producer to determine the net price of a hedge. However, a producer has only an estimate of the closing basis. More accurate basis estimates would allow a producer to predict the expected net price with more certainty.

In summary, the main reasons a producer would cross-hedge are pro-

Table 4. Examples of Hedging with Different Basis Changes

I. Constant Basis or Perfect Hedge

	Open		Close		Gain/Loss	
buy cash	1.40	$/bu	sell cash	1.06 $/bu	-.34	$/bu
sell futures	1.52	$/bu	buy futures	1.18 $/bu	+.34	$/bu
Basis	- .12	$/bu	Basis	- .12 $/bu	0	$/bu

Target Price = 1.40 $/bu

Δ Basis = -.12 + .12 = 0 $/bu

Net Price = 1.40 + 0

= 1.40 $/bu

II. Basis Increase

	Open		Close		Gain/Loss	
buy cash	2.716	$/bu	sell cash	2.3324 $/bu	-.3836	$/bu
sell futures	3.115	$/bu	buy futures	2.6950 $/bu	.42	$/bu
Basis	- .399	$/bu	Basis	- .3626 $/bu	+.0364	$/bu

Target Price = 2.716 $/bu

Δ Basis = -.3626 + .399 = .0364 $/bu

Net Price = 2.716 + .0364

= 2.7524 $/bu

III. Basis Decrease

	Open		Close		Gain/Loss	
buy cash	2.352	$/bu	sell cash	1.9208 $/bu	-.4312	$/bu
sell futures	2.860	$/bu	buy futures	2.5300 $/bu	+.33	$/bu
Basis	- .508	$/bu	Basis	- .6092 $/bu	-.1012	$/bu

Target Price = 2.352 $/bu

Δ Basis = -.6092 + .508 = -.1012 $/bu

Net Price = 2.352 -.1012

= 2.2508 $/bu

curing a higher price and lowering price variation. Cross-hedging grain sorghum involves selling corn futures while producing grain sorghum in the cash market and closing the hedge by repurchasing the corn futures contract.

Review of Literature

No published studies exist to examine the feasibility of cross-hedging grain sorghum in the Texas High Plains. However, previous studies are available where similar analyses were performed on other commodities for different production areas. Working examined the hedging of sizable wheat inventories by large flour mills. Part of Working's methodology was to regress the change in the spot premium on the opening spot premium on a certain day.[3] The reason for the regression was to provide for basis forecasting so the net price could be more accurately estimated. The paper listed several reasons large flour mills hedged wheat inventories. One of the main reasons was reduction of price risk.

Purcell, Holland, and Hague applied a mean/variance analysis to evaluate the effectiveness of alternative hedging strategies for cattle feeding. The area for the study was the Texas High Plains, Oklahoma Panhandle, Kansas, and New Mexico. Weekly price and cost data for the years 1965-1970 were used in seven hedging strategies to determine effectiveness for each strategy. The return's mean and variance were calculated for each strategy. These results were compared to the mean return and variance for a cash position only (i.e., no use of futures markets). The study found three hedging strategies with a higher mean returns and a lower variances than the cash strategy.

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[3]Spot premium and basis are the same. Cash price minus futures price.

Kenon and Blakely examined basis estimation procedures and hedging effectiveness for corn and soybeans produced in Virginia. Three methods for predicting harvest basis were studied: (1) a 3-year moving average, (2) regression analysis, and (3) a 5-year moving average. In addition to basis prediction, hedging effectiveness was examined for three simple hedging strategies. Kenon and Blakely found the 3-year moving average to be the most accurate basis forecastor. The study found the hedging strategies at least equal to the cash-only strategy in terms of mean return and variance.

Another means of ascertaining hedging effectiveness is to regress the change in the cash price on the change in the futures price over several hedging periods:

$$\Delta C = a + b\Delta F \quad (4)$$

where: ΔC is the change in the cash price during a hedge.

a is the intercept.

ΔF is the change in the futures price during a hedge.

b is the slope of the regression line.

Heifner derived this hypothesis as a method to approximate the risk minimizing hedging level. According to Heifner, holding one dollar of futures for every dollar of cash commodity is the optimal hedging level only if cash and futures prices are perfectly negatively correlated. When the cash and futures prices are not perfectly correlated, the risk minimizing hedge level can be approximated with the slope coefficient or B. Risk shifting effectiveness of the minimum risk hedge is measured by the coefficient of determination (r^2) from the regression of the cash price change on the futures price change. For example, a slope coefficient of .75 and r^2 of .95 suggests (1) holding .75 cents of futures for

every dollar of cash commodity and (2) that 95 percent of the risk has been shifted using the futures market.

Heifner's hypothesis was applied by Shafer and Howard to determine hedging effectiveness for cotton in three different areas of the country. Simple hedging strategies were formulated along with an estimation of the harvest basis. The study found the minimum risk hedging level for the High Plains area was .82 units of futures for every 1 unit of the cash commodity for the 1971-1978 period. For the same area and period, the risk shifting effectiveness of the January through December hedging period was .96; i.e., 96 percent of the price risk had been shifted by hedging. However in most cases, especially 1973, the cash or unhedged price was higher than the net price from hedging. Cash prices frequently exceeded the hedged net prices because of rising cash prices and basis decreases during the hedge.

Procedure

Data. Weekly price data for cash sorghum, cash corn, and closing Chicago Board of Trade corn futures contracts were gathered for the nine years 1971-1979. Midweek cash sorghum and corn quotations were obtained from weekly issues of the Texas Livestock Market News for the area north of the Canadian River. Chicago Board of Trade midweek closing corn futures prices were collected from 1971-1978 issues of the Statistical Annual of the Chicago Board of Trade. Closing corn futures quotations for 1979 were collected from the Wall Street Journal. The data were punched on computer cards and then placed in direct access files. To equalize corn and sorghum in terms of value per unit weight, cash sorghum prices were converted from dollars per hundredweight to dollars per

bushel by multiplying cash sorghum prices by .56[4]

Descriptive Statistics and Graphs. To determine the relationship between cash sorghum and corn prices, several descriptive statistics were computed from the midweek data. The mean, standard deviation, and range were calculated for the midweek cash sorghum prices, cash corn prices, and the first five futures contract months prices available each week. Each statistic was computed for each calendar year and for the entire nine year period. The first five futures contracts available each midweek were plotted by year to graphically delineate movement of each option. Cash sorghum prices were plotted against cash corn prices to graphically examine their relationship. Correlation coefficients were calculated for cash sorghum prices against (1) cash corn prices and (2) each corn futures option to ascertain whether a linear relationship existed. Correlation matrices were computed for each calendar year as well as the nine year period. The yearly correlation matrices were compared to the overall matrix to determine if the same relationship existed during a certain year as existed in the nine year data matrix.

Price Regressions. Linear regression was used to evaluate the relationship between cash sorghum prices, cash corn prices and various corn futures prices. Simple regression was used to relate the price of cash sorghum to the price of cash corn:

(5) $Pmilo = a + bPcorn$

where: Pmilo is the weekly price of grain sorghum

a is the intercept of the regression line

b is the slope of the regression line

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[4]A bushel of corn weighs 56 pounds.

and Pcorn is the weekly price of cash corn.

From this regression the following hypotheses were tested:

I H_o: Pmilo = .95 Pcorn (β_1 = .95)

H_A: Pmilo ≠ .95 Pcorn (β_1 ≠ .95)

α = .05

II H_o: β_o = 0

H_A: β_o ≠ 0

α = .05

A slope of .95 was tested because research shows sorghum to be 95 percent as good as corn for feeding livestock.

To test for the possible effects of seasonality on the corn/sorghum price relationship, eleven dummy variables were added to the regression where:

Dummy 1 was 1 in January and 0 all other months.

Dummy 2 was 1 in February and 0 all other months.

Dummy 3 was 1 in March and 0 all other months.

⋮

Dummy 11 was 1 in November and 0 all other months.

December received no dummy variable as it was the base period. Multiple regression was used to estimate the price of sorghum as a function of the price of corn and the eleven seasonality variables:

(6) Pmilo = f(Pcorn, Dummy 1 ... Dummy 11)

All regressions were performed for each year and for the entire nine year period. Each regression model was evaluated for reasonableness in terms of R^2 and t-tests on slope coefficients, intercept coefficients, and F-

test was used to evaluate the model for goodness of fit.

Hedging Strategies. Nine arbitrary cross-hedging strategies were formulated to determine if cross-hedging could: (1) obtain targer prices, (2) reduce price risk, and (3) increase the price received by a producer. The strategies were:

Strategy I - December Cash Sale: Sell the harvested crop during the second week of December. Strategy I served as a base to evaluate cross-hedging strategies that were closed in December soon after harvest.

Strategy II - March Cash Sale: Hold the harvested crop until the following March then sell it. Strategy II served as a base to evaluate hedging strategies that were closed in March following harvest of the previous fall.

Strategy III - June Week 1 to December Week 1: Open the hedge the first week of June, early growing season, then close the hedge the first week of December.

Strategy IV - June Week 2 to December Week 2: Open the hedge the second week of June, early growing season, with the close of the hedge occuring the second week of December. Strategies III and IV are very similar but may detect differences in basis behavior over slightly different periods.

Strategy V - June 1 1% December Hedge: Open a hedge when the cash price drops 1 percent of the June first price. The hedge was closed the second week of December.

Strategy VI - June to March Hedge: Open the hedge the first week of June, and close the following March. Strategy VI was used to examine whether December or March hedges were more successful.

Strategy VII - July to December Hedge: Open a hedge the third week of

July, middle of the growing season, closing the hedge during the second week of December.

Strategy VIII - June 1 2% to December Hedge: Open a hedge when the cash price drops 2 percent of the June 1 price. Close the hedge the second week of December. Strategy VIII is strategy V except Strategy VIII used a 2% trip. The reason for the 2% was to permit more flexibility in an attempt to lock in a higher target price.

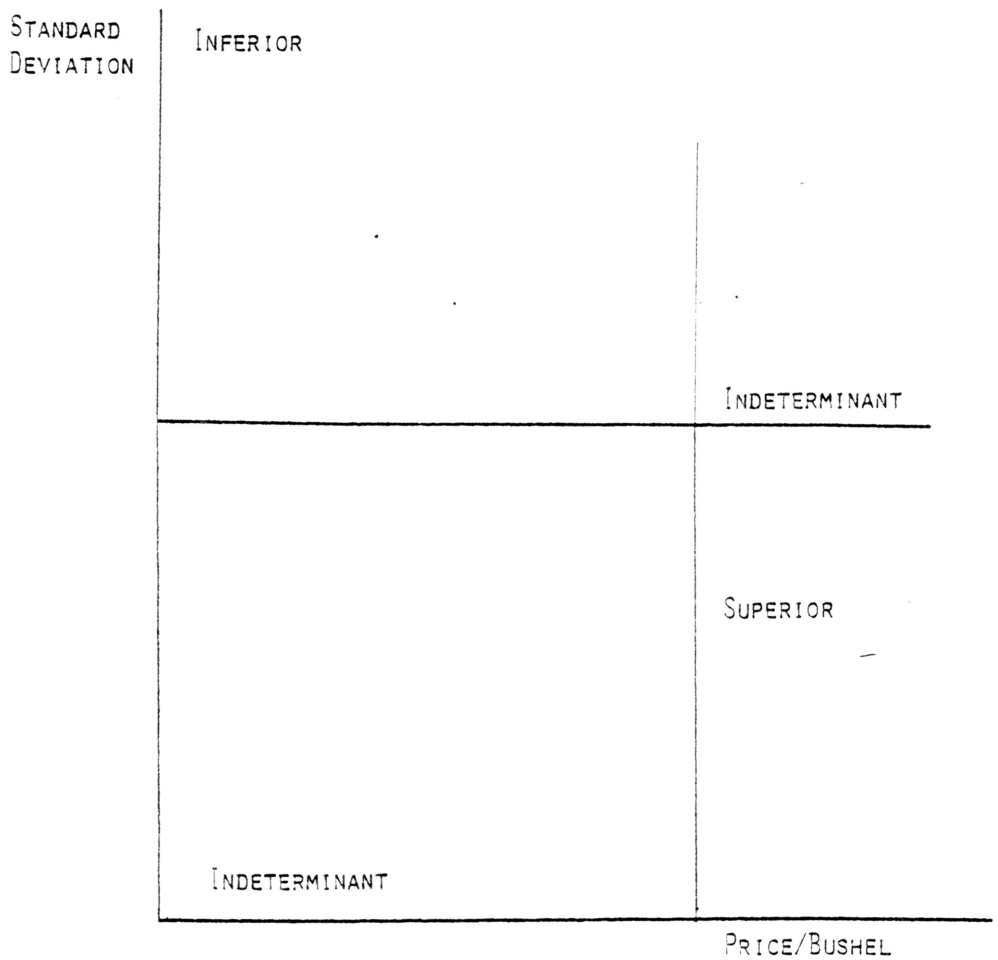
Strategy IX - June 1 2% to March Hedge: Begin the first of June. Hedge in the following March contract if a 2%, of the June 1 price, drop in cash prices occurs. Close the hedge the following March. Strategy IX, like Strategy VI, was used to determine whether December or March was the best hedging month.

Strategy X - June 1 Variable % to December Hedge: Beginning on June 1 open a hedge if cash sorghum prices fall 2% of the June 1 level. If cash prices rise more than 10% over the June 1 cash price, hedge as soon as prices drop 1% of the June first price. Close the hedge the second week of December.

Strategy XI - June 1 Variable % to March Hedge: Beginning on June 1, open a hedge if cash sorghum prices fall 2% of the June 1 level. If cash sorghum prices rise over 10% of the June 1 level, hedgs as soon as prices drop 1% of the June first price. Close the hedge the following March. The purpose of the variable percentages of Strategies X and XI to obtain a higher target price. Strategies X and XI also examined the question of hedging in December versus March.

Evaluation Criteria. The hedging strategies' performances were evaluated with several criteria. A mean/variance graph was used to compare the average net price and standard deviation to the mean cash price

FIGURE 3: MEAN/VAIANCE ANALYSIS OF HEDGING STRATEGIES VERSUS CASH SELLING BASE



and standard deviation which served as the base (figure 3). Average net price was compared with average target price to determine if, on the average, hedging protected the target price. The risk minimizing hedging level for each strategy was estimated by regressing the change in cash prices that occur during a hedge on the change in the futures prices that occur during the hedge. Hedging effectiveness of the minimum risk hedges was based on the r^2's associated with the same regressions.

Basis Behavior. To be able to better predict the closing basis, several statistics were calculated. The mean, standard deviation, and range were computed for the opening, closing, and the changes in basis. Yearly basis changes were calculated between planting time and selling time in either December or March. Corn and soybean bases were plotted to graphically delineate movement of the corn and sorghum bases.

Results

A strong relationship between cash corn and cash sorghum prices was suggested by plotting the price of cash sorghum and cash corn on the same axes (figure 4). Overall cash corn and cash sorghum prices tended to move in the same direction. A similar situation was found to apply to the corn and sorghum bases. The corn and sorghum bases had a high positive correlation (figure 5).

As expected from the plots, the overall linear correlation coefficients for cash sorghum prices against (1) cash corn and (2) corn futures prices were close to +1.0 (table 5). Correlation coefficients close to +1.0 mean that a strong positive relationship existed between cash sorghum prices and both cash corn prices and corn futures prices. Even though the overall correlation coefficients were between .95 and .99, the correlation

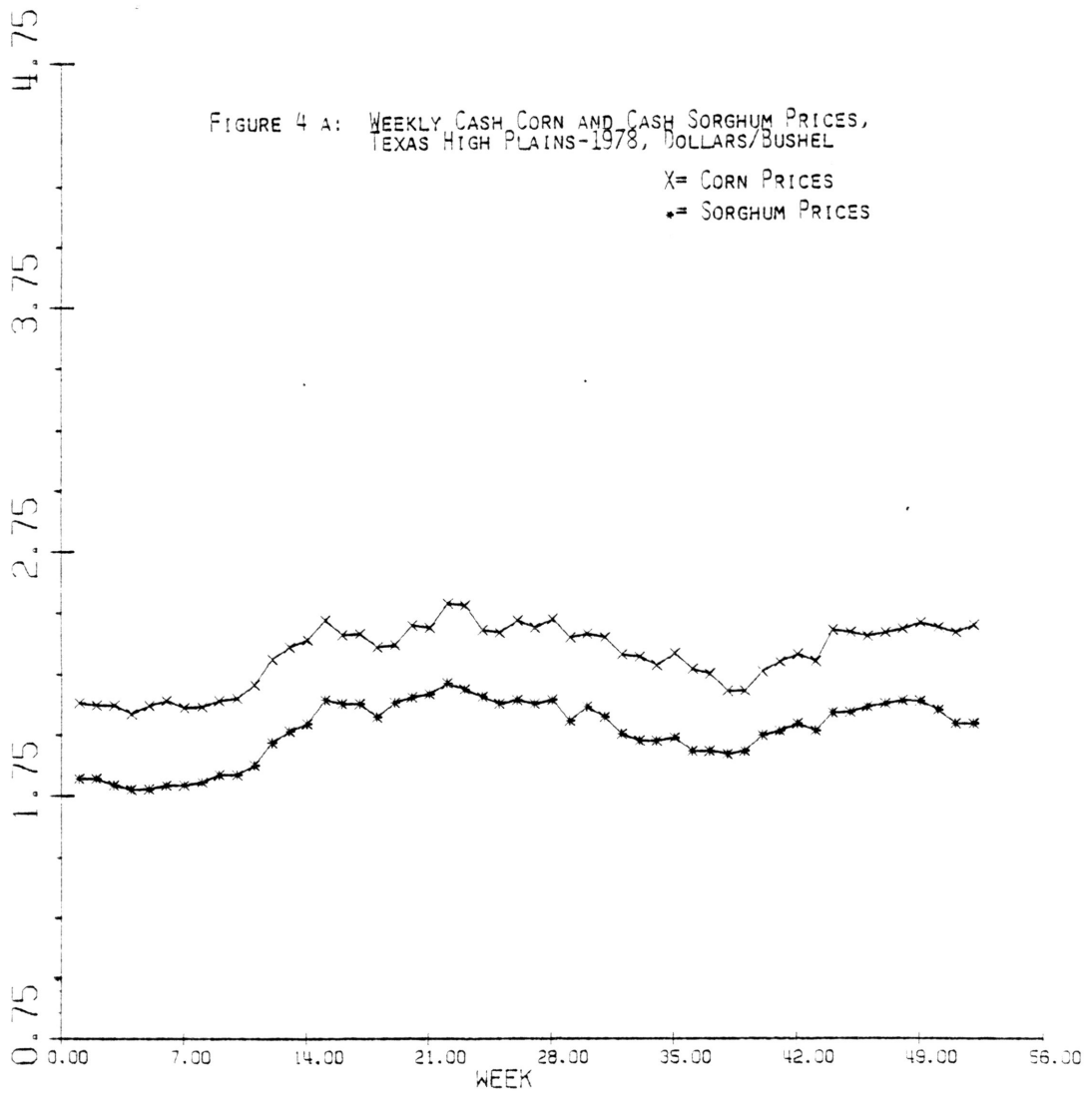


FIGURE 4 A: WEEKLY CASH CORN AND CASH SORGHUM PRICES, TEXAS HIGH PLAINS-1978, DOLLARS/BUSHEL

X= CORN PRICES

*= SORGHUM PRICES

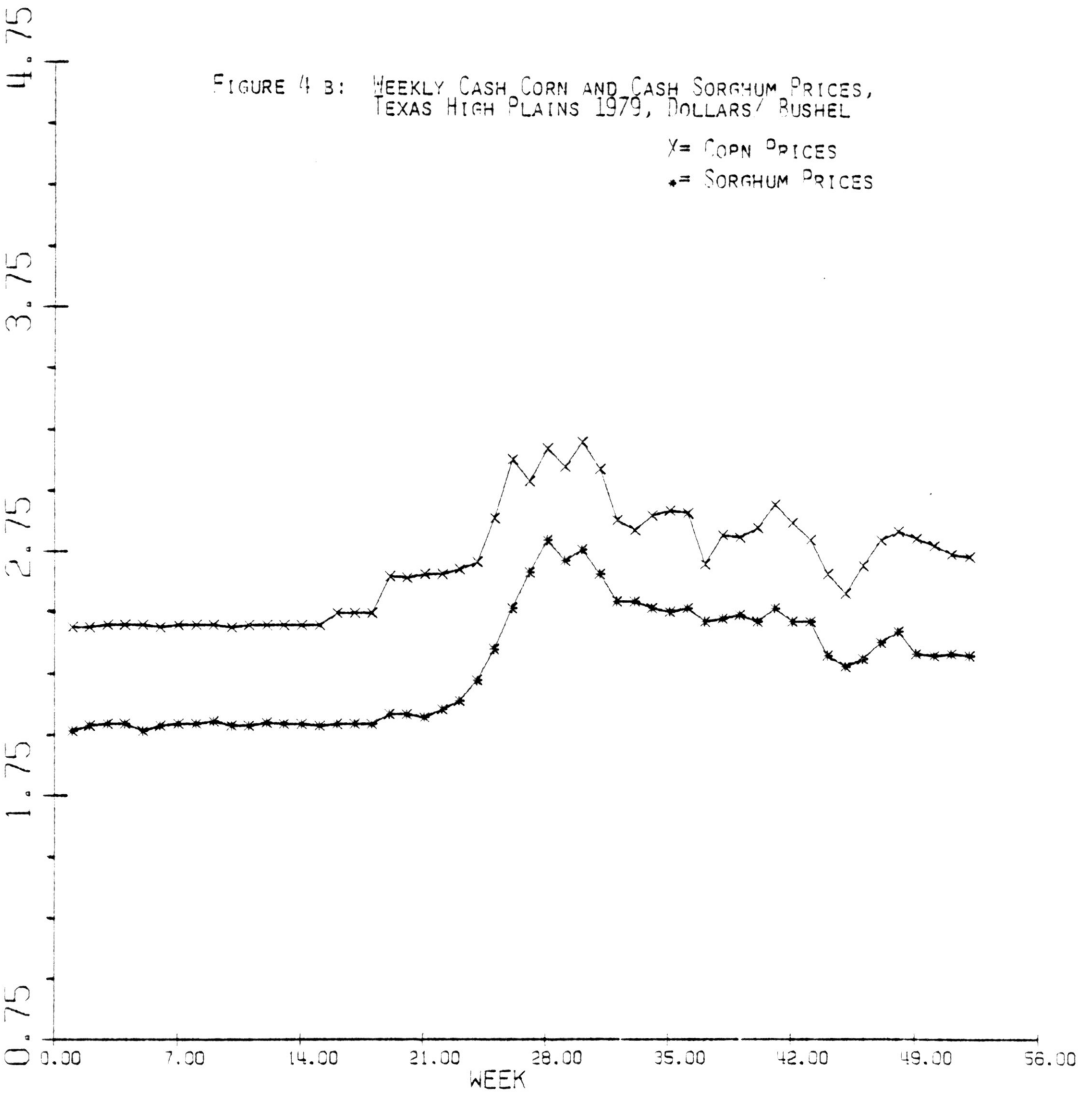


FIGURE 4 B: WEEKLY CASH CORN AND CASH SORGHUM PRICES,
TEXAS HIGH PLAINS 1979, DOLLARS/ BUSHEL
X= CORN PRICES
*= SORGHUM PRICES
4.75
3.75
2.75
1.75
0.75
0.00
7.00
14.00
21.00
28.00
35.00
42.00
49.00
56.00
WEEK

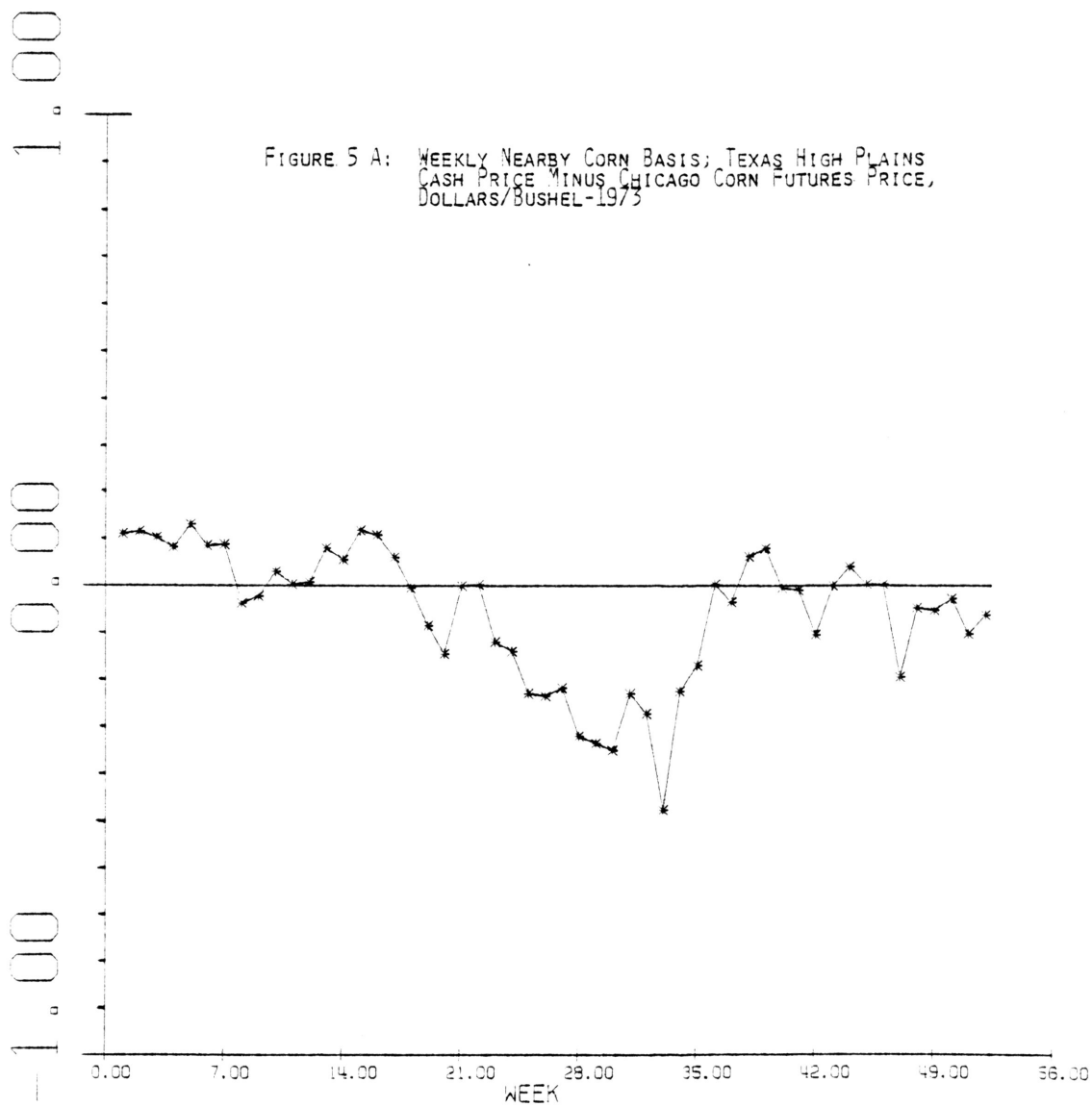


FIGURE 5 A: WEEKLY NEARBY CORN BASIS; TEXAS HIGH PLAINS CASH PRICE MINUS CHICAGO CORN FUTURES PRICE, DOLLARS/BUSHEL-1973

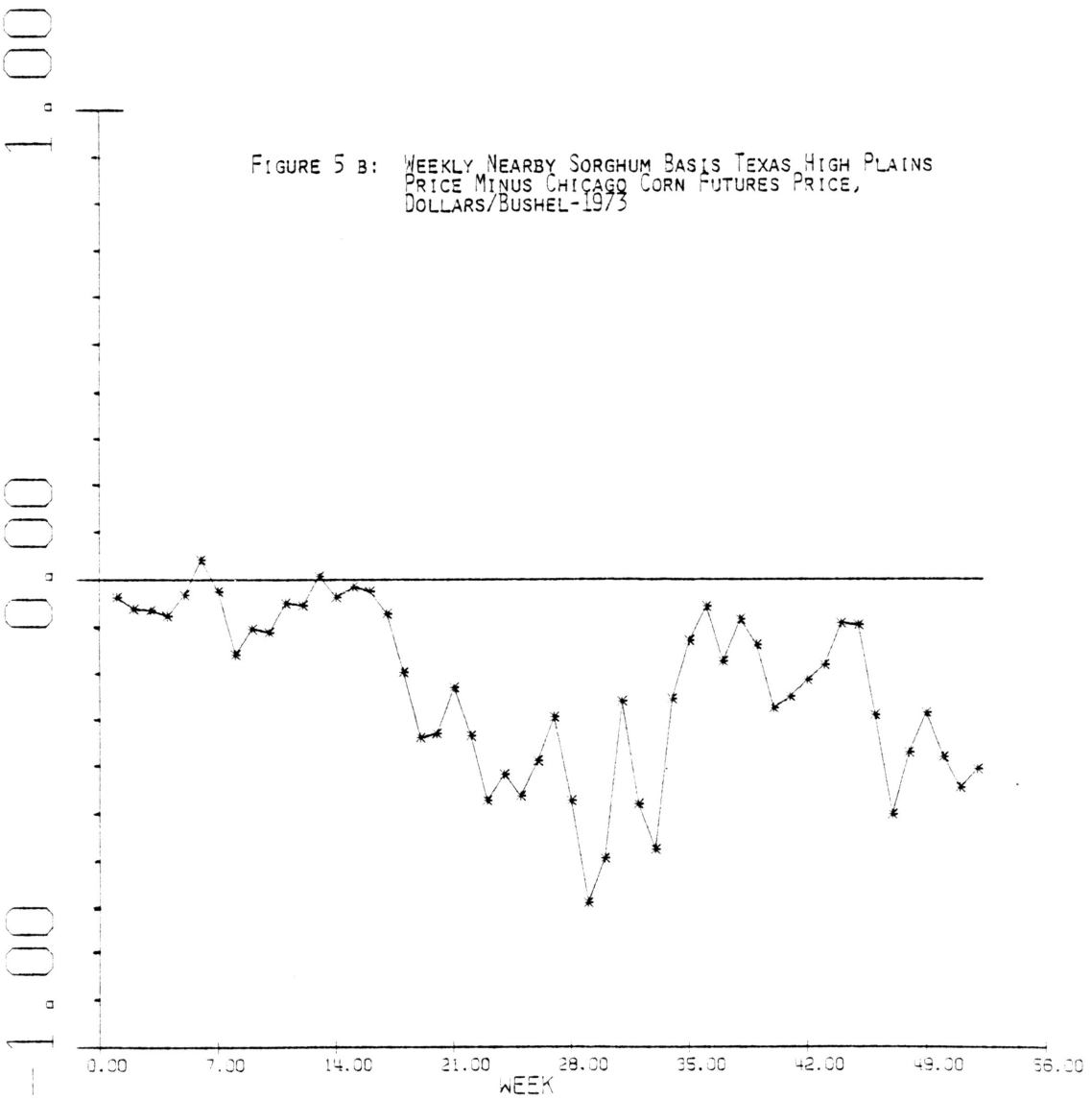


FIGURE 5 B: WEEKLY NEARBY SORGHUM BASIS TEXAS HIGH PLAINS PRICE MINUS CHICAGO CORN FUTURES PRICE, DOLLARS/BUSHEL-1973

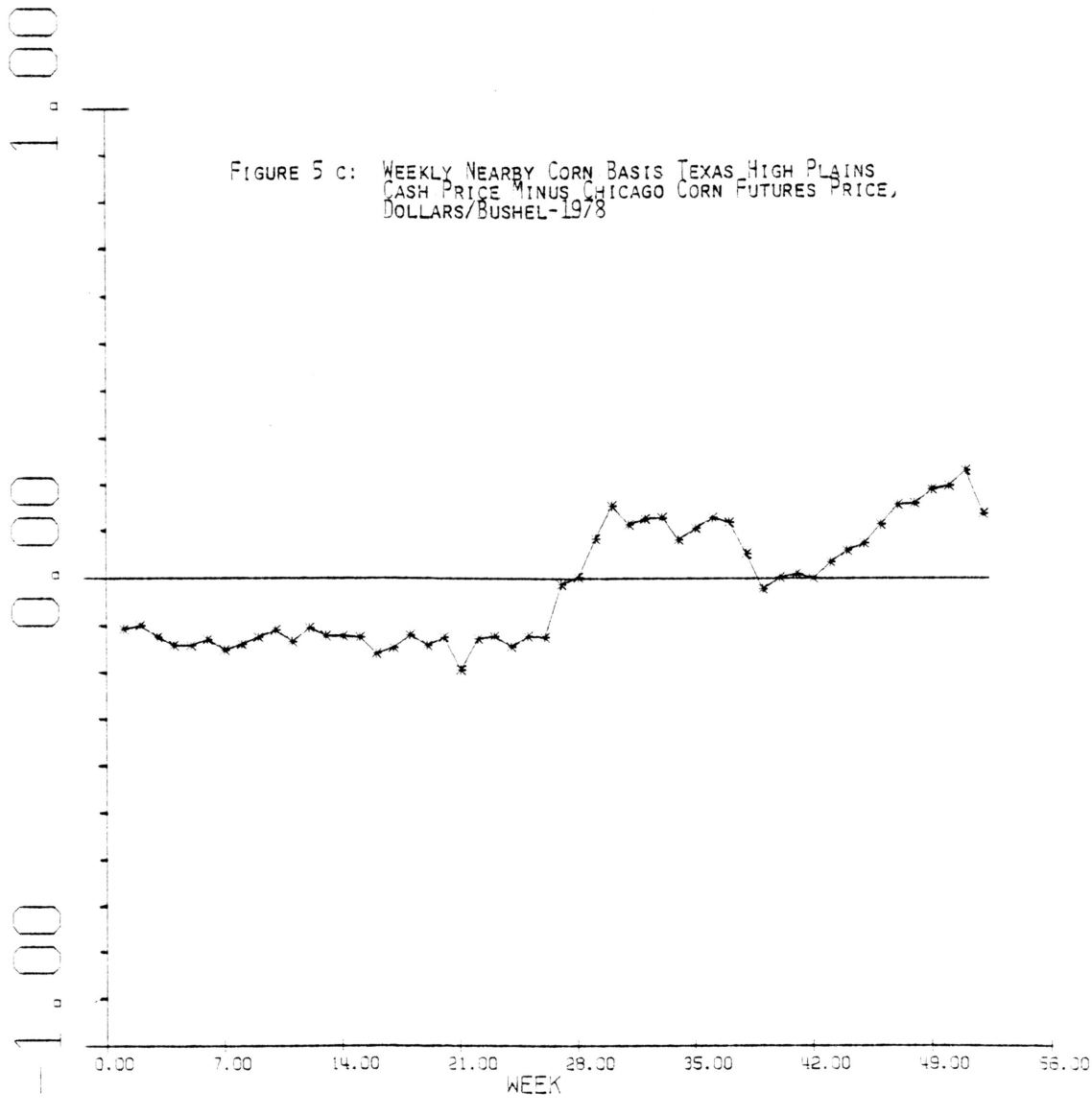


FIGURE 5 C: WEEKLY NEARBY CORN BASIS TEXAS HIGH PLAINS CASH PRICE MINUS CHICAGO CORN FUTURES PRICE, DOLLARS/BUSHEL-1978

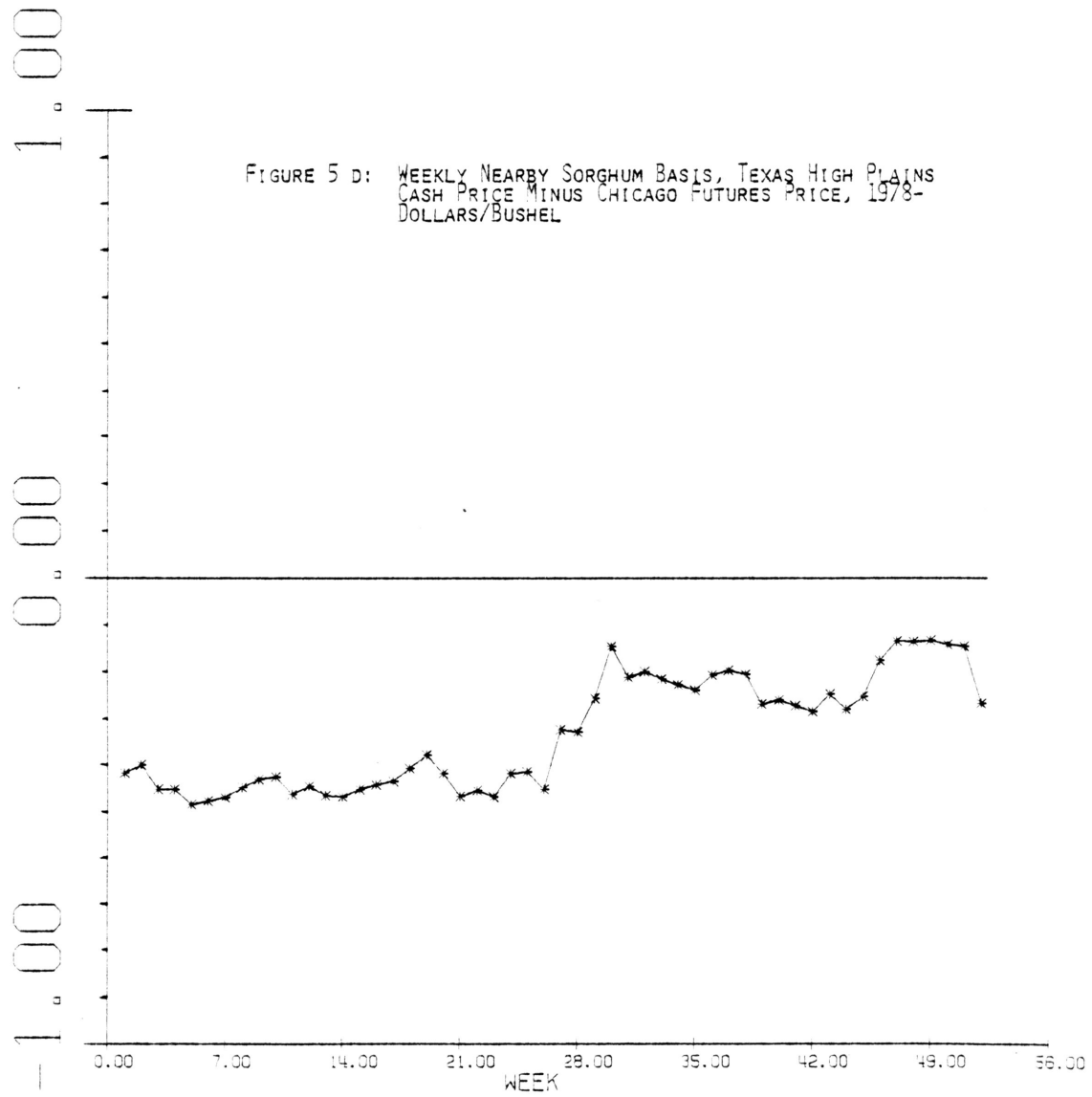


FIGURE 5 D: WEEKLY NEARBY SORGHUM BASIS, TEXAS HIGH PLAINS CASH PRICE MINUS CHICAGO FUTURES PRICE, 1978- DOLLARS/BUSHEL

Table 5. Correlation Coefficients Between Weekly Prices for Cash Sorghum, Cash Corn, and Corn Futures, 1974, 1975 1979, and 1971-1979

Year	Cash Corn	Nearby[a] Futures Contract	2nd Nearby[b] Futures Contract	3rd Nearby[c] Futures Contract	Number of Observations
	----------(r-value)----------				
1974	.9625	.9326	.9590	.9767	52
1975	.8829	.7100	.5417	.5096	52
1979	.9487	.9037	.8938	.9046	51
1971-1979	.9826	.9668	.9627	.9577	468

[a]The nearby futures is the nearest trading contract calendar month available for trading at any point in time.

[b]The second nearby futures contract is the second closest trading month available for trading at any point in time.

[c]The third nearby futures contract is the third closest contract month available for trading at any point in time.

coefficient varied between +.5 and +1.0 among the nine years. For the years with correlation coefficients close to +.5, the relationship between sorghum prices, cash corn prices and corn futures prices was weak resulting in higher risk for cross-hedges.

Regressing cash sorghum price on cash corn price revealed some unanticipated results. Instead of the hypothesized equation:

(7) Pmilo = 0 + 0.95 Pcorn

where Pmilo = the cash sorghum price in $/bushel

Pcorn = the cash corn price in $/bushel

b_1 = .95, the slope of the regression line,

the following equation was found:

(8) Pmilo = .05 + .861 Pcorn.

The intercept was significantly above the hypothesized zero and the slope was significantly below .95, α = .01. An intercept of .05 means that if corn price was zero sorghum price would be five cents per bushel. Selected yearly regression models and the overall model for the nine year period are presented in table 6. The addition of eleven dummy variables found some definite seasonality (tables 7a - 7c). The number of significant seasonality variables ranged from 5 in the overall model to 11 in the 1972 model.

The mean/variance analysis of the hedging strategies is presented in figures 6 and 7. Figure 6 is the analysis for all hedging strategies that were closed in December. The intersection of the solid lines is the mean net price and standard deviation of the December cash sale, strategy I, which served as the evaluation base for December closing hedges. Figure 7 is the mean/variance graph for all hedging strategies closed in March. The intersection of the solid lines is the mean net price and

FIGURE 6: MEAN/VARIANCE ANALYSIS OF HEDGING STRATEGIES CLOSED IN DECEMBER WITH STRATEGY I BASE

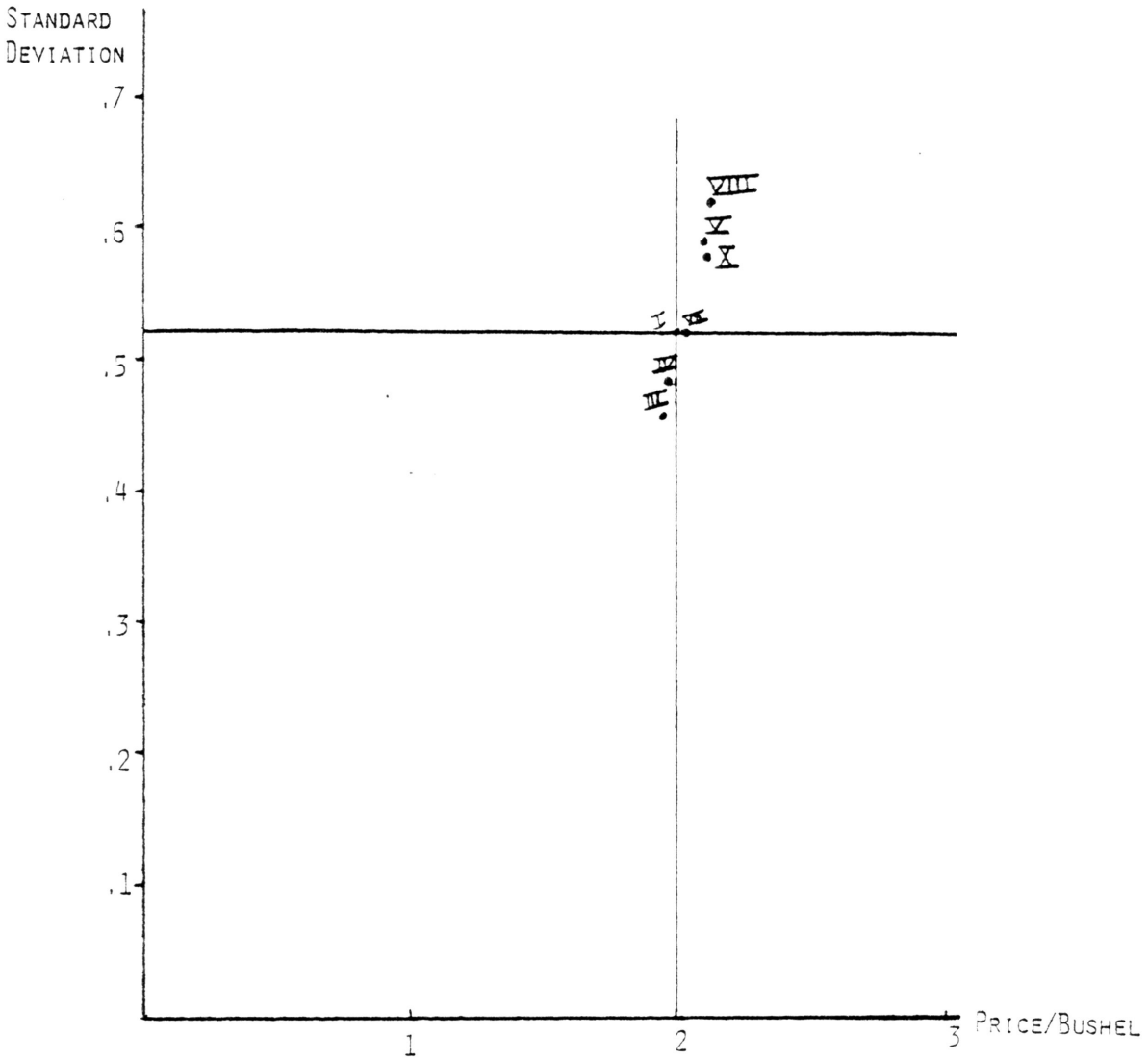


FIGURE 7: MEAN/VAIANCE ANALYSIS OF HEDGING STRATEGIES CLOSED IN MARCH WITH STRATEGY II BASE

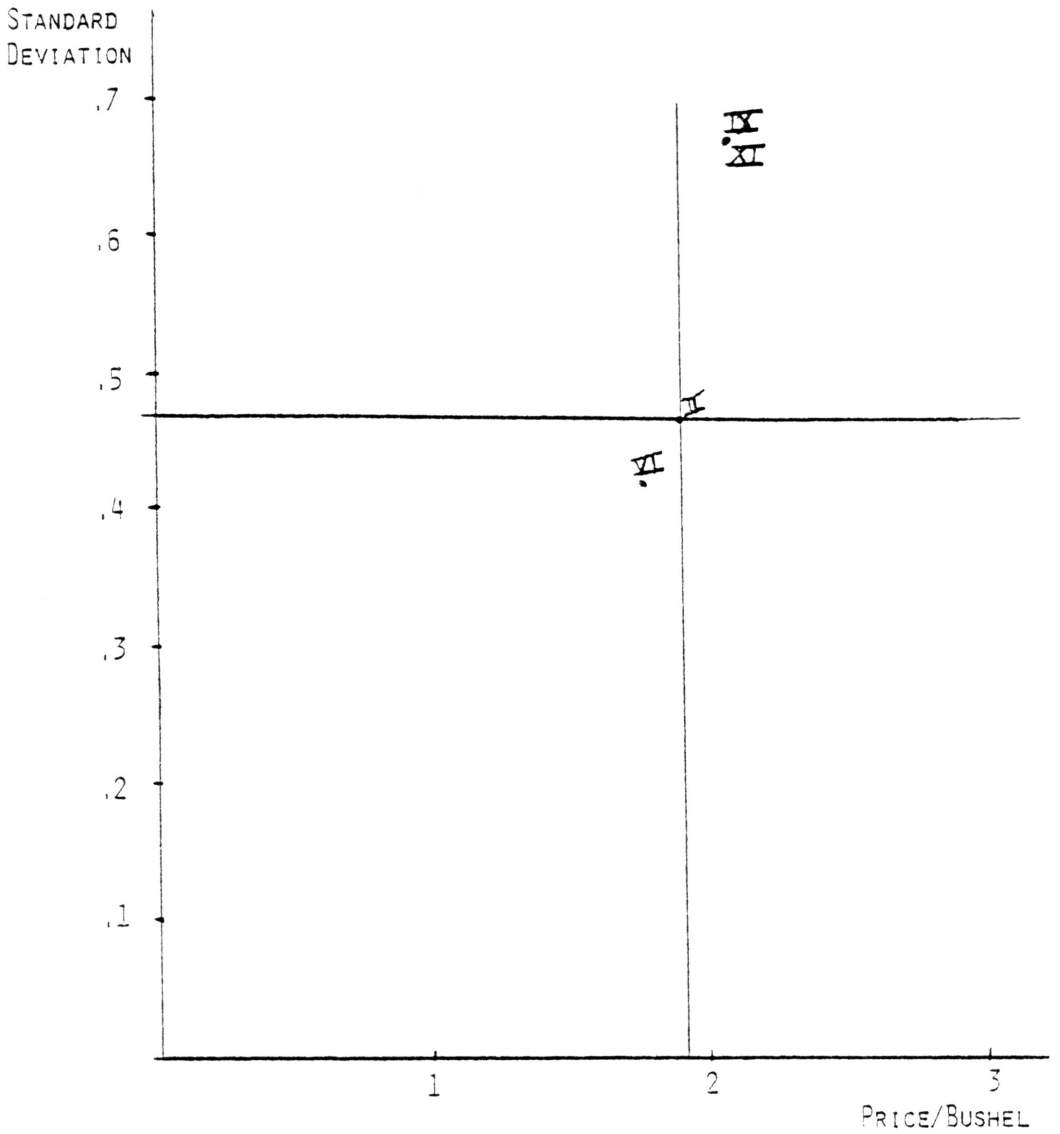


Table 6. Simple Regression Models Regressing Weekly Cash Sorghum Prices On Cash Corn Prices for 1975, 1976, 1979 and 1971-1979

Year	Intercept	Slope	r^2	F-Value	Number of Observations
1975	.8696	.5589	.7794	180.22	52
	(7.66)	(13.42)[a]			
1976	.0804	.8497	.9535	1,026.22	52
	(1.19)	(32.04)			
1979	-.4163	.9991	.90	441.35	51
	(-3.22)	(21.01)			
1971-1979	.0505	.8609	.9656	13,068.72	468
	(2.92)	(114.32)			

[a] t-values in parentheses.

Table 7a. Multiple Regression Models with Seasonality Variables for 1977

Variable	Estimate	t-value
Intercept	.7640	6.13
Cash Corn Price	.4974	8.38
Dummy 1	.0504	3.27
Dummy 2	.0308	2.31
Dummy 3	.0205	1.29
Dummy 4	.0036	0.22
Dummy 5	-.0522	-4.13
Dummy 6	-.1178	-9.96
Dummy 7	-.0631	-3.98
Dummy 8	-.0851	-3.42
Dummy 9	-.0828	-3.12
Dummy 10	-.0199	-1.18
Dummy 11	.0024	.19
R-Square	.9875	
F-Value	257.12	
N	52	

Table 7b. Multiple Regression Models with Seasonality Variables for 1978

Variable	Estimate	t-value
Intercept	.3573	2.33
Cash Corn Price	.6948	11.05
Dummy 1	-.0330	-1.33
Dummy 2	-.0287	-1.19
Dummy 3	.0040	0.25
Dummy 4	.0830	5.91
Dummy 5	.1075	7.69
Dummy 6	.0823	6.19
Dummy 7	.0559	4.00
Dummy 8	.0130	0.84
Dummy 9	.0472	2.40
Dummy 10	.0579	3.80
Dummy 11	.0774	5.84
R-Square	.9810	
F-Value	168.06	
N	52	

Table 7c. Multiple Regression Models with Seasonality Variables for 1971-1979

Variable	Estimate	t-value
Intercept	.0442	2.00
Cash Corn Price	.8575	118.85
Dummy 1	-.0109	- .51
Dummy 2	-.0069	- .32
Dummy 3	-.0022	- .11
Dummy 4	.0167	.78
Dummy 5	-.0273	-1.28
Dummy 6	-.0446	-2.09
Dummy 7	.0163	.76
Dummy 8	.0479	2.25
Dummy 9	.0737	3.45
Dummy 10	.0663	3.10
Dummy 11	.0332	1.55
R-Square	.9698	
F-Value	1216.39	
N	468	

standard deviation of the March cash sale, strategy II, the evaluation base for strategies closed in March. The mean net price, standard deviation, minimum risk hedge, and risk shifting effectiveness for each strategy are presented in table 8.

Over the 1971-1979 period, strategy VII was judged to be the best for several reasons:

(1) high risk shifting effectiveness, $r^2 = .91$

(2) mean net price and standard deviation equal to strategy I, cash sale strategy,

(3) strategy VII either obtained the target price or returned a net price above the cash sale price, strategy I, 8 out of 9 years, (table 9).

Strategy VII had a mean price that was one cent per bushel higher than the December cash sale, strategy I, and a standard deviation equal to that of strategy I. A graphical analysis of strategy VIII, comparing opening cash prices with closing cash prices, opening futures prices with closing futures prices, and target prices with net prices is presented in figure 8.

December closing strategies III and IV fell in the "indeterminant" category (figure 6), with a lower mean price and standard deviation than the December cash sale, strategy I. Strategy III obtained the target price or better during four of the nine years examined (table A-1). During two of the five off years a producer would still have been better off hedged than unhedged. Strategy IV obtained the target price five of the nine years studies (table A-2).

December closing strategies V, VIII and X fell in the "indeterminant" category with a higher mean net price and standard deviation than the

Table 8. Mean Net Price, Standard Deviation, Minimum Risk Hedging Level, and Hedging Effectiveness for the Hedging Strategies

Strategy	Mean Net Price	Standard Deviation	Minimum Risk Hedge	Risk Shifting Effectiveness
	$/bushel	$/bushel		
I[a]	2.00	.52	-----	-----
II[b]	1.95	.47	-----	-----
III	1.936	.4574	.726	.7336
IV	1.96	.4760	.698	.7513
V	2.092	.5745	.728	.6264
VI	1.852	.4267	.672	.6925
VII	2.022	.52	1.0	.9126
VIII	2.139	.6063	.753	.7148
IX	2.043	.6734	.78	.8073
X	2.087	.5826	.689	.5464
XI	2.042	.6753	.78	.758

[a]Strategy I was the base used to evaluate Strategies III, IV, V, VII, VIII, and X.

[b]Strategy II was the base used to evaluate Strategies VI, IX, and XI.

Table 9. Annual Results of Hedging Strategy VII

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.46	1.31	-.15	1.04	+.27
1972	1.15	1.21	+.06	1.57	-.36
1973	1.90	1.88	-.02	2.27	-.39
1974	2.41	2.30	-.11	2.88	-.58
1975	2.46	2.28	-.18	2.20	+.08
1976	2.58	2.41	-.17	1.93	+.48
1977	1.65	1.78	+.13	1.81	-.03
1978	2.11	2.24	+.13	2.04	+.20
1979	2.76	2.78	+.02	2.33	+.45

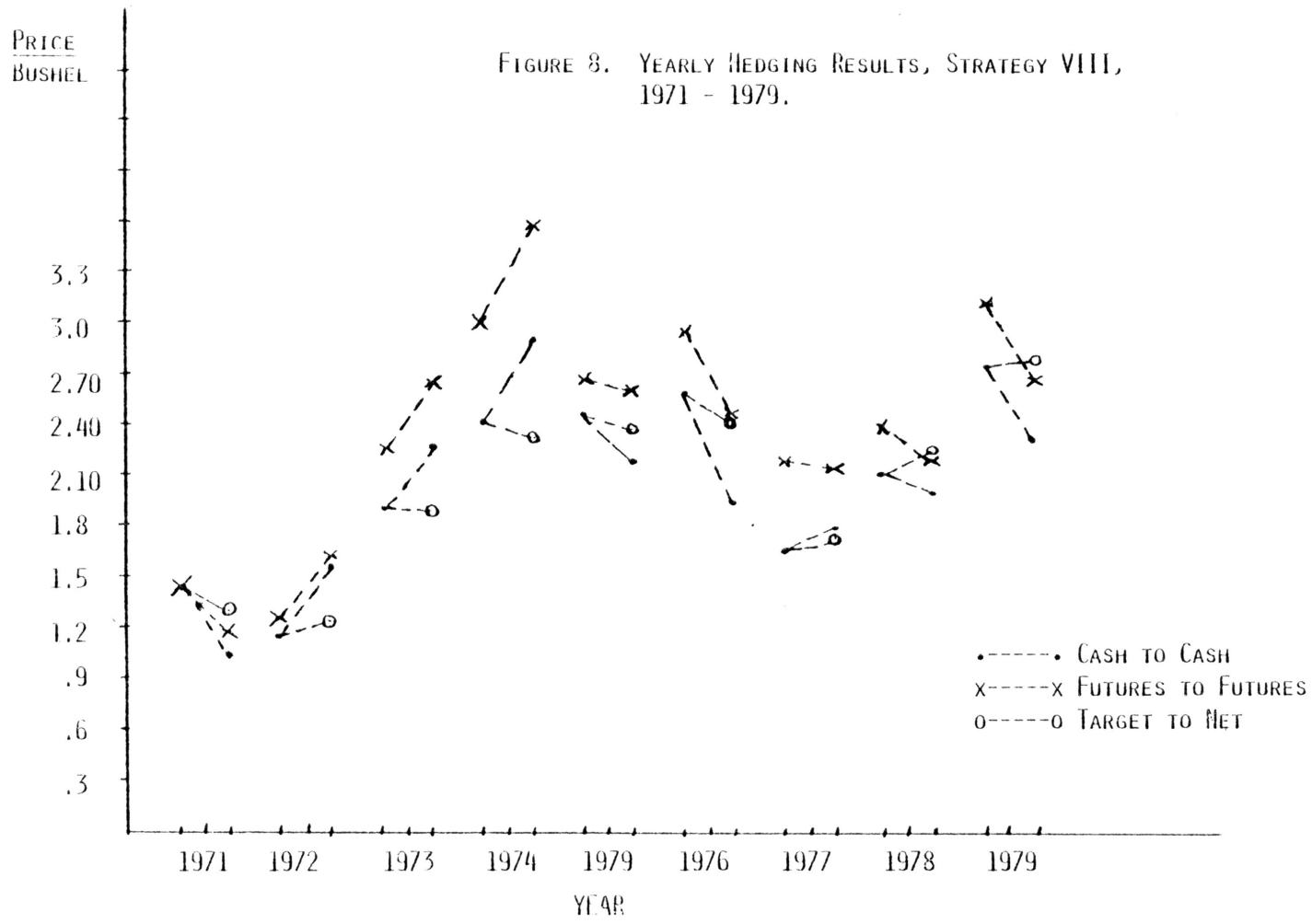


FIGURE 8. YEARLY HEDGING RESULTS, STRATEGY VIII, 1971 - 1979.

December cash sale, strategy I (figure 6). Strategy V protected the target price four of the nine seasons examined (table A-3). Of the 5 years strategy V did not protect the target price, strategy V returned a net price above the cash sale price only once. Strategy VIII obtained the target price five of the nine years covered (table A-5). Only during one of the 4 missed years would a producer have received a net price above the December cash sale price. Strategy X protected the target price five of the nine seasons examined (table A-7). However, during two of the four missed years, strategy X had a net price above the December sale price.

Over the period 1971-1979 some hedging strategies performed better than others. However, all these hedging strategies failed to protect the target price in 1973. Several strategies missed the target price in 1974, 1975 or 1976 in addition to 1973.

All of the March strategies fell into the "indeterminant" categories (figure 7). Strategy VI had a mean net price and standard deviation lower than the March cash sale, strategy II, evaluation base for March closing strategies. Strategy VI did not protect the target price during 4 of the 8 hedging periods studied (table A-4). During one year, 1976, of the 4 years the target price was not protected strategy VI's net price was greater than the March cash sale. Strategies IX and XI had mean net prices and standard deviations above the strategy II base. Strategy IX protected the target price during five of the eight years studied (table A-6). Of the 3 years, strategy IX returned a net price lower than the target price, a producer would have been better off hedged during two of those three years. Strategy XI procured the target price five of the eight years covered (table A-8), and a producer would have been better off

hedged during 2 of the 3 years strategy XI did not protect the target price. Graphical analysis of strategies III, IV, V, VI, VIII, IX, X, and XI presented in Appendix A show that target prices were generally achieved in the face of wide swings in the price level.

Summary

Grain sorghum producers have historically faced both yield risk and price risk. Since 1971 both intraseasonal and interseasonal price variation has increased substantially. While the price received by grain sorghum producers has moved up and down, the cost of producing grain sorghum has generally risen, resulting in a cost-price squeeze. The purpose of this research was to determine if cross-hedging would provide (1) a means of reducing price variation to an individual producer and (2) more certainty in the planning process.

Methodology

I. Determine the relationship between cash grain sorghum prices and cash corn prices for the Texas High Plains.

II. Formulate simple cross-hedging strategies.

III. Evaluate the hedging strategies by:

(a) mean/variance analysis of prices

(b) comparing target prices with net prices

(c) determining the risk minimizing hedge and the risk shifting effectiveness of the risk minimizing hedge.

Results

Regressing weekly cash grain sorghum prices on cash corn prices for the nine year period 1971-1979 resulted in a regression model of:

$$Pmilo = .051 + .861\ Pcorn$$

where: Pmilo = price of cash grain sorghum in dollars per bushel

and Pcorn = price of cash corn in dollars per bushel.

This regression model explained 96.5 percent of the observed grain sorghum price variation. The addition of eleven dummy variables yielded some significant seasonality in grain sorghum prices. The mean/variance analysis found the July to December hedging strategy, strategy VII, to be equal to the December cash sale, strategy I. The remainder of the strategies fell in the "indeterminant" categories. The risk minimizing hedging level for the July to December strategy was one dollar of futures for every dollar of cash grain sorghum produced. During the 1971-1979 period, the July to December strategy was effective in shifting 91 percent of the price risk by holding one dollar of futures for every dollar of cash grain sorghum produced. From 1971-1979 the July to December hedging strategy either obtained the target price or returned a net price greater than the December cash sale price during 8 of the 9 hedging periods examined. Only in 1974 did the cash price and the target price exceed the net price of strategy VII.

Hedging yielded lower returns than cash sales during 1973 for all strategies generally due to rising prices. However, on the whole, either target price prices were obtained or prices were greater with hedging than with the cash strategies so that hedging could be judged beneficial under the procedures and assumption used herein.

Conclusions

1. Weekly grain sorghum prices and corn prices were generally highly correlated during the study period 1971-1979.

2. Cross-hedging performed well when prices were falling, but did

not always perform well when prices were rising.

3. The erratic basis behavior was the principal reason cross-hedging did not always perform well. Further hedging protects against price increases as well as price decreases.

4. Cross-hedging could provide a means of forward pricing a crop, however particular attention must be paid to the basis; e.g., a wide negative basis at the opening of the hedge lends itself to a successful hedge while a narrow basis does not.

5. Strategy VII, the July to December hedge, performed better in terms of price mean/variance, net prices and risk shifting effectiveness than any of the other strategies examined.

Points for Further Research

1. Increase the number of observations for each hedging strategy to allow for more degrees of freedom.

2. Develop more sophisticated hedging strategies, possibly using technical trading methods.

3. Closer scrutinizing of the harvest basis so that more accurate basis forecasts can be made.

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APPENDIX A

ANNUAL RESULTS OF HEDGING STRATEGIES

III, IV, V, VI, VIII, IX, X, XI

Table A-1. Annual Results of Strategy III, the June Week 1 to December Week 1 Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.40	1.32	-.08	1.01	.31
1972	1.05	1.23	.18	1.51	- .28
1973	1.85	1.80	-.05	2.27	- .47
1974	2.02	1.79	-.23	3.01	-1.22
1975	2.38	1.97	-.41	2.27	- .30
1976	2.35	2.21	-.14	1.87	.34
1977	1.72	2.14	.42	1.81	.33
1978	2.18	2.55	.37	2.10	.45
1979	2.23	2.43	.20	2.32	.09

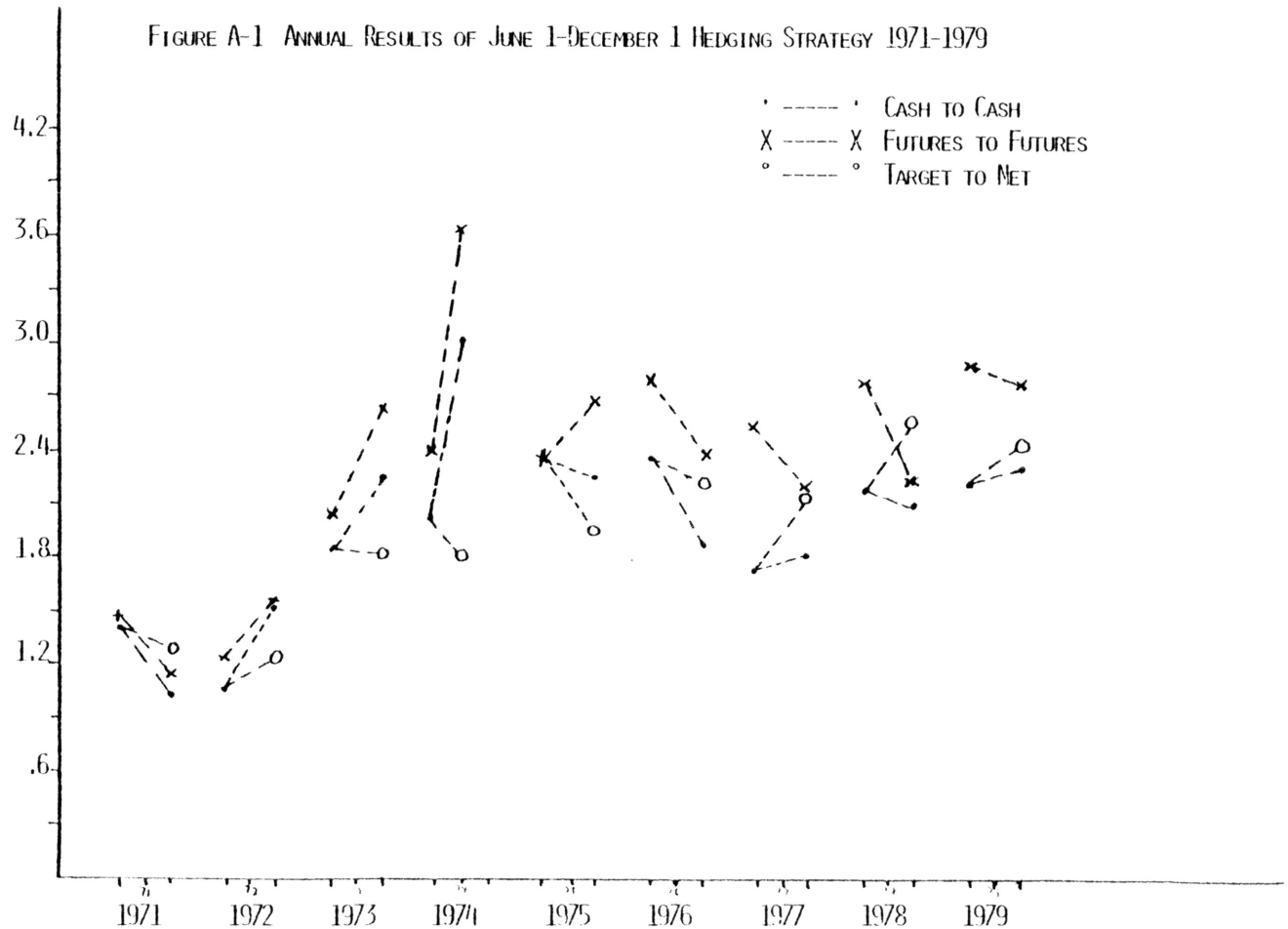


FIGURE A-1 ANNUAL RESULTS OF JUNE 1-DECEMBER 1 HEDGING STRATEGY 1971-1979
CASH TO CASH
FUTURES TO FUTURES
TARGET TO NET
4.2
3.6
3.0
2.4
1.8
1.2
.6
1971
1972
1973
1974
1975
1976
1977
1978
1979

Table A-2. Annual Results of Strategy IV, the June Week 2 to December Week 2 Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.43	1.44	.01	1.04	.40
1972	1.06	1.21	.15	1.57	- .36
1973	1.90	1.74	-.16	2.27	- .53
1974	1.99	1.74	-.25	2.88	-1.14
1975	2.38	1.97	-.41	2.20	- .23
1976	2.42	2.36	-.06	1.93	.43
1977	1.67	2.09	.42	1.81	.28
1978	2.16	2.47	.31	2.04	.43
1979	2.35	2.62	.27	2.33	.29

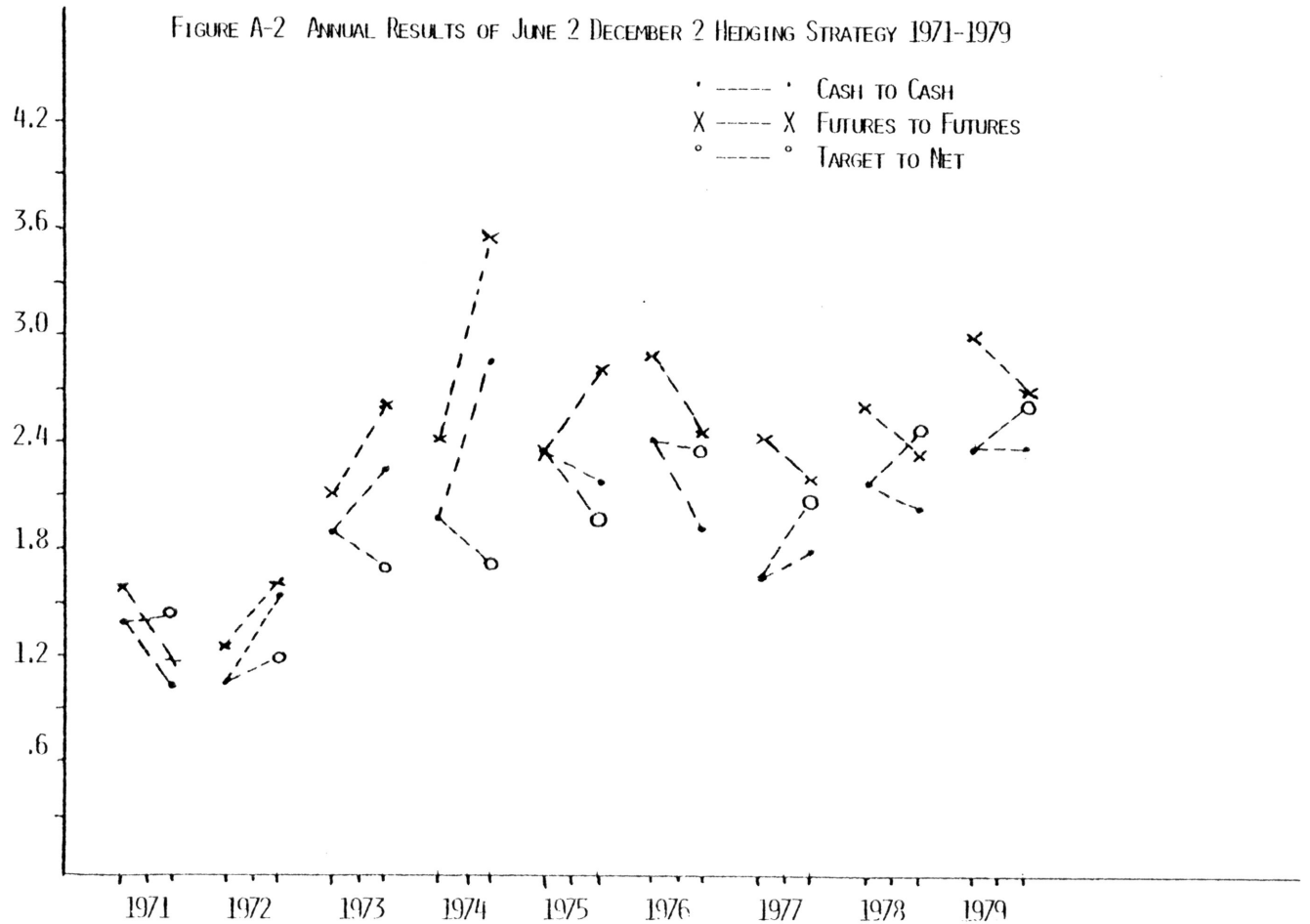


FIGURE A-2 ANNUAL RESULTS OF JUNE 2 DECEMBER 2 HEDGING STRATEGY 1971-1979
CASH TO CASH
FUTURES TO FUTURES
TARGET TO NET
4.2
3.6
3.0
2.4
1.8
1.2
.6
1971
1972
1973
1974
1975
1976
1977
1978
1979

Table A-3. Annual Results of Strategy V, the June 1 1% to December Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.43	1.37	-.06	1.04	.33
1972	1.08	1.23	.15	1.57	-.34
1973	1.85	1.63	-.22	2.27	-.64
1974	2.97	2.80	-.17	2.88	-.08
1975	2.44	2.13	-.31	2.17	-.04
1976	2.42	2.36	-.06	1.93	.46
1977	1.68	2.09	.41	1.81	.28
1978	2.16	2.47	.31	2.04	.43
1979	2.72	2.75	.03	2.33	.42

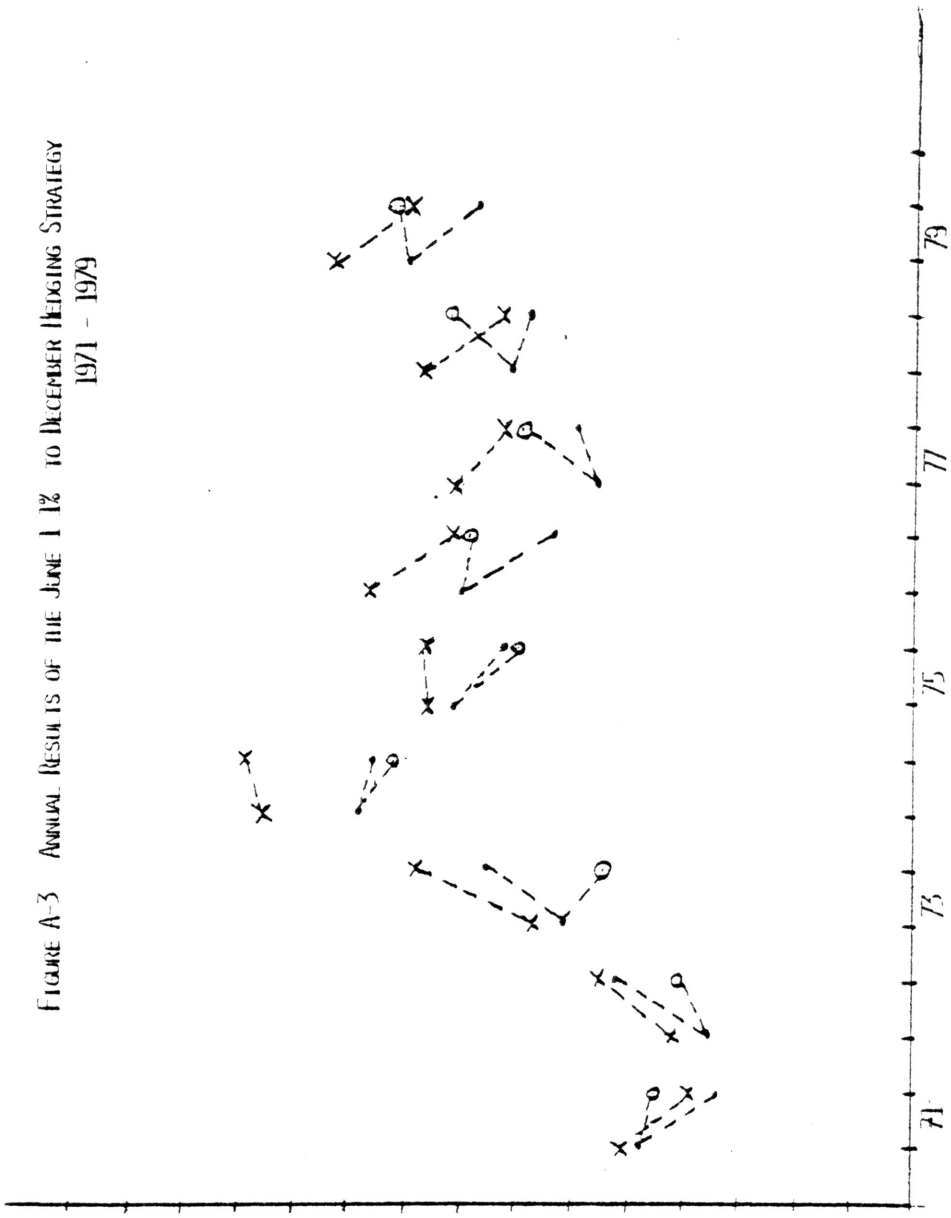


FIGURE A-3 ANNUAL RESULTS OF THE JUNE 1 1% TO DECEMBER HEDGING STRATEGY
1971 - 1979

Table A-4. Annual Results of Strategy VI, the June to March Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.40	1.40	0	1.06	.34
1972	1.05	1.20	.15	1.57	- .37
1973	1.85	1.57	-.28	2.58	-1.01
1974	2.02	1.83	-.19	2.17	- .34
1975	2.38	2.05	-.33	2.31	- .26
1976	2.35	2.19	-.16	1.92	.27
1977	1.72	2.19	.47	1.83	.36
1978	2.18	2.39	.21	2.04	.35

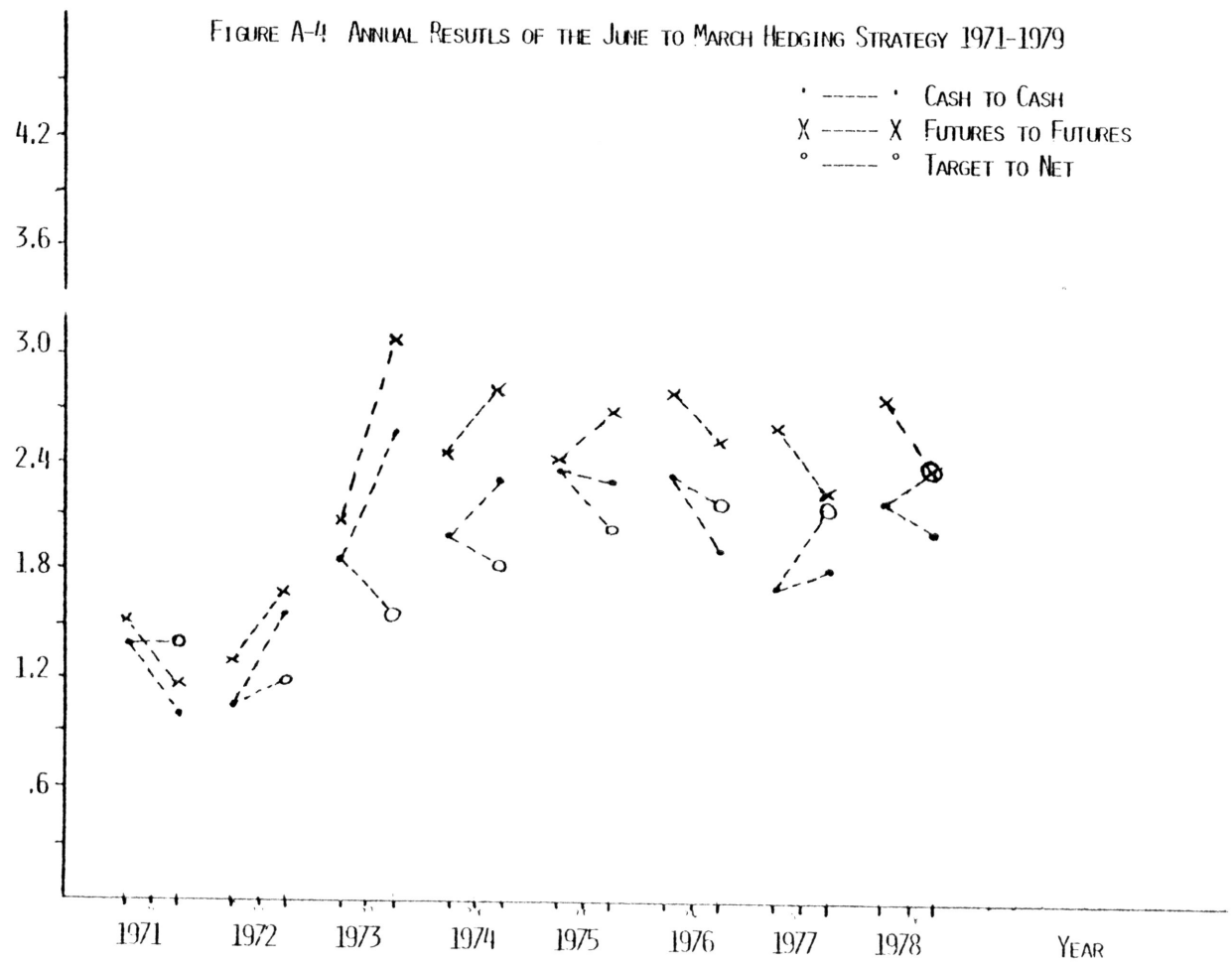


FIGURE A-4 ANNUAL RESUTLS OF THE JUNE TO MARCH HEDGING STRATEGY 1971-1979
CASH TO CASH
FUTURES TO FUTURES
TARGET TO NET
4.2
3.6
3.0
2.4
1.8
1.2
.6
1971
1972
1973
1974
1975
1976
1977
1978
YEAR

Table A-5. Annual Results of Strategy VIII, the June 1 2% to December Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.43	1.37	-.06	1.04	.33
1972	1.12	1.23	.09	1.57	-.34
1973	1.85	1.63	-.22	2.27	-.64
1974	2.97	2.80	-.17	2.88	-.08
1975	2.62	2.73	.11	2.20	.53
1976	2.35	2.24	-.11	1.93	.31
1977	1.67	2.09	.42	1.81	.28
1978	2.13	2.42	.29	2.04	.38
1979	2.72	2.75	.03	2.33	.42

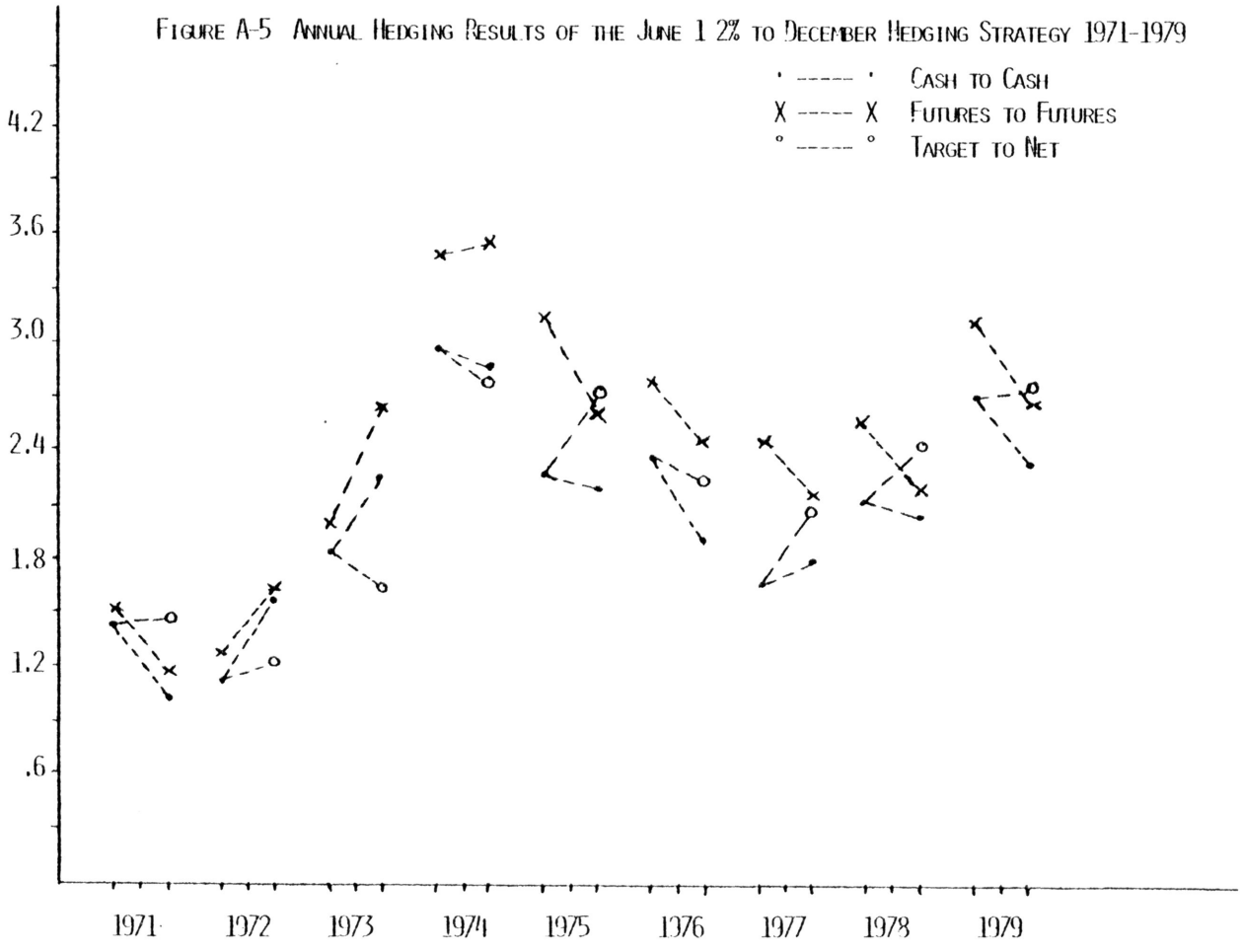


FIGURE A-5 ANNUAL HEDGING RESULTS OF THE JUNE 1 2% TO DECEMBER HEDGING STRATEGY 1971-1979
CASH TO CASH
FUTURES TO FUTURES
TARGET TO NET
4.2
3.6
3.0
2.4
1.8
1.2
.6
1971
1972
1973
1974
1975
1976
1977
1978
1979

Table A-6. Annual Results of Strategy IX, the June 1 2% to March Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.43	1.23	-.20	1.06	+ .17
1972	1.12	1.21	.09	1.57	- .36
1973	1.85	1.49	-.36	2.57	-1.08
1974	2.97	2.93	-.04	2.17	.76
1975	2.62	2.84	.22	2.31	.53
1976	2.35	2.25	-.10	1.92	.33
1977	1.67	2.12	.45	1.83	.29
1978	2.13	2.28	.15	2.03	.25

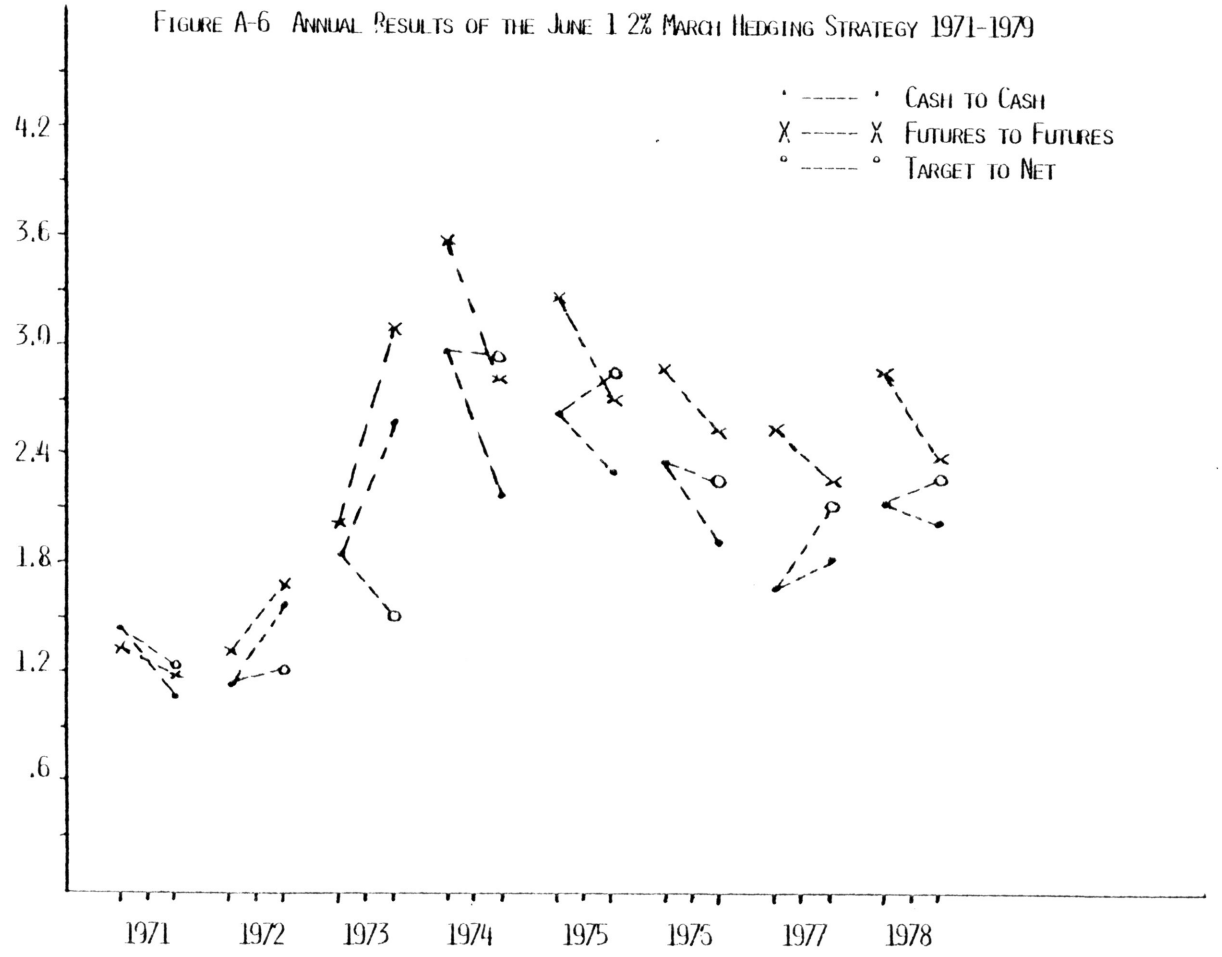


FIGURE A-6 ANNUAL RESULTS OF THE JUNE 1 2% MARCH HEDGING STRATEGY 1971-1979
CASH TO CASH
FUTURES TO FUTURES
TARGET TO NET
4.2
3.6
3.0
2.4
1.8
1.2
.6
1971
1972
1973
1974
1975
1975
1977
1978

Table A-7. Annual Results of Strategy X, the June 1 Variable % to December Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.43	1.37	-.06	1.04	.33
1972	1.12	1.23	.09	1.57	-.34
1973	1.85	1.63	-.22	2.27	-.64
1974	2.86	2.90	.04	2.88	.02
1975	2.44	2.16	-.22	2.20	-.04
1976	2.35	2.24	-.11	1.93	.31
1977	1.67	2.09	.42	1.81	.28
1978	2.13	2.42	.29	2.04	.38
1979	2.72	2.75	.03	2.33	.42

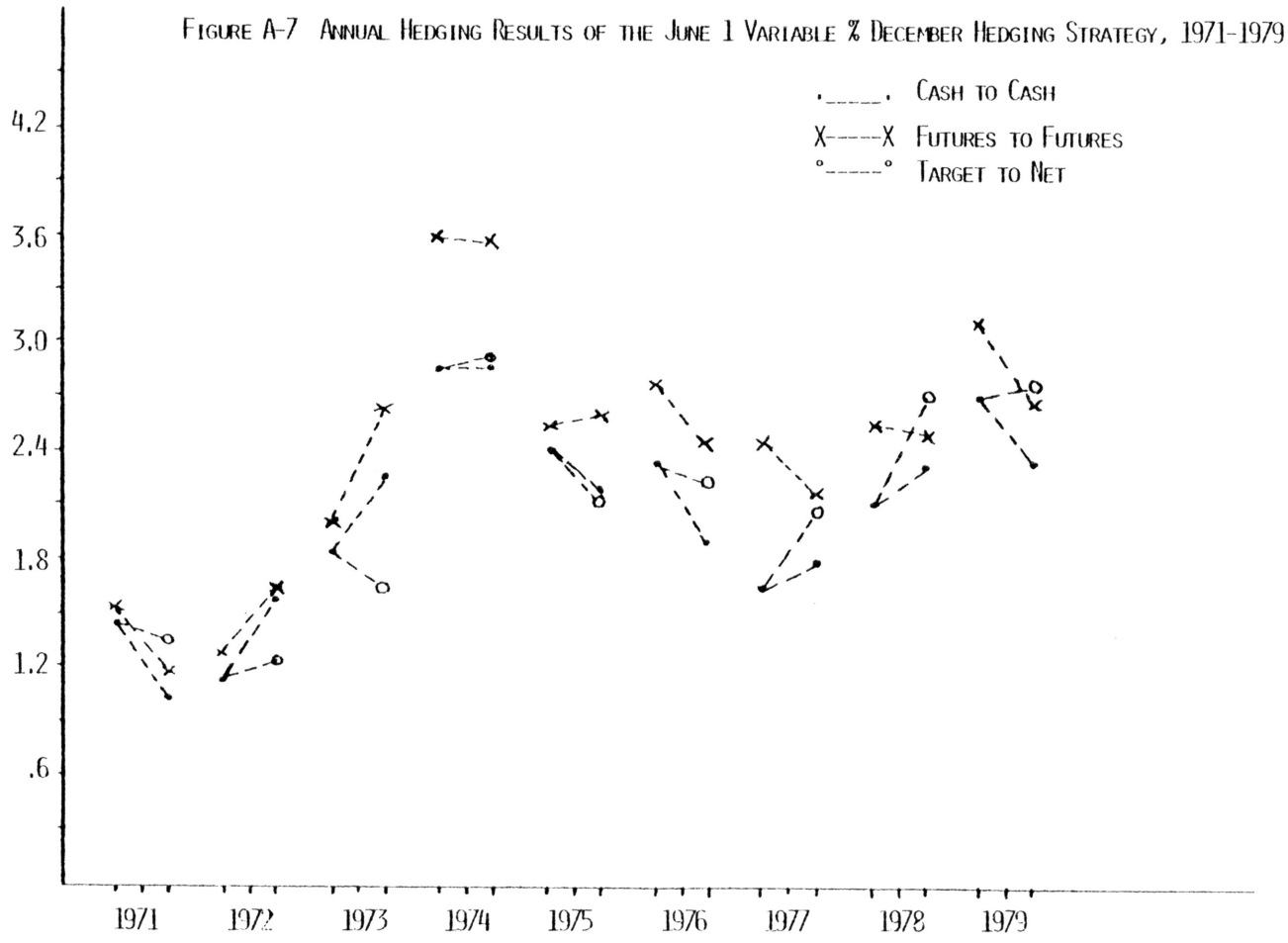


FIGURE A-7 ANNUAL HEDGING RESULTS OF THE JUNE 1 VARIABLE % DECEMBER HEDGING STRATEGY, 1971-1979
CASH TO CASH
FUTURES TO FUTURES
TARGET TO NET
4.2
3.6
3.0
2.4
1.8
1.2
.6
1971
1972
1973
1974
1975
1976
1977
1978
1979

Table A-8. Annual Results of Strategy XI, the June 1 Variable % to March Hedge 1971-1979

Year	Target Price	Net Price	Net Price-Target Price	Cash Price	Net Price-Cash Price
	($/bushel)				
1971	1.43	1.21	-.22	1.05	.16
1972	1.12	1.20	.08	1.57	-.37
1973	1.85	1.56	-.29	2.53	-.97
1974	2.86	2.94	.08	2.27	.67
1975	2.62	2.86	.24	2.32	.54
1976	2.49	2.21	-.28	1.94	.27
1977	1.67	2.08	.41	1.88	.20
1978	2.13	2.27	.14	2.04	.23

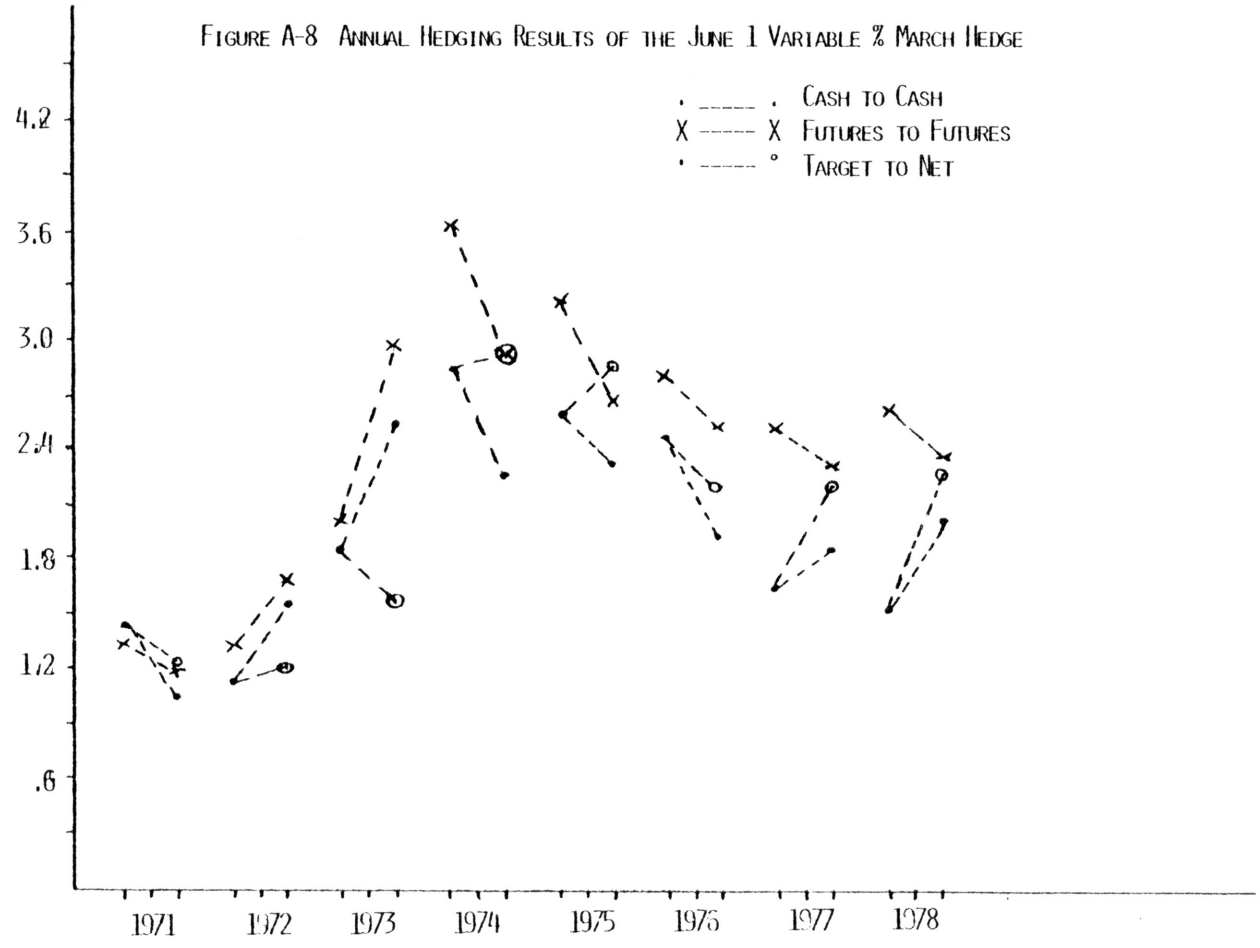


FIGURE A-8 ANNUAL HEDGING RESULTS OF THE JUNE 1 VARIABLE % MARCH HEDGE
CASH TO CASH
FUTURES TO FUTURES
TARGET TO NET
4.2
3.6
3.0
2.4
1.8
1.2
.6
1971
1972
1973
1974
1975
1976
1977
1978

APPENDIX B

PLOTS OF THE WEEKLY NEARBY CORN AND MILO

BASIS 1971-1979

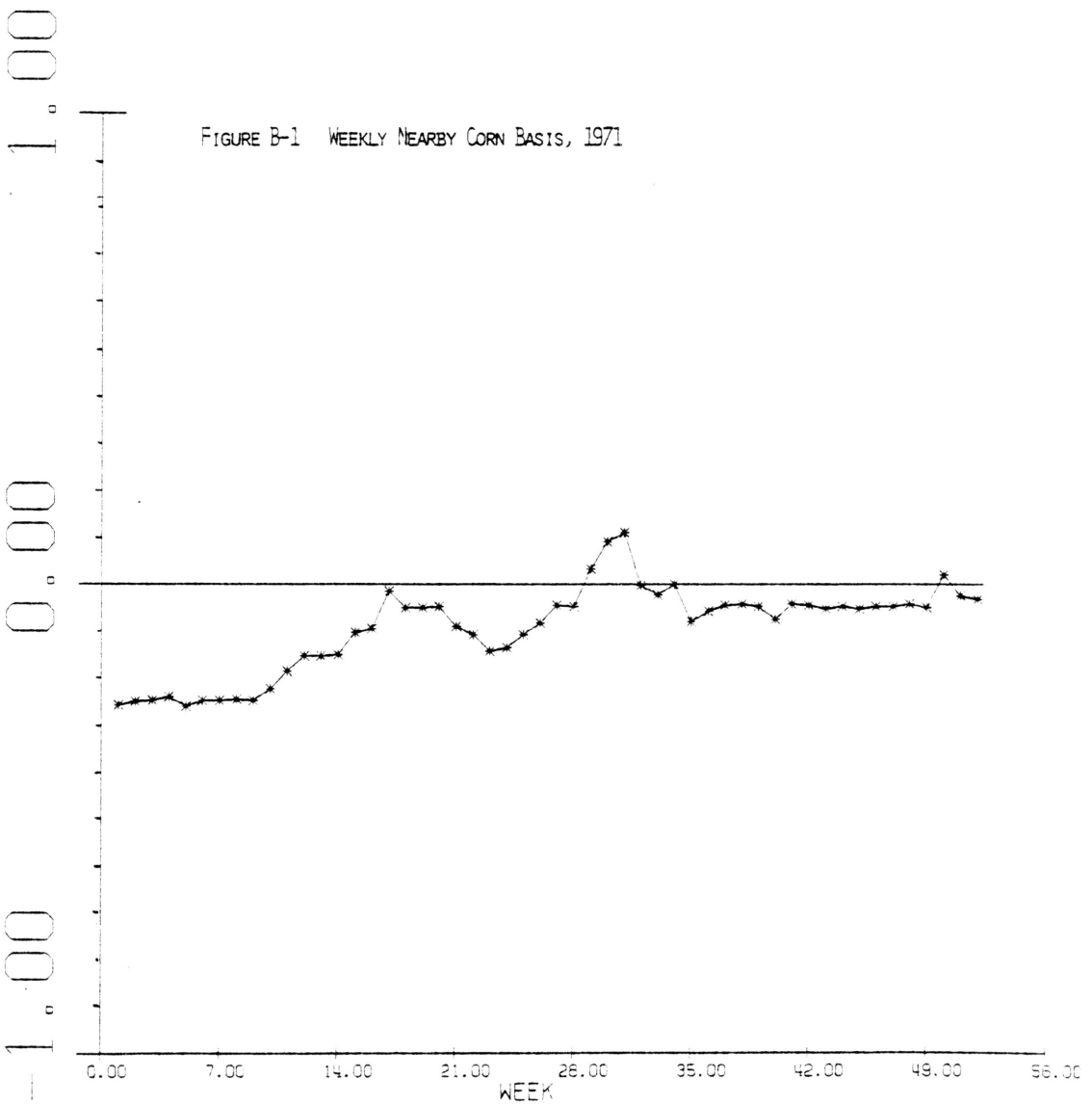
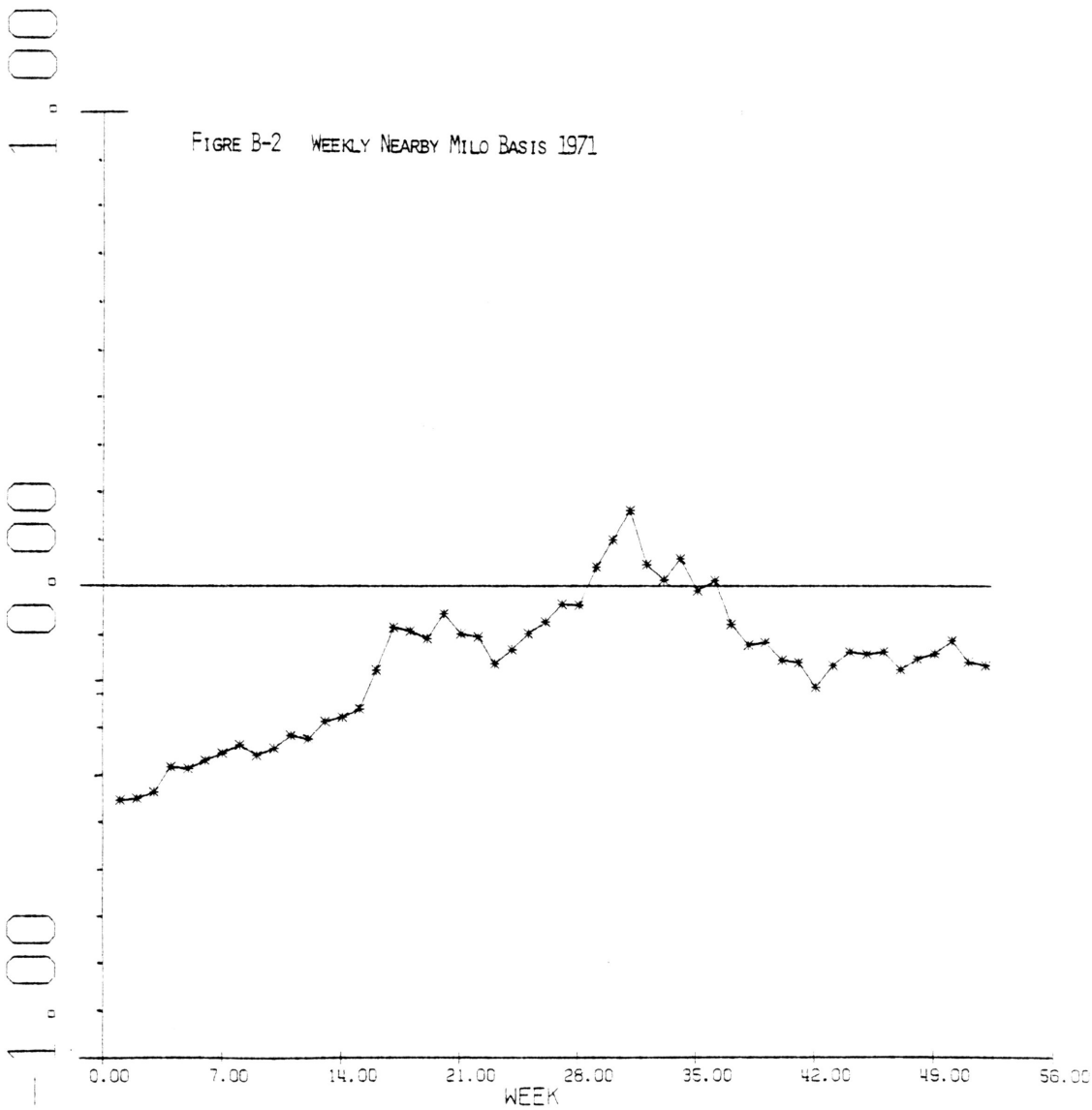


FIGURE B-1 WEEKLY NEARBY CORN BASIS, 1971



FIGRE B-2 WEEKLY NEARBY MILO BASIS 1971

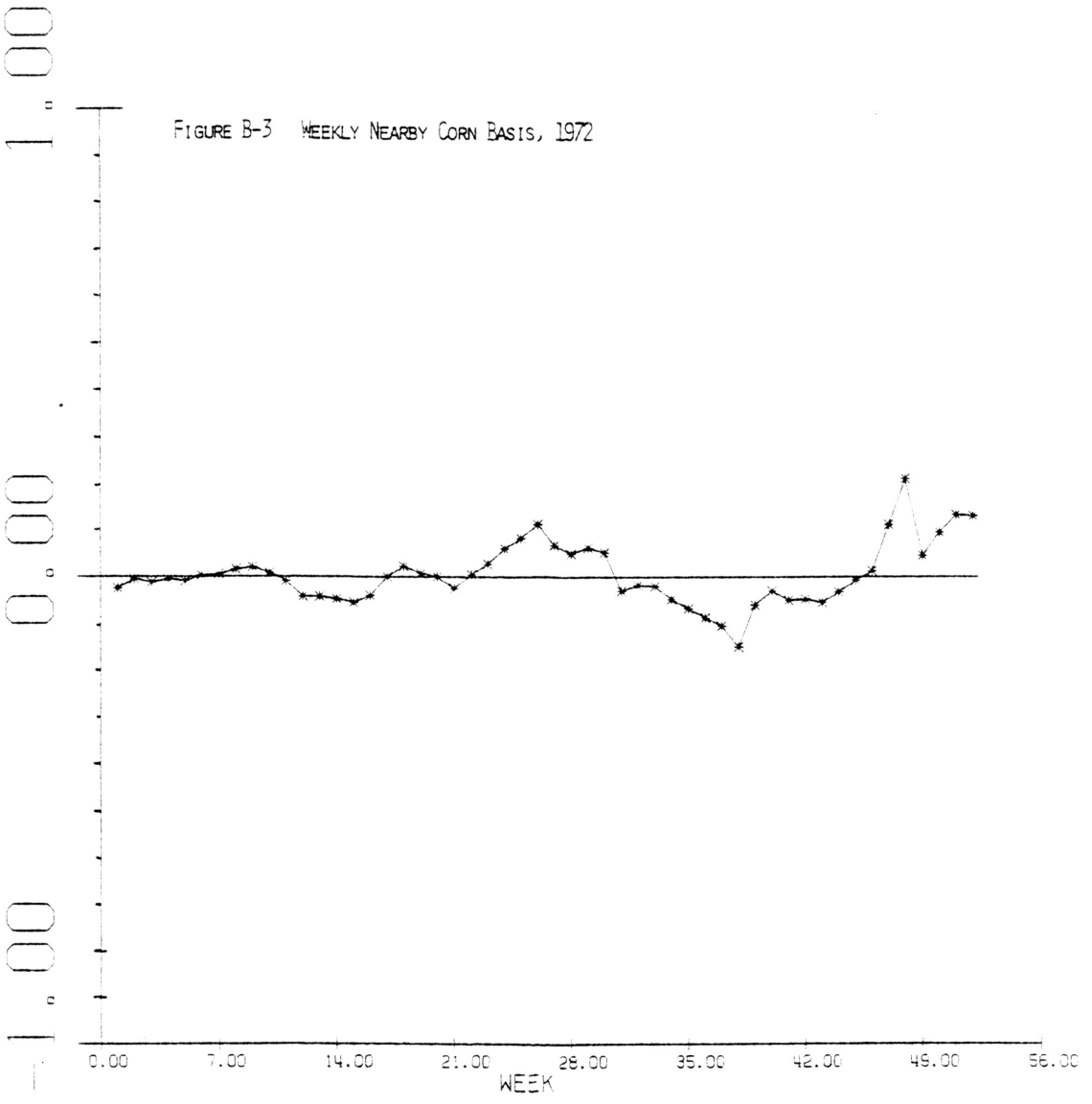


FIGURE B-3 WEEKLY NEARBY CORN BASIS, 1972

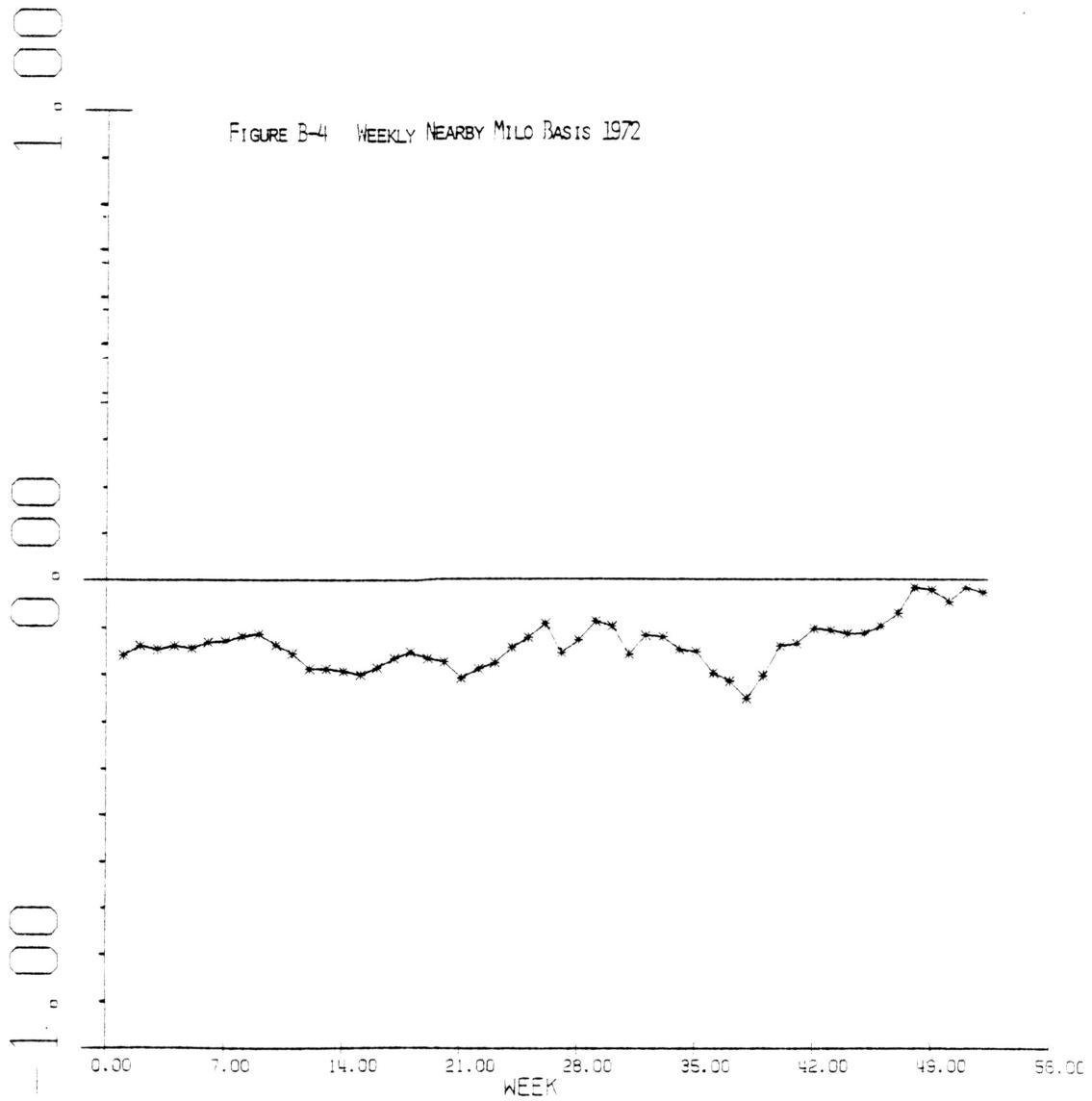


FIGURE B-4 WEEKLY NEARBY MILO BASIS 1972

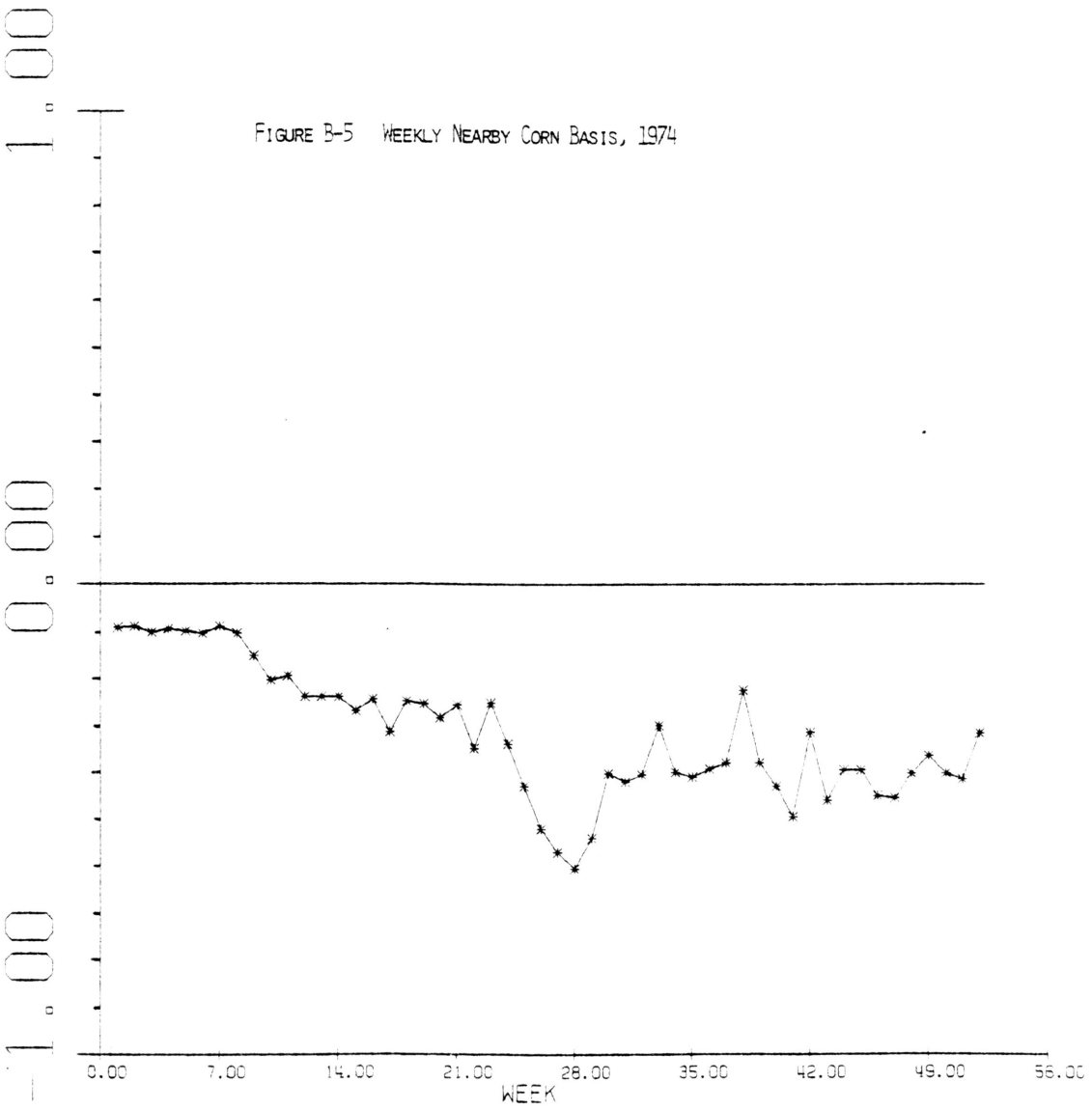


FIGURE B-5 WEEKLY NEARBY CORN BASIS, 1974

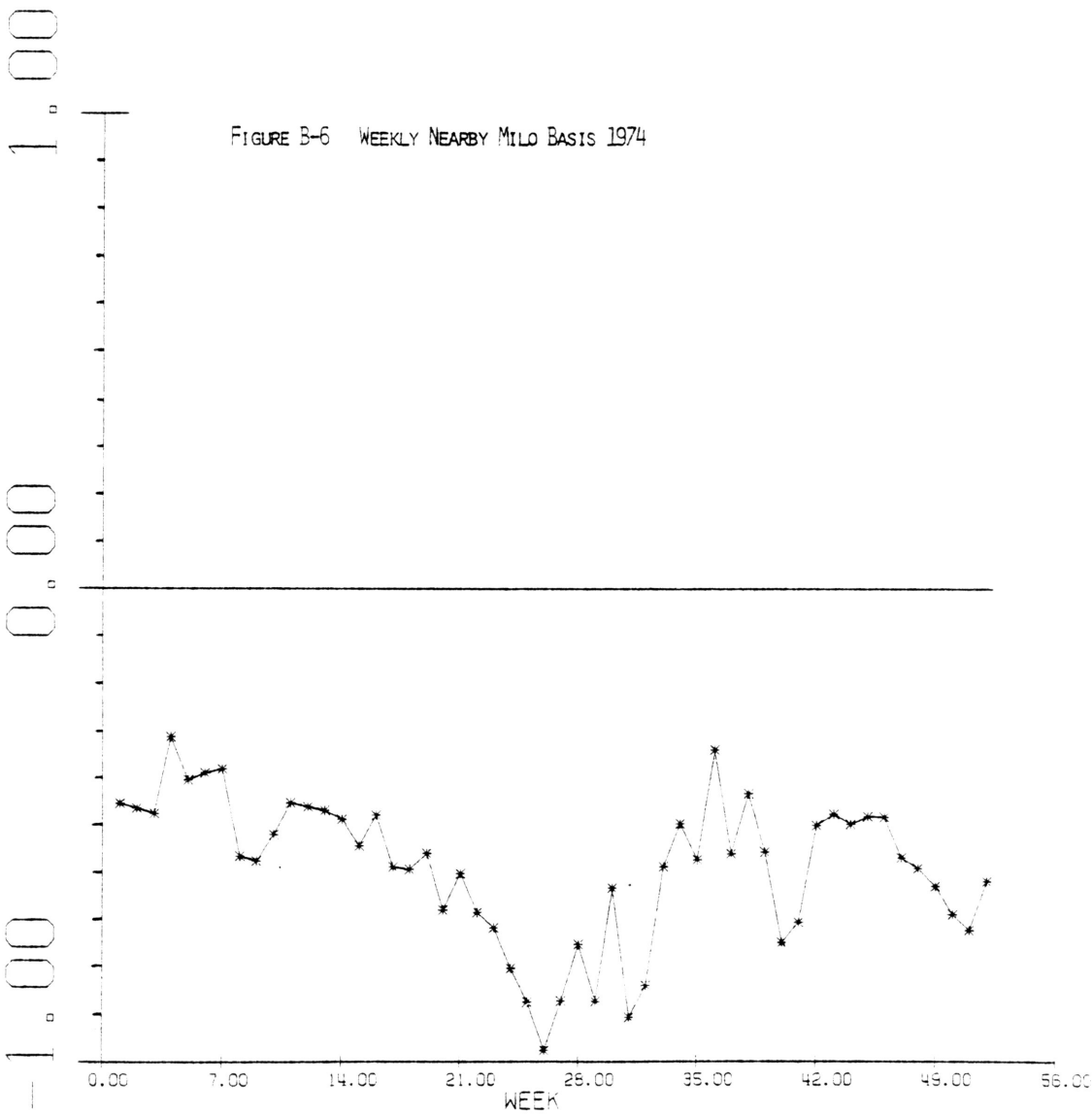


FIGURE B-6 WEEKLY NEARBY MILO BASIS 1974

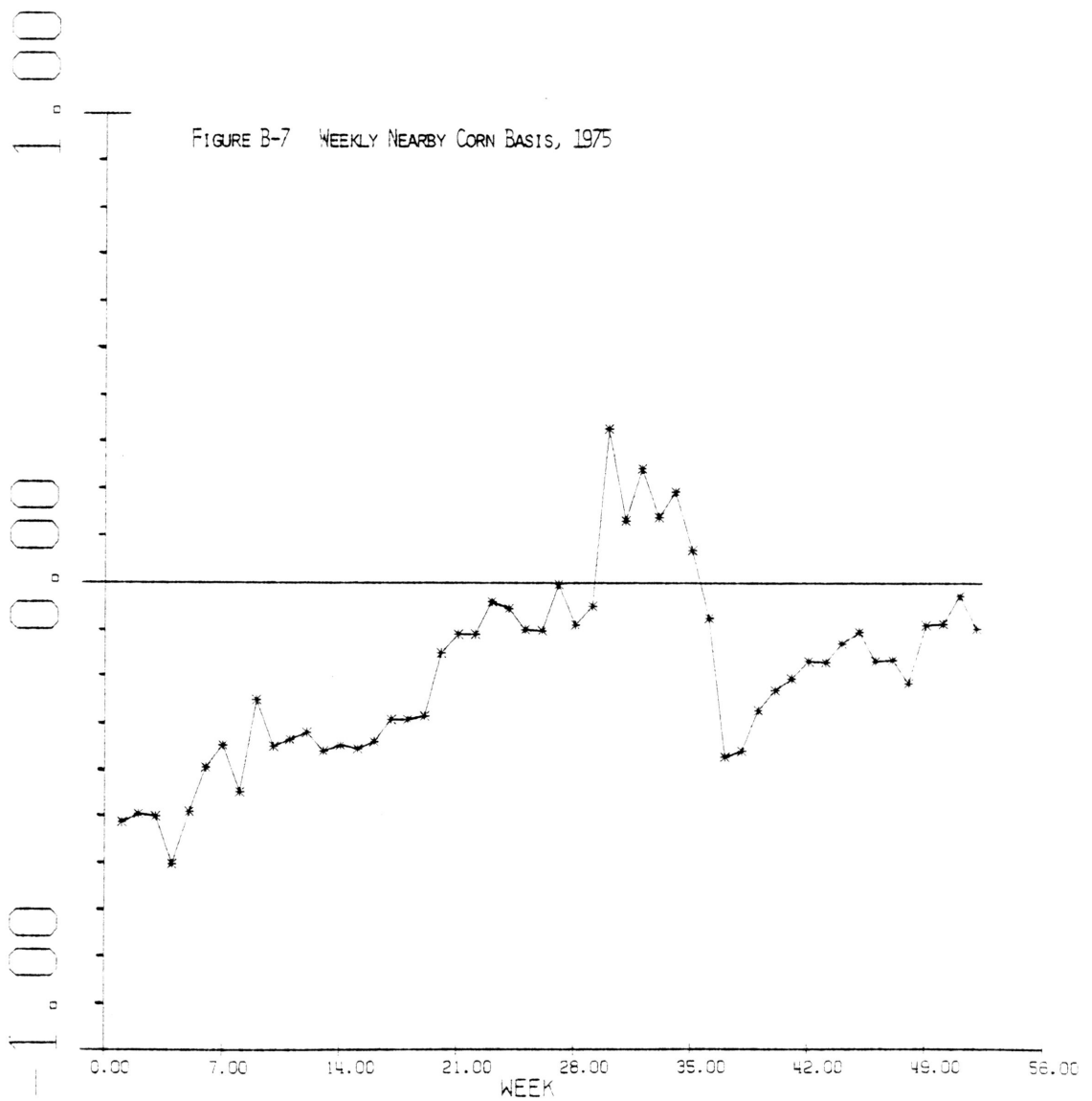


FIGURE B-7 WEEKLY NEARBY CORN BASIS, 1975

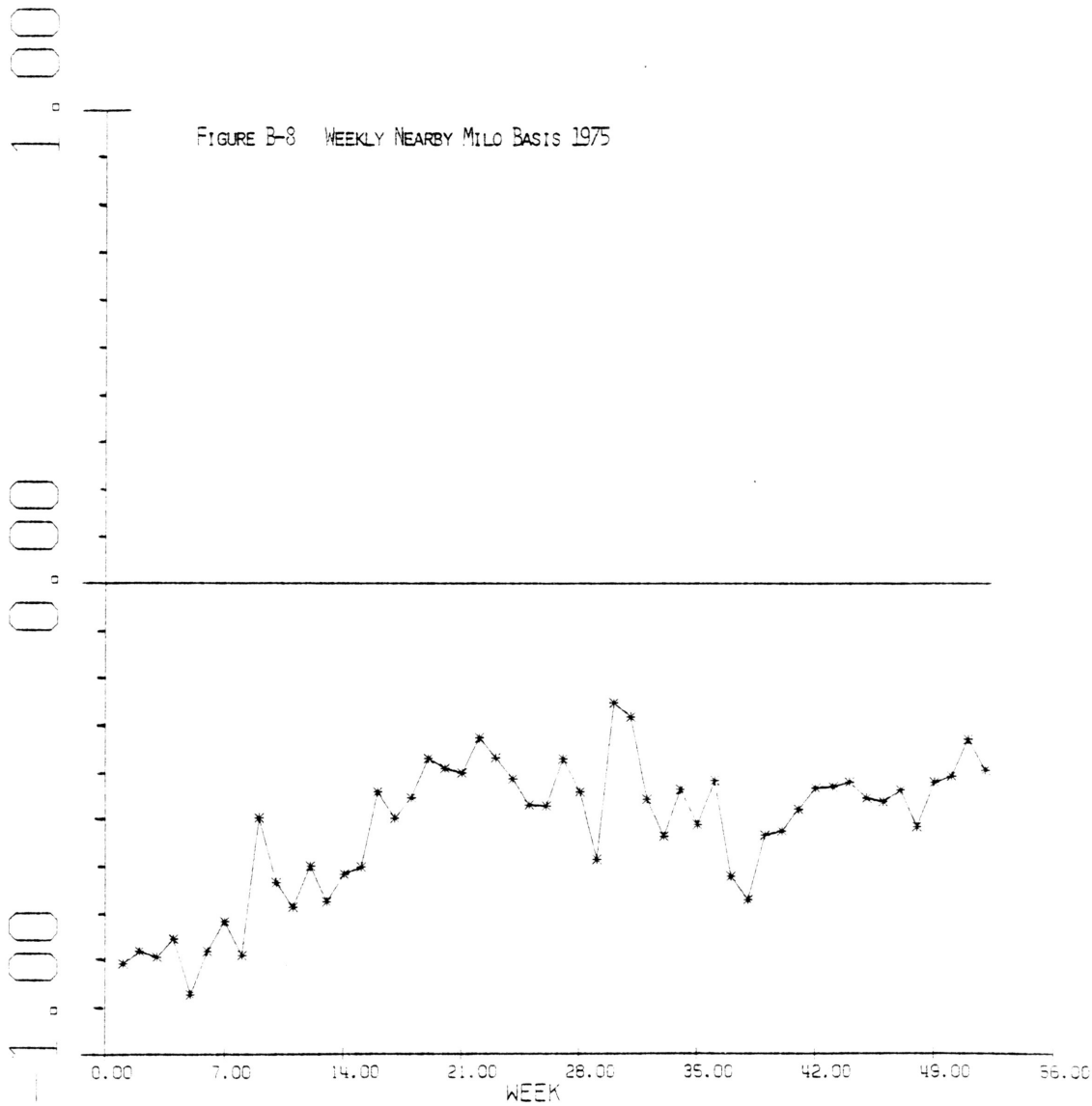


FIGURE B-8 WEEKLY NEARBY MILO BASIS 1975

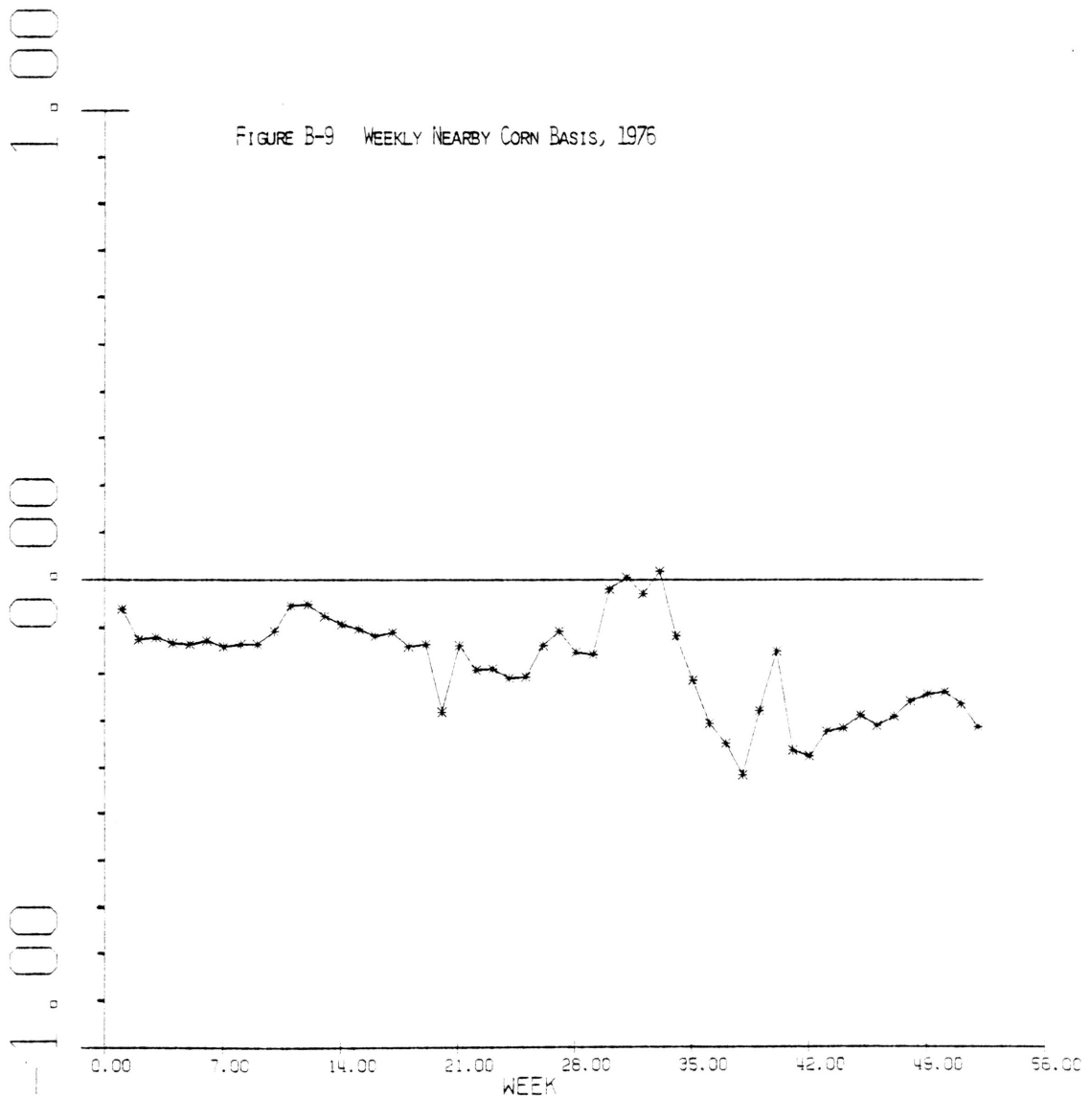


FIGURE B-9 WEEKLY NEARBY CORN BASIS, 1976

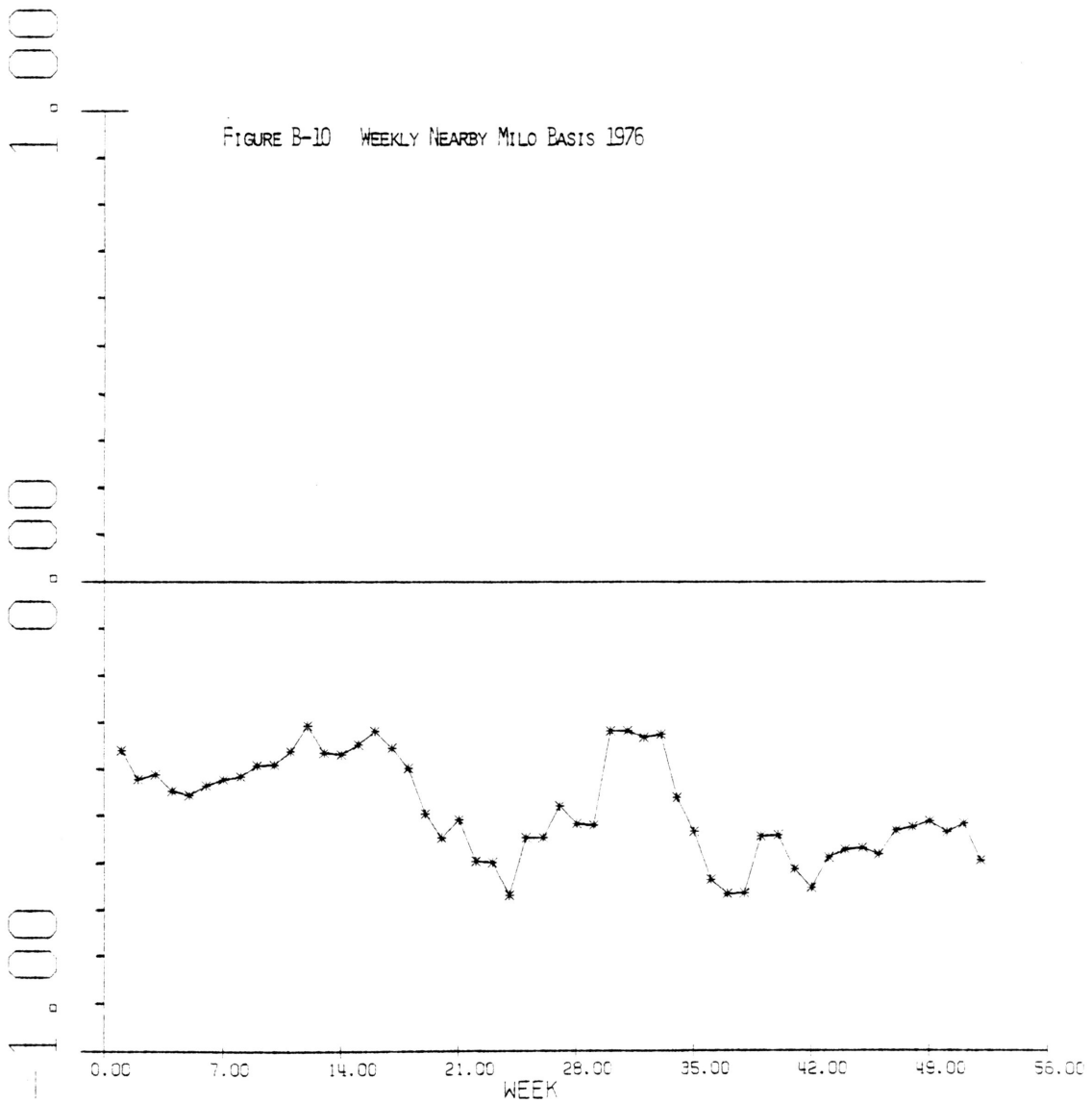


FIGURE B-10 WEEKLY NEARBY MILO BASIS 1976

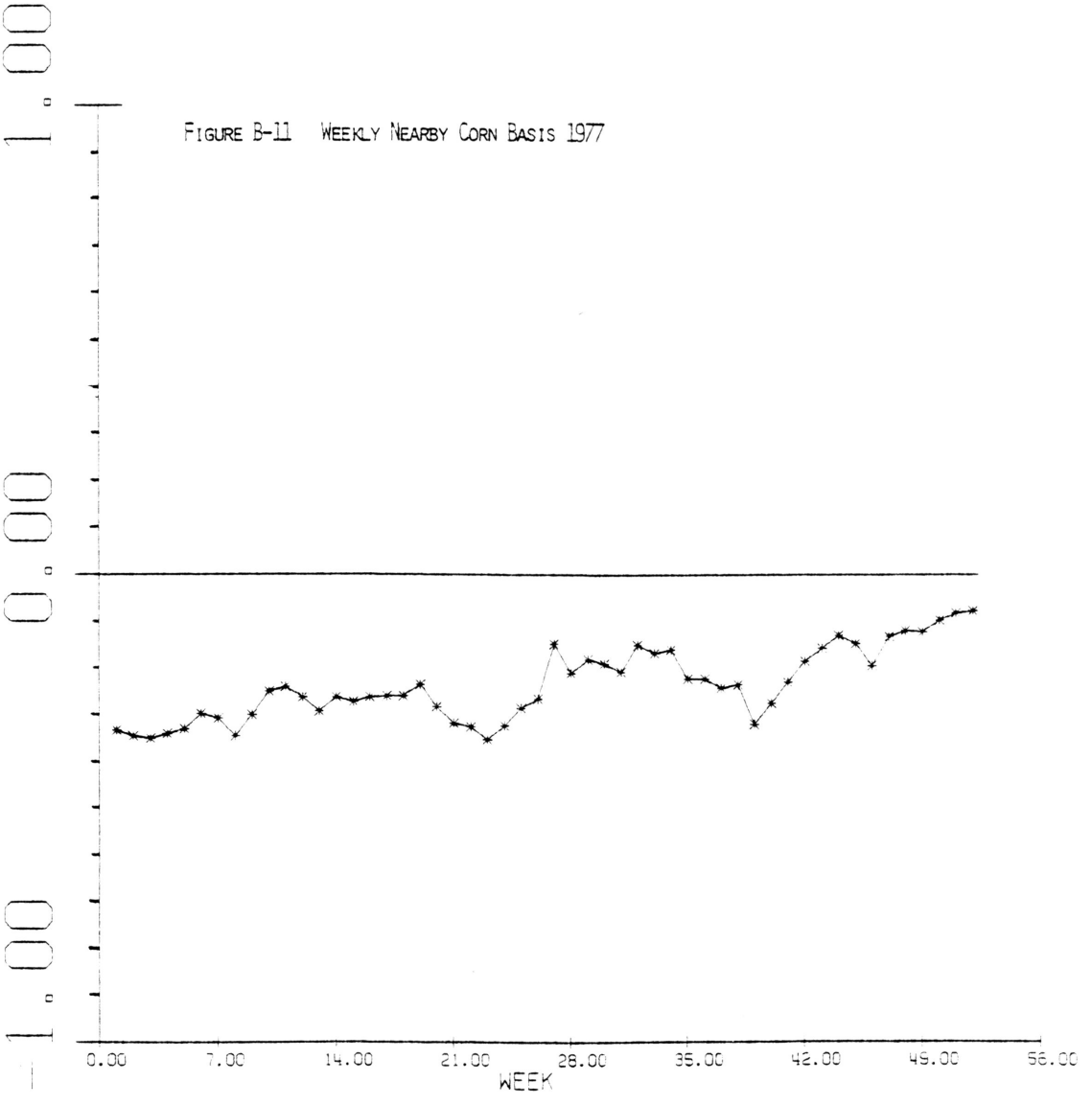


FIGURE B-11 WEEKLY NEARBY CORN BASIS 1977

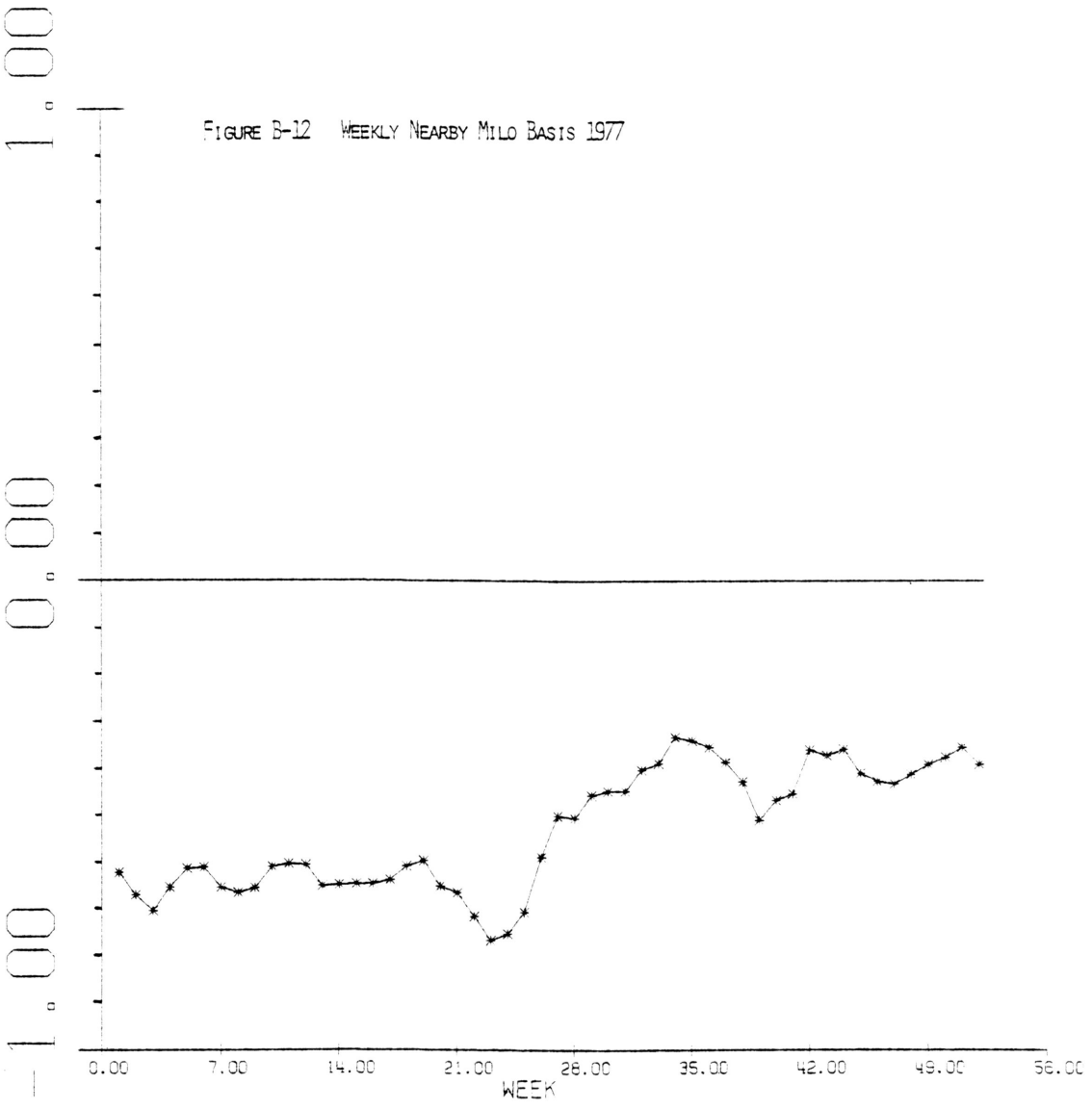


FIGURE B-12 WEEKLY NEARBY MILO BASIS 1977

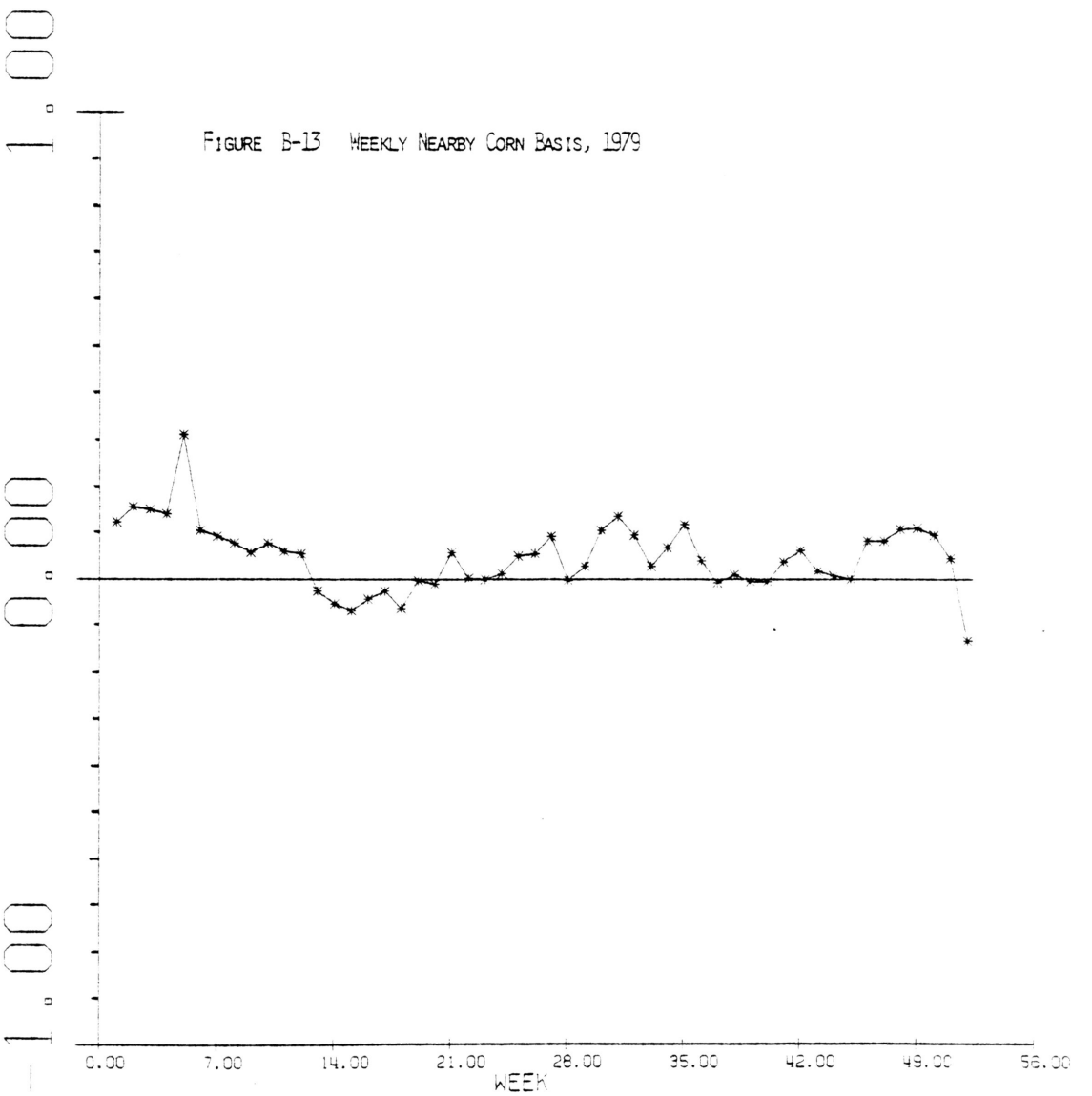


FIGURE B-13 WEEKLY NEARBY CORN BASIS, 1979

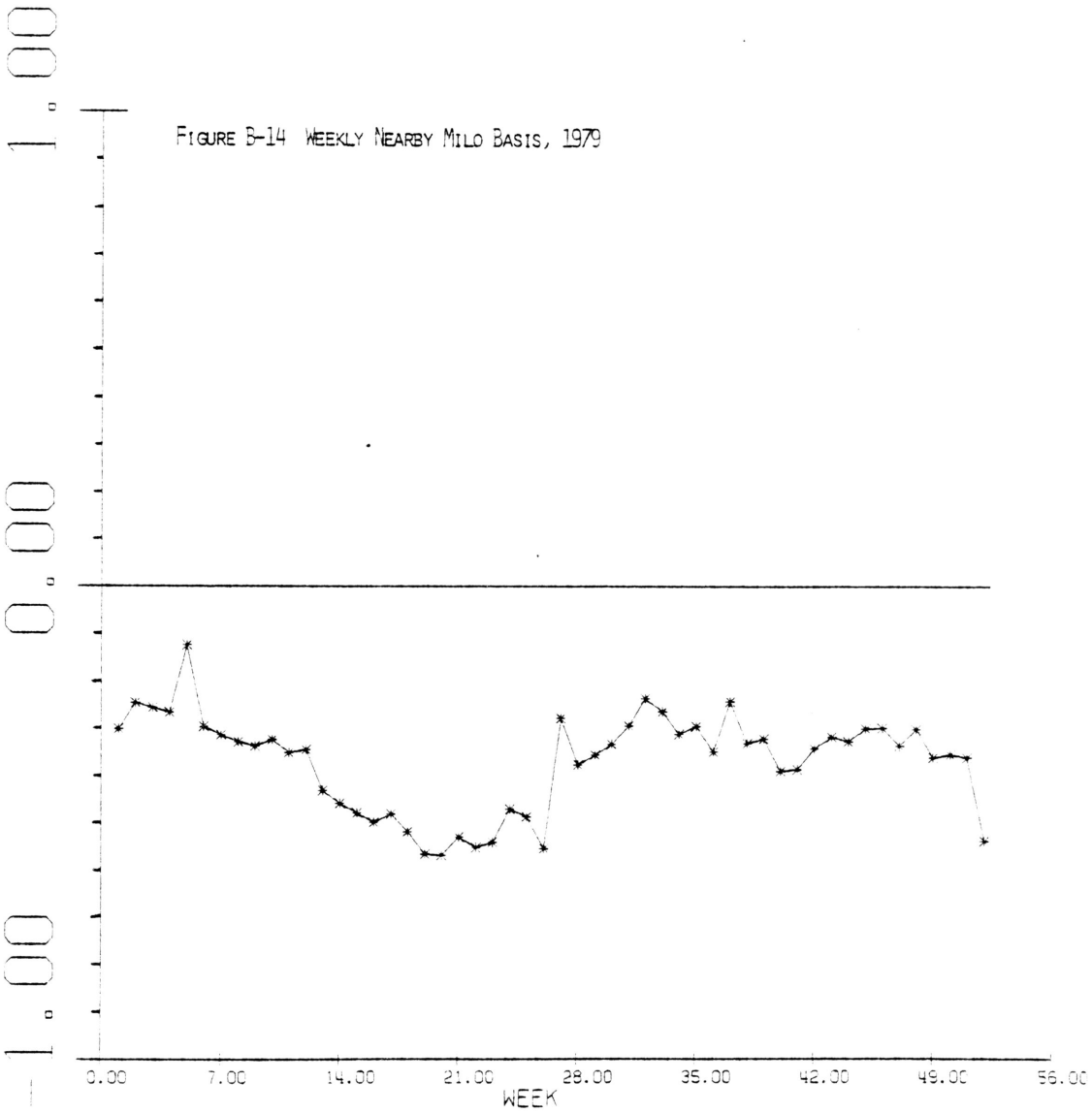


FIGURE B-14 WEEKLY NEARBY MILO BASIS, 1979

APPENDIX C

PLOTS OF CASH CORN PRICE AND CASH SORGHUM PRICES 1971-1979

FIGURE C-1 WEEKLY CASH CORN AND CASH MILO PRICES, 1971, DOLLARS/BUSHEL

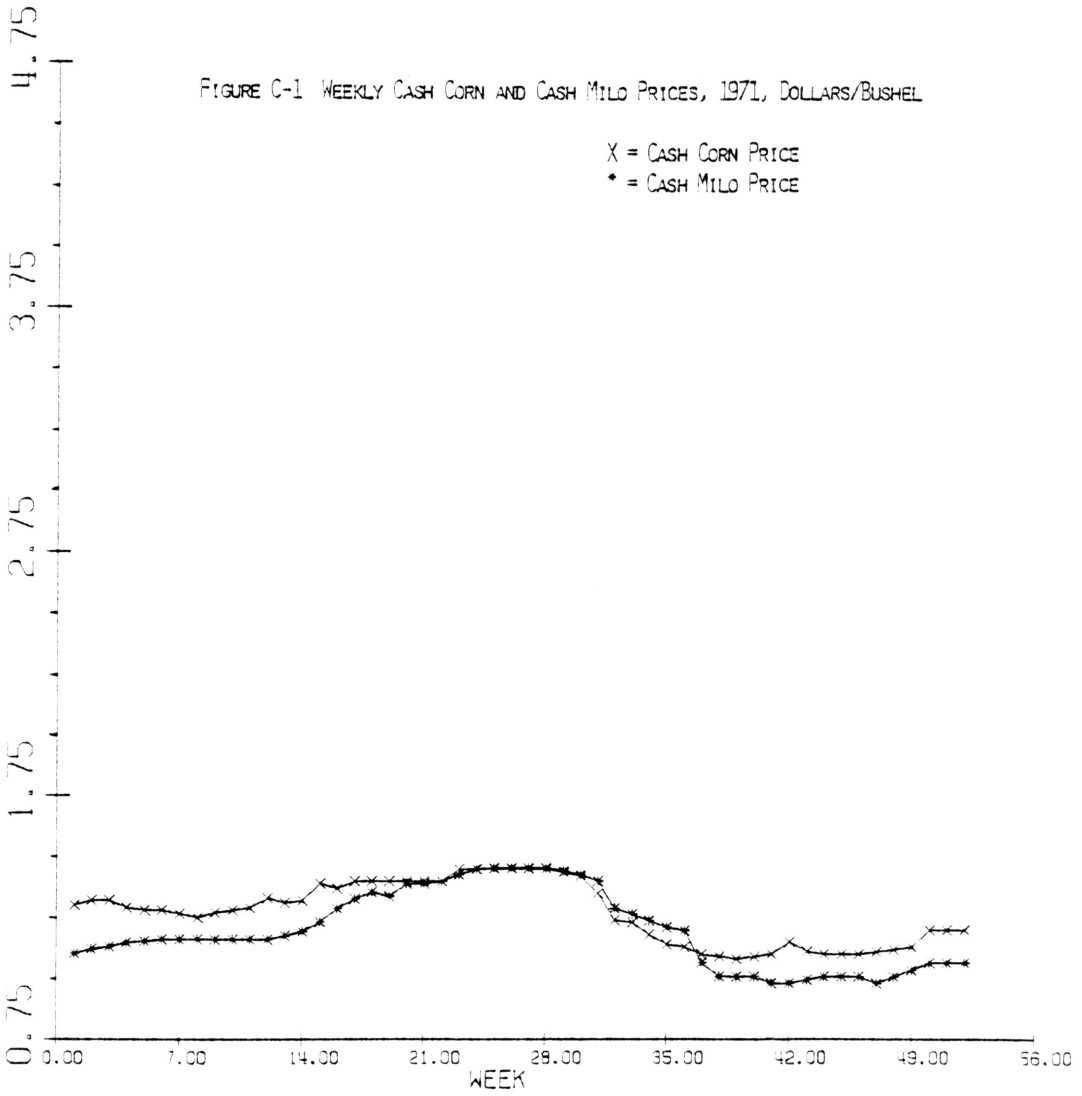
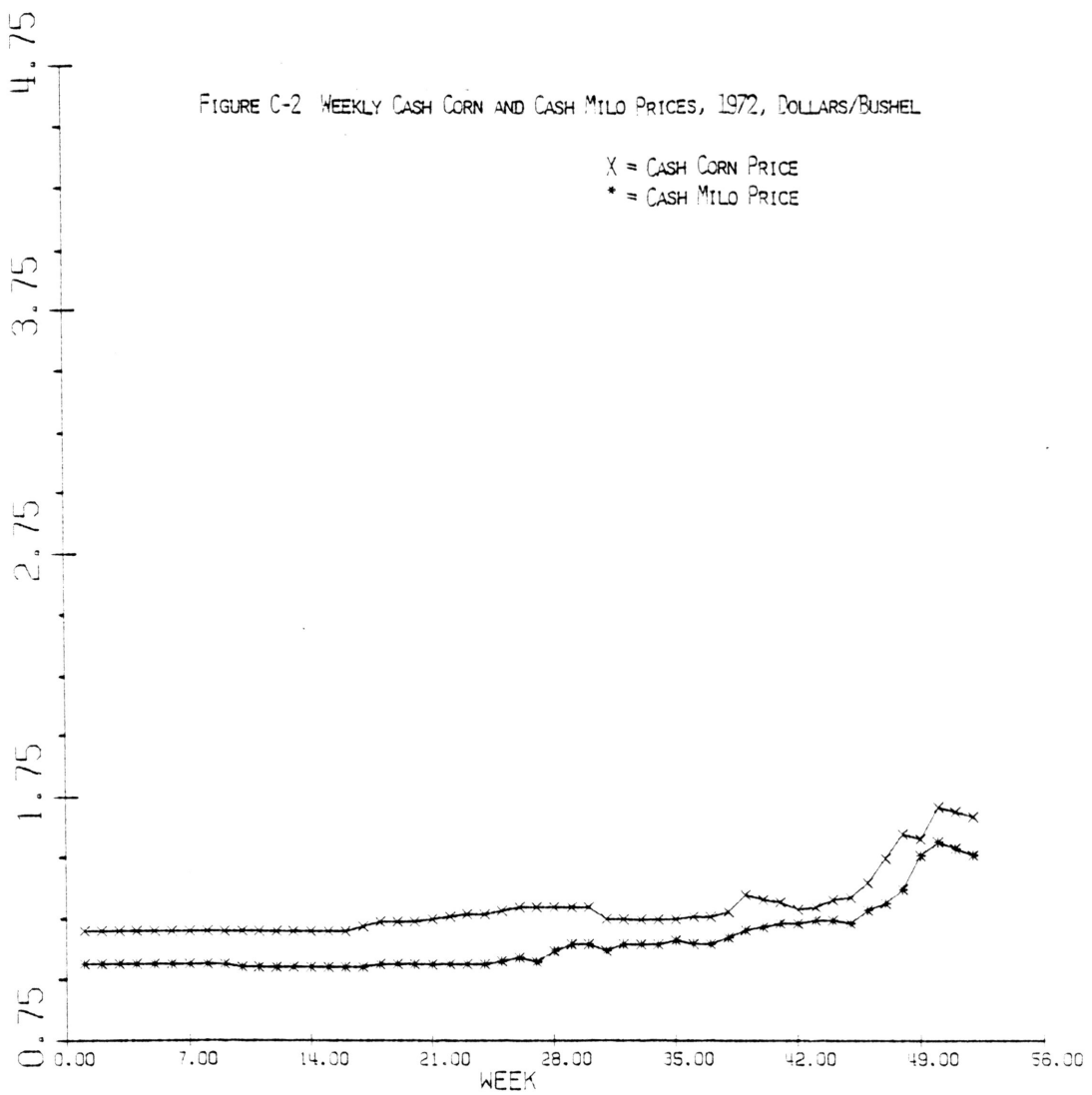


FIGURE C-2 WEEKLY CASH CORN AND CASH MILO PRICES, 1972, DOLLARS/BUSHEL



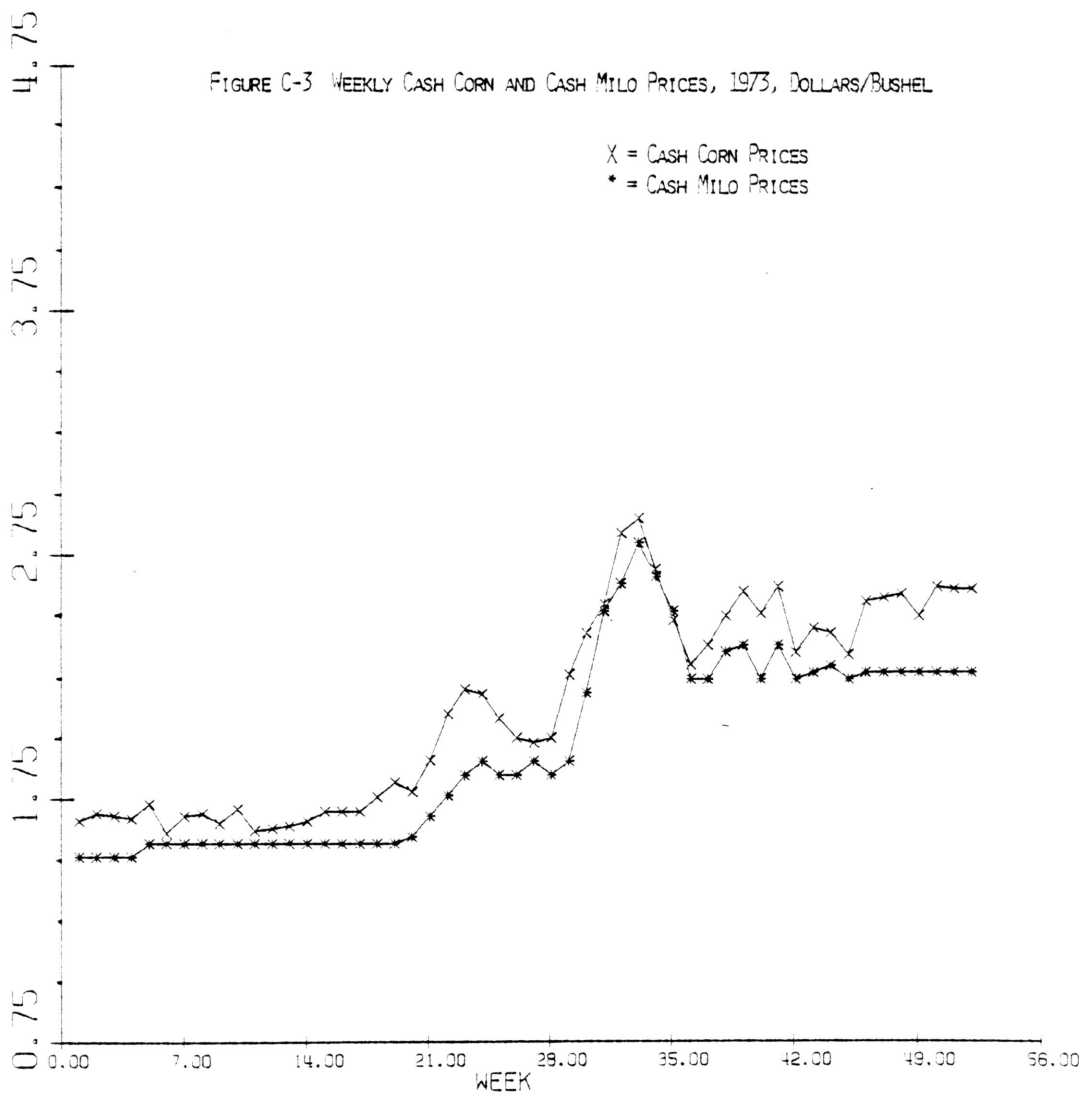


FIGURE C-3 WEEKLY CASH CORN AND CASH MILO PRICES, 1973, DOLLARS/BUSHEL
X = CASH CORN PRICES
* = CASH MILO PRICES
4.75
3.75
2.75
1.75
0.75
0.00
7.00
14.00
21.00
28.00
35.00
42.00
49.00
56.00
WEEK

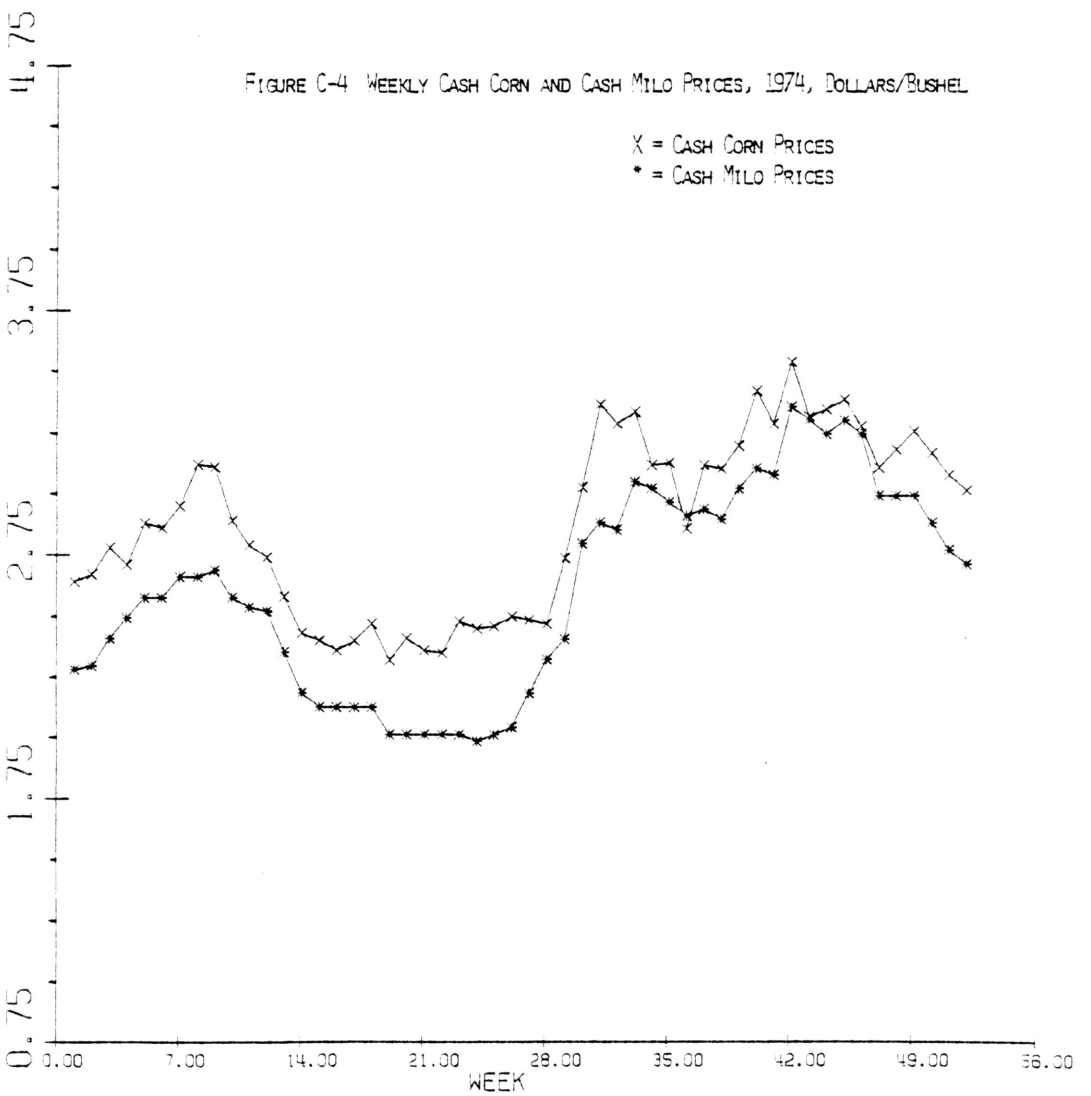


FIGURE C-4 WEEKLY CASH CORN AND CASH MILO PRICES, 1974, DOLLARS/BUSHEL
X = CASH CORN PRICES
* = CASH MILO PRICES
4.75
3.75
2.75
1.75
0.75
0.00
7.00
14.00
21.00
28.00
35.00
42.00
49.00
56.00
WEEK

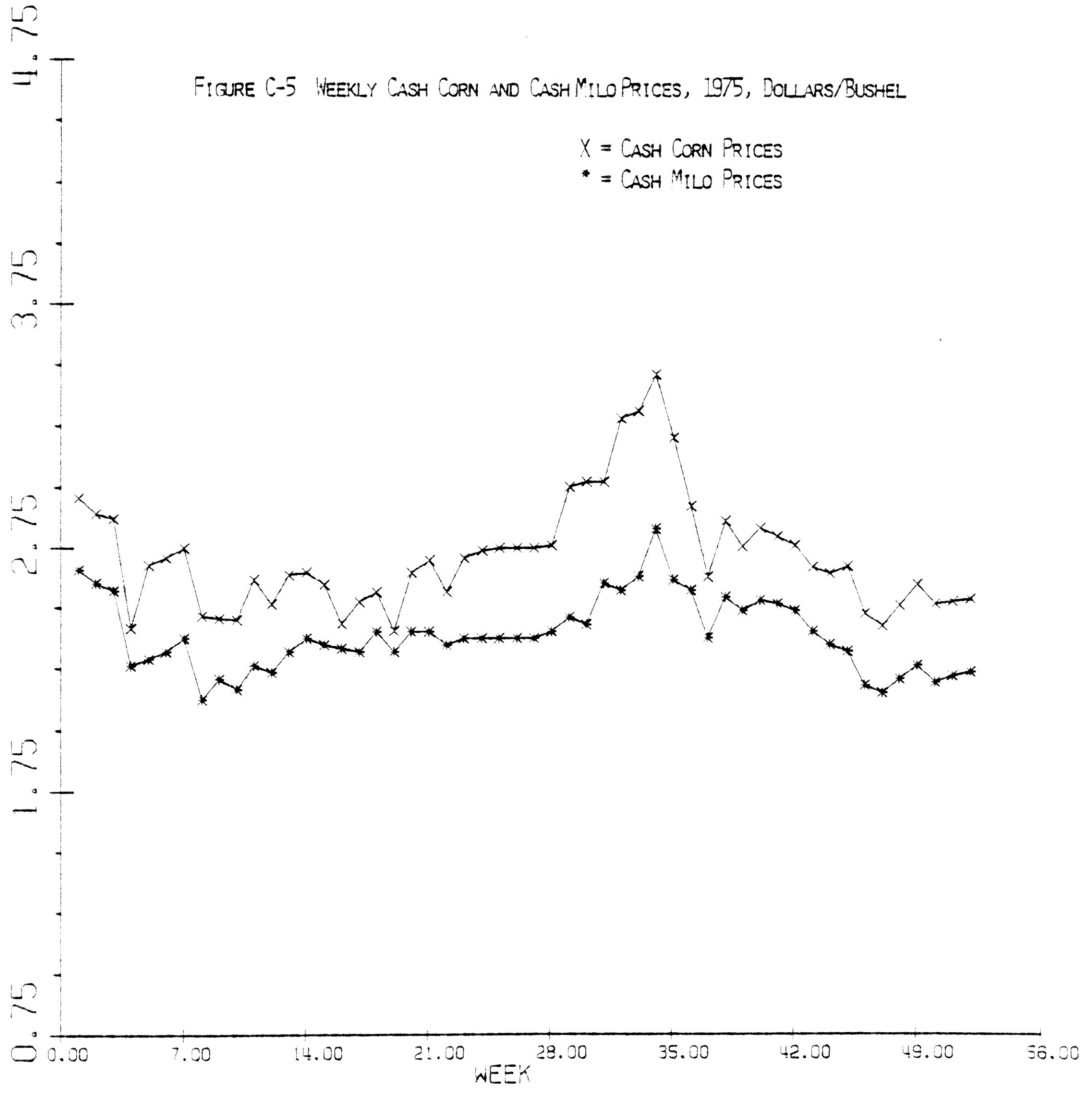


FIGURE C-5 WEEKLY CASH CORN AND CASH MILO PRICES, 1975, DOLLARS/BUSHEL
X = CASH CORN PRICES
* = CASH MILO PRICES
4.75
3.75
2.75
1.75
0.75
0.00
7.00
14.00
21.00
28.00
35.00
42.00
49.00
56.00
WEEK

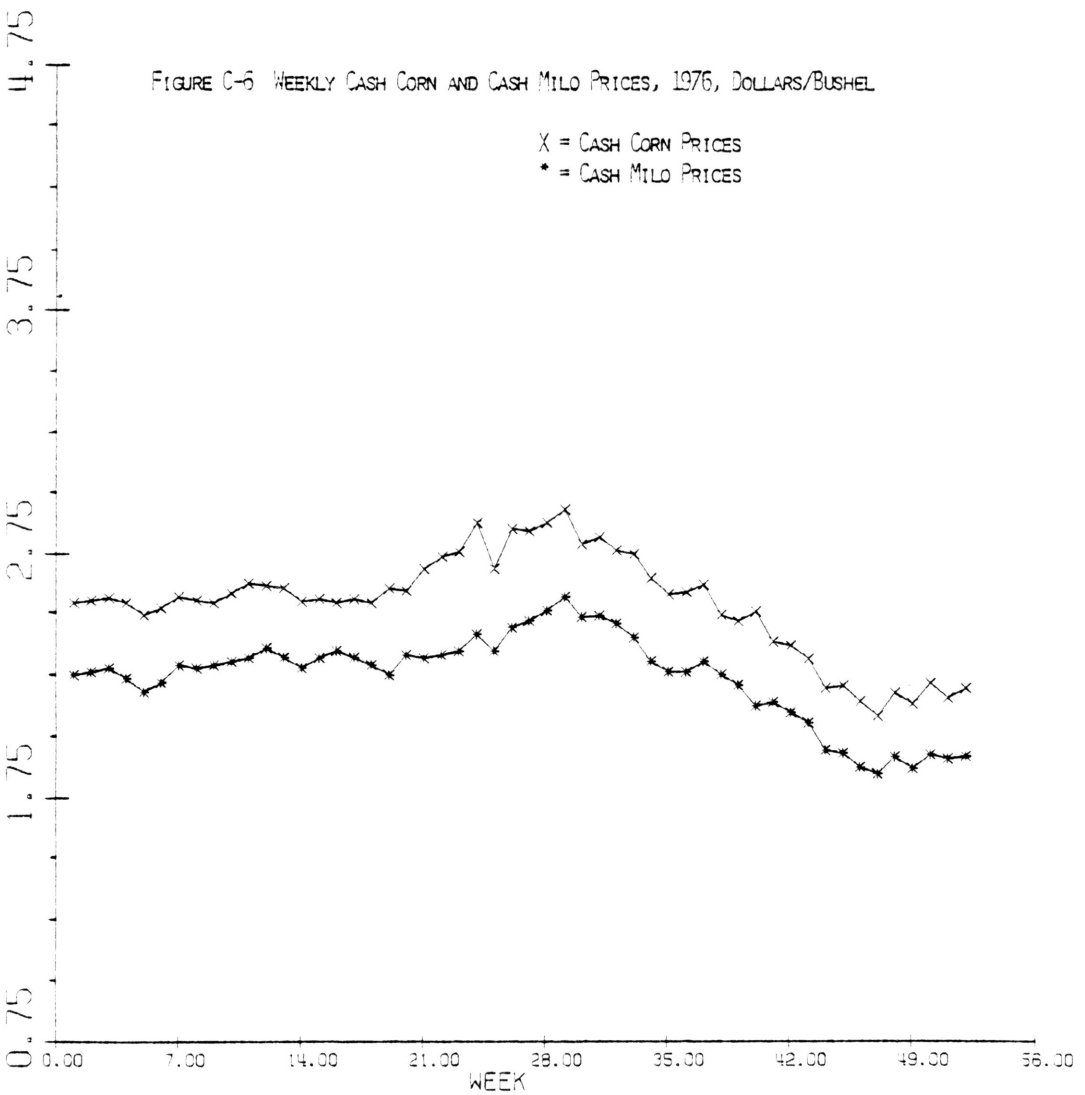


FIGURE C-6 WEEKLY CASH CORN AND CASH MILO PRICES, 1976, DOLLARS/BUSHEL

X = CASH CORN PRICES
* = CASH MILO PRICES

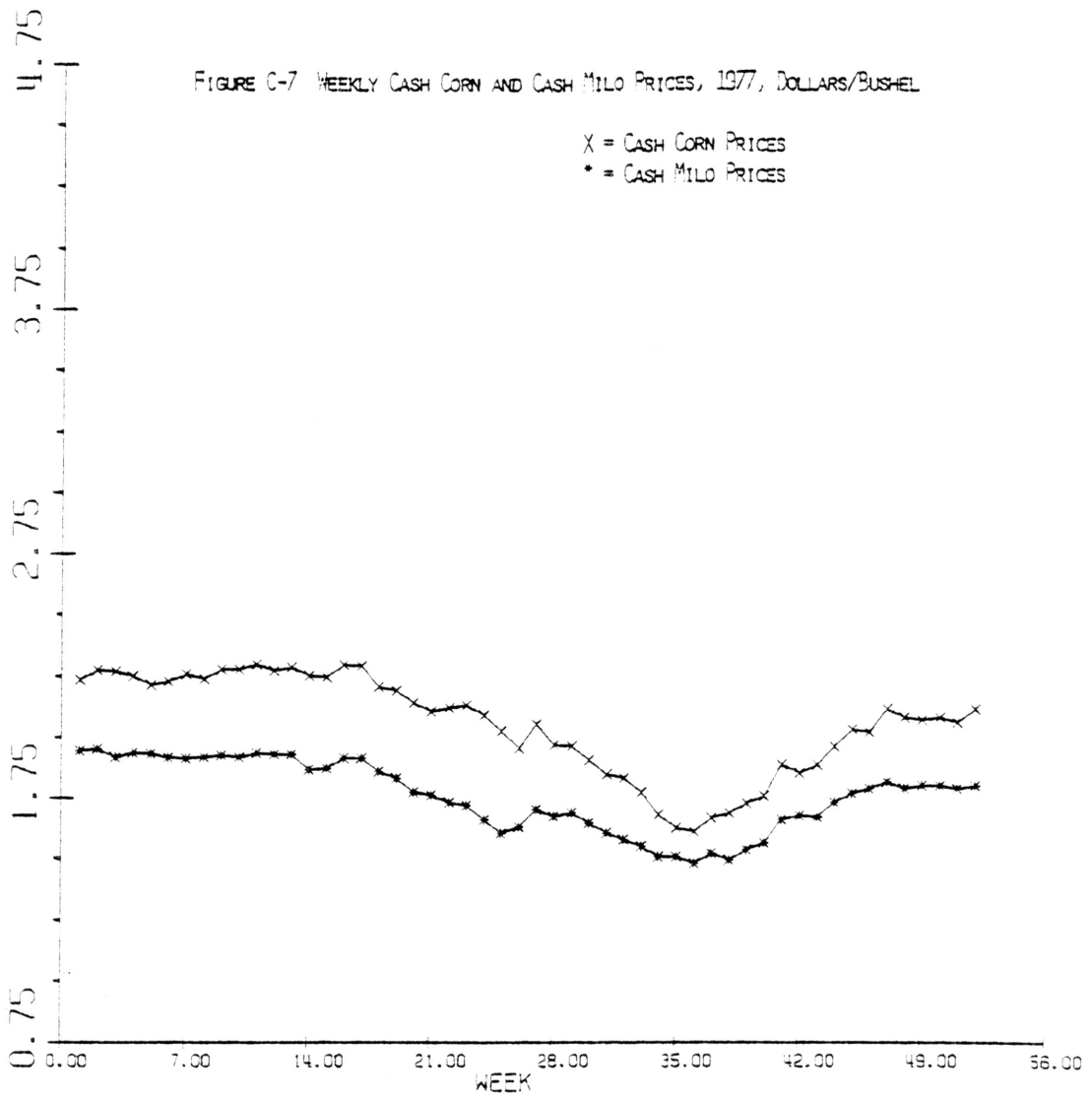


FIGURE C-7 WEEKLY CASH CORN AND CASH MILO PRICES, 1977, DOLLARS/BUSHEL

X = CASH CORN PRICES
* = CASH MILO PRICES

APPENDIX D

MEAN AND RANGE FOR THE OPENING, CLOSING AND CHANGE IN BASIS OF STRATEGIES III-XI

Table D-1. Mean Opening, Closing, and Change in Basis for Strategies III-XI

Strategy	Mean Opening Basis	Mean Closing Basis	Mean Change in Basis	Widest Closing Basis
III	-.3516	-.3221	+.02954	-.615
IV	-.3739	-.3430	+.0309	-.689
V	-.3575	-.3461	+.0112	-.689
VI	-.3769	-.3939	-.0170	-.635
VII	-.3111	-.3430	-.0320	-.689
VIII	-.3882	-.3430	+.0451	-.689
IX	-.4203	-.3933	+.0270	-.630
X	-.3689	-.3430	+.0259	-.689
XI	-.4189	-.3964	+.0225	-.687