ANALYSIS OF SELECTED BASIS RELATIONSHIPS FOR SPRING WHEAT

By

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Highlights

This study evaluates the effectiveness of the Minneapolis and Chicago futures markets as a hedging market for North Dakota producers of hard red spring wheat. The study is based on historic market price data collected from the Minneapolis and Chicago markets during the decade of the 70's. Several farmer hedging strategies were evaluated using both the Chicago and Minneapolis markets.

The results of the analysis indicate that hard red spring wheat generally can be successfully hedged in the Minneapolis market and that hedging results can be predicted within reasonable limits. The results of simulated spring wheat hedges were far less successful in yielding predictable results. The greater variation in Chicago market hedges for spring wheat are most likely related to differing supply and demand forces influencing prices of hard red spring and soft red winter wheats in a given year.

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Futures markets provide farmers with a marketing tool for establishing prices for their crops. An understanding of the relationship between the cash price and futures price for a commodity allows a producer to forward price his product. The buying and selling of futures contracts in conjunction with the planting and harvesting of an actual commodity offers the farmer the opportunity to produce at predetermined prices. A farmer can forward contract to avoid the risks of a price decline by trading futures contracts during the storage period. Producers may hedge to fix prices in advance. A producer that is hedging is substituting the often unpredictable risk of a commodity price change with the more predictable risk of a change in the cash-futures price relationship (basis). The "basis" is an important price relationship and is one of the keys to hedging. It is the difference between the cash and futures price for a commodity. The behavior of the basis is relatively predictable from year to year, so it is possible to anticipate changes in the basis in the future. A hedger can determine the cash price that can be established by hedging by analyzing the basis relationship. Successful hedging by the farmer is dependent on how accurately the farmer can predict changes in the basis for his particular crop. The analysis in this study provides specific insight into the predictability of the basis for spring wheat and, therefore, the potential for using futures markets as a marketing tool by North Dakota farmers.

The Basis

Cash and futures markets are separate markets that are related by price. Cash transactions take place in the regular commercial channels for buying and selling actual commodities for immediate delivery. A futures market is a market where agreements to purchase or sell commodities for future

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delivery are made. Trading is done with the understanding that the contracts are for future fulfillment. Futures contracts are fulfilled only if the buyer or seller decides to hold the contract until maturity.

The basis is stated as the number of cents the cash price is over or under the futures price. If the cash price for 14 percent protein spring wheat in Minneapolis on May 30 were $3.40 and the futures price for July wheat were $3.24, then the basis would be quoted as "16 over July." The basis would be "16 under July" if the July futures were $3.56.

The basis can be graphically illustrated by plotting the cash-futures price difference on a graph (Figure 1). The basis was calculated by subtracting the futures price from the cash price. Figure 1 illustrates the movement of the cash price relative to the futures price.

The cash price and the futures price for a commodity should be approximately equal in the delivery month of the futures commodity. The provision in futures contracts which allows for the delivery of a commodity assures this equality. The difference that is noted between cash and futures prices in the delivery month is usually based on commercial factors; this difference is consistent and can be expected each year.

The difference between the cash price and the futures price for a storable commodity represents a return to storage. The quantity of grain that must be carried forward into the storage season influences the return to storage. For example, if stocks of wheat were exceptionally large at harvest, then the return for carrying wheat through the storage season would be high. The price for limited storage facilities would be bid up because of a large supply of wheat which must be carried forward. Similarily, if stocks of grain at harvest were small, then the return for carrying wheat forward would be low. Competition among the owners of storage facilities for the limited supplies of the commodity would decrease the price for storage in those facilities. Owners of a storable commodity, then, can estimate the return to be expected from storing a commodity. The difference between quoted prices for the commodity for two different delivery dates is the expected return for storing the commodity. As an example, if the cash price for wheat in December were $3.20/bu. and March futures were $3.40/bu., then the market would be returning $.20 per bushel to those storing wheat over that time period.

The cash-futures price relationship may also reflect a negative return to storing a commodity. Negative prices of storage can be expected when

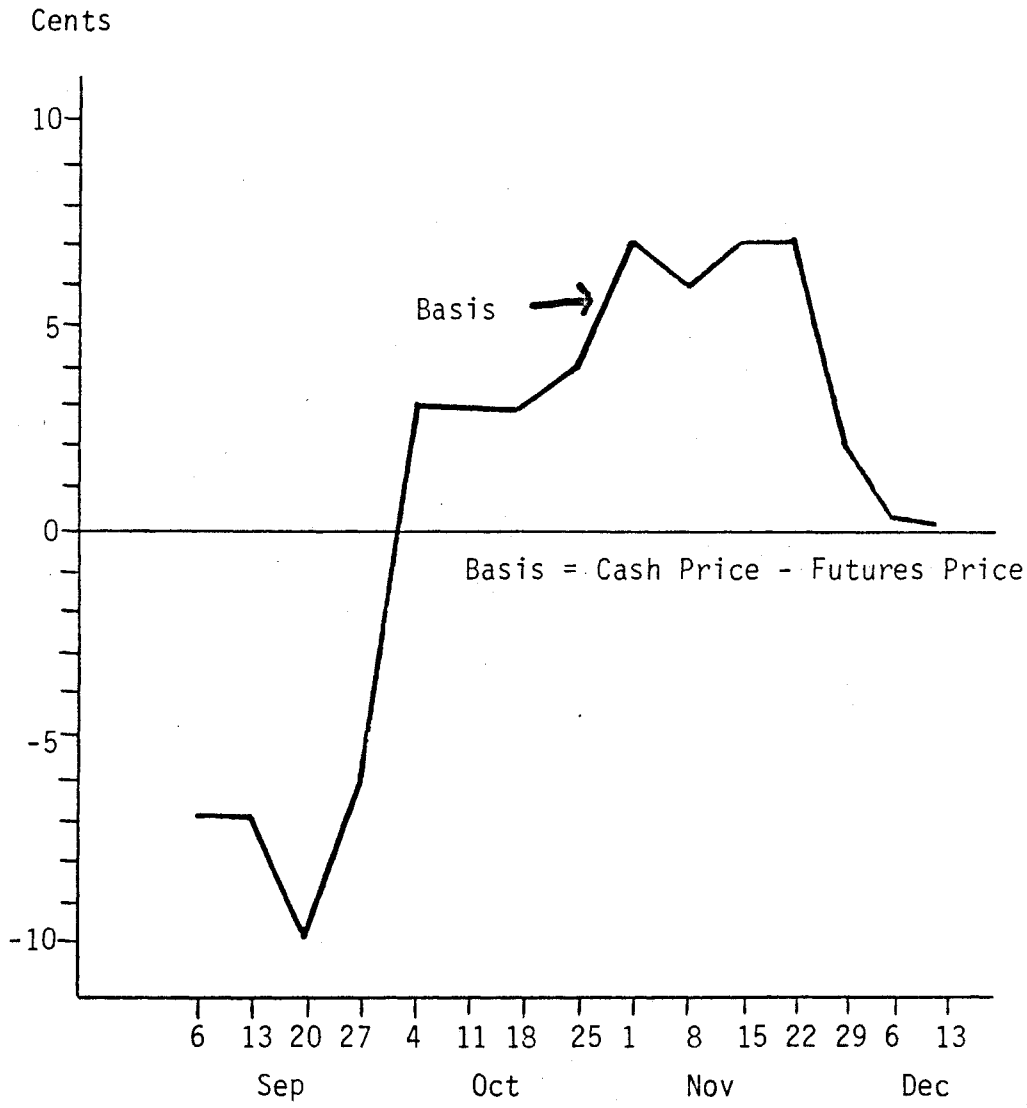

Figure 1. Graphical Depiction of the Basis

supplies are scarce. The market is exerting pressure for commodities to be taken out of storage and made available for current consumption. Consequently, when cash wheat in September is $3.50/bu., the December futures price is $3.30/bu., and the March futures price is $3.00/bu., then the market is indicating to the owner of wheat to sell now rather than store.

Using the Basis and Futures Markets

The basis gains its predictability because cash and futures prices normally are equal in the contract delivery month. Theoretically, the cash price will increase relative to the futures price during the life of a futures contract if the price comparison is being made within a marketing year. An individual who buys, produces, or owns commodity for sale at a future date will incur carrying charges such as interest on borrowed working capital, storage charges, commissions, transportation charges, insurance, and handling charges. A futures trader, however, can buy a contract and, with the exception of a margin deposit, incur very little additional cost. Consequently, the holder of an actual commodity inventory should expect a regular increase in the cash price during the storage season as compensation for absorbing the costs of storage. The futures trader should not expect a regular price increase because he is not absorbing a cost in holding a futures contract.

Pricing a commodity in advance of production. Futures markets can be used to establish the price of a growing crop. Producers can contract an approximate price before planting or during the growing season by selling futures contracts. The futures quotation and the anticipated harvest basis for the commodity determine a target price that represents the farmer's expected net price at harvest at his local elevator. The futures contracts are offset when the crop is sold in the local cash market.

An example best illustrates this use of the futures markets. A farmer in North Dakota would like to fix the price for his wheat in order to be assured of covering production costs. The September futures price for wheat in Minneapolis on April 27 was $2.92/bu. During previous years the basis at the farmer's local cash market averaged $.38 under the September futures price during the last week of August and the first week of September. A target price of $2.54/bu. was calculated by subtracting the average harvest basis of $.38 from the September futures price of $2.92. The market was offering this

price ($2.54) in April for a commodity to be sold in September at the local elevator. The farmer deemed the target price an acceptable price for his crop so he sold enough September futures contracts to equal his anticipated production. The harvest was completed on September 1, and the wheat was delivered and sold to the local elevator for a cash price of $2.16/bu. The farmer bought September futures at the same time to offset and to settle his futures contracts. The September futures on September 1 sold for $2.48/bu. Summarizing the results in Table 1:

TABLE 1. PRICING A COMMODITY IN ADVANCE OF PRODUCTION

Date	Cash	Futures		Basis
April 27	Decide to grow wheat	Sell Sep Futures	$2.92	(Expected) -$.38
Sep 1	Sell wheat $2.16	Buy Sep Futures	2.48	-$.32
		Gain	+$.44	+$.06

Cash Price $2.16

Gain in the Futures Mkt. +$0.44

Net Price $2.60

The net price received by the hedger is directly related to the increase of the cash price relative to the futures price during the marketing period. In the example shown in Table 1, the market yielded a price of $2.60/bu. which was $.06 more than the expected target price of $2.54/bu. The $.06 gain was the result of a favorable change in the harvest basis. The cash-futures price difference was expected to be $.38 under the September futures price but actually narrowed to $.32 under the futures price. If the price had not been contracted ahead, the farmer would have received only $2.16/bu. The use of the futures market and the relatively predictable behavior of the basis provided the farmer a $.44 increase in price for his wheat.

Farmers are relatively flexible in their trading decisions when using the futures market as a hedging device. They can be selective in choosing when to buy and offset their futures contracts. Also, a fixed price can easily be cancelled. An offsetting purchase of futures contracts will free the farmer to take advantage of a market that is unexpectedly rising rapidly. The use of futures markets is a flexible procedure that is adaptable to both increasing and decreasing market prices.

Pricing a commodity held in storage. Farmers can profit from storing grain even though the cash price for their grain in storage may decline. Storage income can be earned in a manner similar to fixing prices in advance of production. A target price is established by using the futures price and the predicted basis at the end of a particular storage period. The following hypothetical example illustrates forward pricing of grain in storage.

A farmer has just completed his harvest in early September and is contemplating fixing the price of wheat to be held in storage. The local elevator cash price on September 8 was $3.00/bu. while the May futures price was $3.63/bu. An analysis of the basis at the elevator during recent years indicated that the cash price averaged $.55 under the May futures contract price in September and then increased to $.30 under the May futures contract price at the maturation of the contract. The market usually offered an average incentive of $.25 per bushel to store grain from September until May. The $.30 average basis that had historically occurred in May was subtracted from the May futures price of $3.63 resulting in a target price of $3.33/bu. This price represents an estimate of the price the farmer will receive in May for his stored grain if he uses the futures markets. The target price appeared to be a satisfactory price so the farmer decided to hedge by selling enough May futures contracts to equal the volume of his stored grain. The farmer sold his grain on May 4 at his local elevator and offset his futures position. During the interim the cash price had dropped $.15 to $2.85/bu., while the May futures price had declined to $3.18/bu. Table 2 summarizes the results.

The farmer received $3.30/bu. for his grain in May which was $.30 more than the price in September. Storing the grain from September until May returned $.30 per bushel which was exactly equal to the change in the basis. The target price of $3.33 was not met when the hedge was terminated because the basis did not quite narrow to $.30 under the May futures price. It is a

TABLE 2. PRICING A COMMODITY HELD IN STORAGE

	Cash		Futures		Basis
Sep 8	Store Grain	$3.00	Sell May Futures	$3.63	-$ .63
May 4	Sell Stored Grain	2.85	Buy May Futures	3.18	- .33
	Loss	$ .15	Gain	+$ .45	+$ .30

Cash Price on May 4	$2.85
Gain from the Futures Market	.45
Net Price	$3.30

judgment of the hedger to decide if the cash price will increase relative to the futures price as predicted. The importance of the concept of storage is that a farmer can earn profits from his storage facilities even though the price of the grain he is holding has declined. The flexibility of futures markets, however, also allows a farmer to earn profits from a price increase. A hedger can easily offset his futures position and can take advantage of rising prices by speculating on his stored grain in the cash market.

COMPARISON OF THE SPRING WHEAT BASIS USING THE CHICAGO AND THE MINNEAPOLIS FUTURES MARKETS

The successful use of futures markets as a pricing tool is dependent on the predictability of the basis. A basis pattern that is relatively consistent from year to year enables a producer to establish a reliable expectation of the forward price for this crop. Significant differences between the predicted target price or forward price and the actual net price received indicate that the use of futures markets is not always a suitable pricing tool. Selected basis patterns for spring wheat are analyzed both graphically and statistically in order to illustrate their behavior. Basis relationships that are predictable and that forecast accurate target prices are identified for use as part of a marketing strategy.

The Chicago Board of Trade and the Minneapolis Grain Exchange were analyzed to determine their reliability as a hedging tool for North Dakota farmers. The Chicago wheat contract is less specific than most futures contracts as it allows several kinds of wheat to be delivered against its contract. The Minneapolis wheat contract calls for delivery of spring wheat. Minneapolis is also the closest terminal wheat market for most North Dakota producers. This study evaluated the basis in both the Chicago and the Minneapolis wheat futures markets to determine their value as a guide to decision making in the storage or sale of grain.

Pricing spring wheat in advance of production. A farmer using the futures markets to fix a price for his grain in advance of production is concerned with the closing basis at harvest. The closing basis relationships analyzed consist of a sample of approximately 30 basis values that were computed from daily cash and futures prices quoted during the last six weeks of a particular futures contract. A North Dakota farmer can successfully price his spring wheat in advance of production if the closing basis for his wheat at harvest time is predictable.

The closing harvest basis was calculated using the Minneapolis cash price for 13 percent protein wheat and the September futures contract price for wheat from both the Chicago and the Minneapolis markets. Data on daily prices were recorded during the last four weeks of August and the first two weeks of September for the years 1971 through 1977. A seven-year average was computed for each day in the sample of closing basis values, and the average was used to represent the overall behavior of the closing basis. Figures 2 and 3 illustrate the average daily closing basis for the Minneapolis and the Chicago markets. A 90 percent confidence interval was plotted around the seven-year average basis. The confidence interval represents a 90 percent chance that the true average basis will be within the range specified by the interval. The confidence interval is dependent on the variation in the basis values over the seven years. A confidence interval that is narrower implies more consistent and more predictable basis behavior, while wider confidence intervals imply more erratic behavior by the basis from year to year. The Minneapolis basis becomes more predictable during the last part of August and the first part of September as indicated by the narrowing confidence intervals in Figure 2. The confidence intervals narrow from more than $.10 to less than $.06. The Chicago basis generally maintains the same degree of predictability

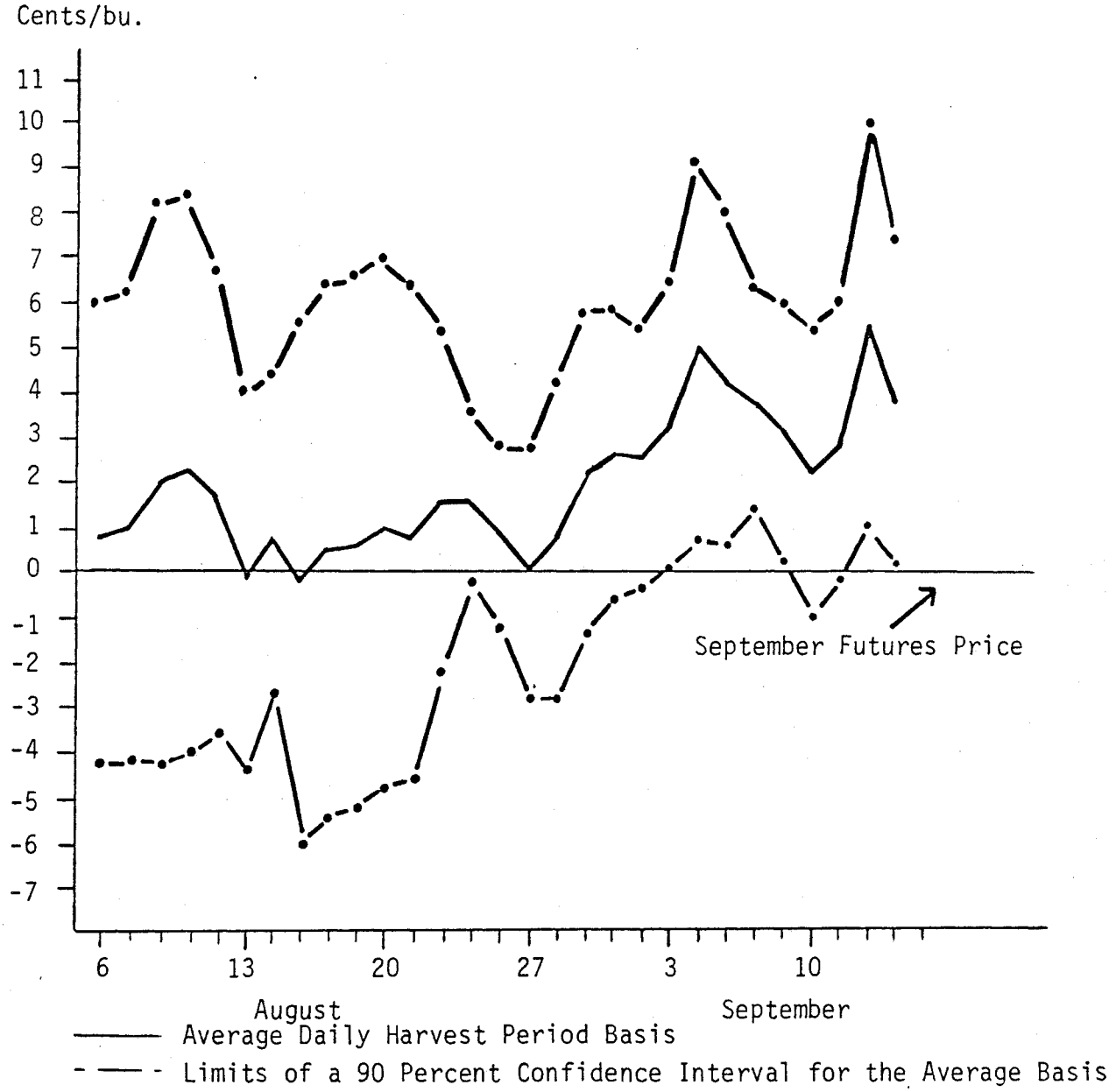

Figure 2. Average Daily Harvest Period Basis, 90 Percent Confidence Interval, 13 Percent Protein Wheat, September Futures Contract, Minneapolis Market, Years 1971-1977

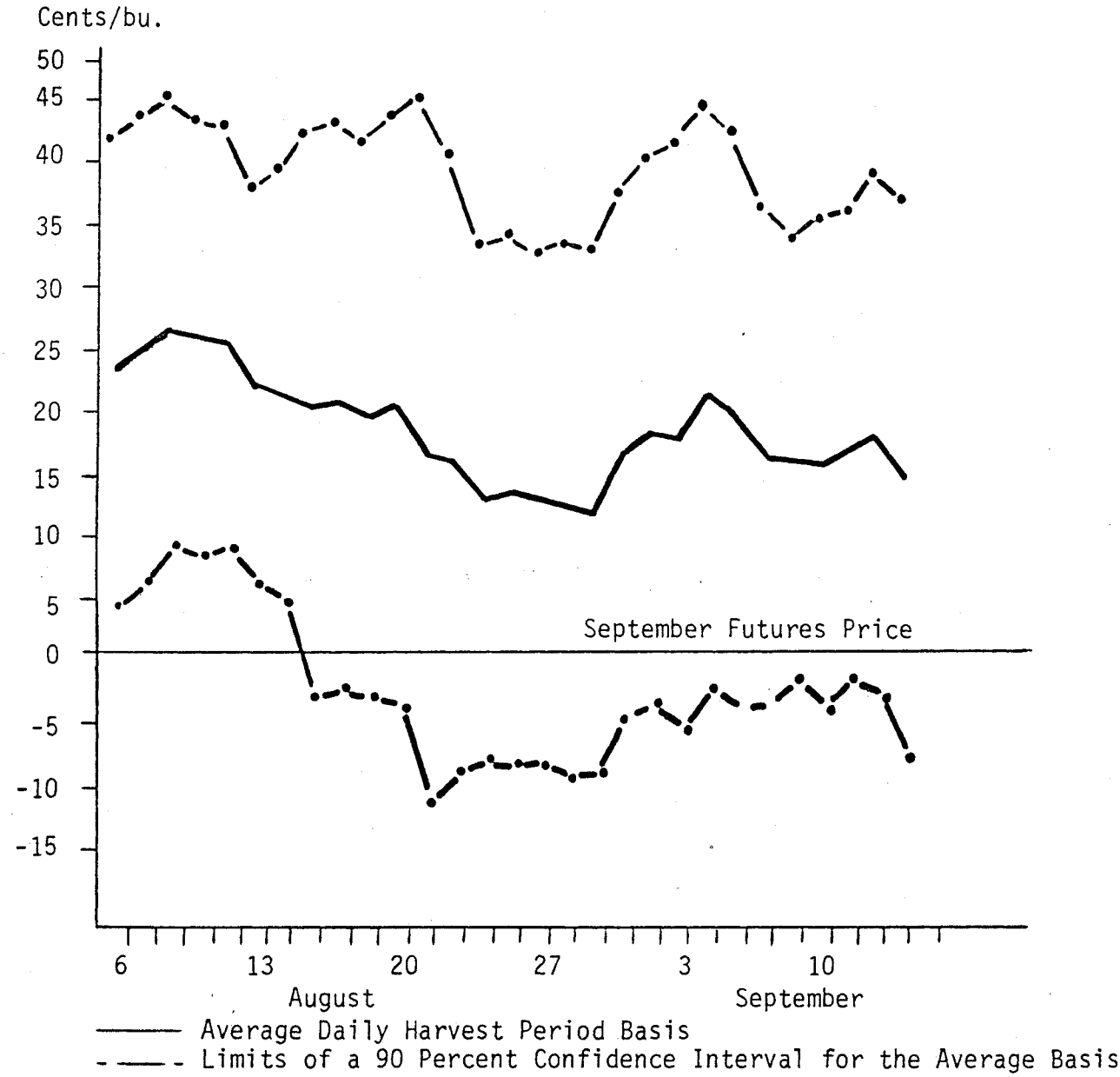

Figure 3. Average Daily Harvest Period Basis, 90 Percent Confidence Interval, 13 Percent Protein Wheat, September Futures Contract, Chicago Market, Years 1971-1977

during the entire six-week period. A 40 percent spread is required to be 90 percent sure of including the true average closing basis in the confidence interval. The narrower confidence intervals associated with the basis of the Minneapolis September wheat contract imply that the Minneapolis basis is more predictable each year than the Chicago basis.

The Minneapolis and Chicago basis relationships for September wheat are analyzed individually for each year from 1971 to 1977 (Table 3). The average basis, the standard deviation, and the range of basis values for the six week period studied for each year are used to summarize the behavior of the basis. The September basis in Minneapolis ranged from $.03 under the September future in 1972 to $.06 over the September future in 1974. The standard deviation of the six-week distribution of basis values ranged from $.016 in 1971 and 1976 to $.099 in 1973. The basis in Chicago, in contrast, ranged from $0.28 under the September future in 1973 to $0.49 over the September future in 1975. The standard deviations of the distributions were similarly more variable as they ranged from $0.02 in 1972 to $.177 in 1973. The standard deviation reflects the daily variability of the basis during the six week period studied of each individual year. Larger deviations imply more erratic behavior of the basis during the particular futures contract and imply less chance of fixing a reliable target price. The greatest variability in basis values for both markets occurred during 1973 after the Soviets had made huge grain purchases and when grain prices were rising to all-time highs. The existence of an unusually volatile grain market such as occurred in 1973 resulted in basis relationships that were more variable and less predictable. A farmer contemplating the use of futures markets to forward price his grain would most likely decide in such years to remain long in the cash market and to postpone forward pricing until the markets and the various basis relationships became more stable.

Hedging to fix a price in advance of production using the Minneapolis basis and the Chicago basis was done to determine what forward pricing results could be expected in each of the years 1971 to 1977 (Tables 4 and 5). A sale of September wheat futures was made in the spring and was followed by a harvest sale of cash wheat and by an offsetting purchase of September futures. The hedge was arbitrarily initiated on April 26 and was offset on August 29. An average basis was selected from the graphical illustrations of the Minneapolis

TABLE 3. MEAN, STANDARD DEVIATION, AND RANGE OF THE SEPTEMBER WHEAT AND 13 PERCENT PROTEIN CASH SPRING WHEAT BASIS, AUGUST THROUGH SEPTEMBER, 1971-1977

Year	Average Basis	Standard Deviation	Range	
			Low	High
		Minneapolis Futures Market		
1971	0.0¢	1.6¢	4.0¢	2.5¢
1972	-3.0	1.8	-6.6	2.0
1973	-2.5	9.9	-16.0	18.5
1974	6.5	5.2	-1.0	17.0
1975	3.0	2.5	-0.5	7.0
1976	4.0	1.6	2.0	7.0
1977	5.0	2.0	3.0	9.0
Average	2.0	3.7	-3.0	6.0
		Chicago Futures Market		
1971	9.0¢	3.7¢	-1.0¢	12.5¢
1972	-1.0	2.0	-6.0	2.5
1973	-28.0	17.7	-56.5	9.0
1974	45.5	8.5	29.5	62.5
1975	49.0	11.0	30.0	68.0
1976	24.5	6.1	12.0	35.5
1977	26.0	5.8	17.5	35.0
Average	17.5	27.0	-28.0	49.0

and Chicago markets. Three cents over the September futures was selected for the average Minneapolis basis, and $0.15 over the September futures price was chosen for the Chicago basis. The average harvest basis for the Minneapolis and Chicago markets was added to the September futures price for wheat on April 26 in both markets in order to establish a target price for each year.

It was assumed the farmer had harvested, delivered, and sold his wheat to the elevator for the current market cash price on August 29. The futures contract sold on April 26 was offset by a purchase of the September futures contract. The net price actually received by the farmer is the cash price received at the elevator plus or minus the gains or losses from the futures transactions.

The data presented in Tables 4 and 5 provide an analysis of how accurately wheat can be priced in advance of harvest delivery using the

TABLE 4. SALE OF WHEAT PRIOR TO PLANTING USING THE MINNEAPOLIS MARKET, TARGET PRICES, AND COMPARISON OF TARGET AND REALIZED PRICES, 1971-1977 CROPS

Date	Action	Crop Year* 1971	1972	1973	1974	1975	1976	1977
26 April	September Futures	161¢	158¢	223¢	410¢	366¢	379¢	294¢
	Average Harvest Basis	+3	+3	+3	+3	+3	+3	+3
	Target Price	164	161	226	413	369	382	297
26 April	Sell September Futures	161	158	223	410	366	379	294
29 August	Buy September Futures	153	188	467	465	444	328	238
	Gain/Loss on Futures	+8	-30	-244	-55	-78	+51	+56
29 August	Sell Cash Wheat	149	185	466	473	446	335	241
	Net Price**	157	155	222	418	368	386	297
	Net Price Minus Target Price	-7	-6	-4	+5	-1	+4	0

* Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.

TABLE 5. SALE OF WHEAT PRIOR TO PLANTING USING THE CHICAGO MARKET, TARGET PRICES, AND COMPARISON OF TARGET AND REALIZED PRICES, 1971-1977 CROPS

Date	Action	Crop Year* 1971	1972	1973	1974	1975	1976	1977
26 April	September Futures	152¢	148¢	238¢	402¢	342¢	351¢	274¢
	Average Harvest Basis	+15	+15	+15	+15	+15	+15	+15
	Target Price	167	163	253	417	357	366	289
26 April	Sell September Futures	152	148	238	402	342	351	274
29 August	Buy September Futures	150	186	511	433	407	306	218
	Gain/Loss on Futures	+2	-38	-273	-31	-65	+45	+56
29 August	Sell Cash Wheat	149	185	466	473	446	335	241
	Net Price**	151	147	193	442	381	380	297
	Net Price Minus Target Price	-16	-16	-60	+25	+24	+14	+8

*Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.

Minneapolis and Chicago futures markets. The actual net price received in the Minneapolis market was under the target price three times, over the target price three times, and equal to the target price once. The range of variation over the seven-year period was from $.07 under to $.05 over the target price. The analysis of the Chicago market resulted in being under the target price three times and over the target price four times. The range was from $.60 less than to $.25 more than the expected target price. The results of the analysis of the seven-year average closing basis, the analysis of the closing basis for each individual year, and the analysis of the hypothetical hedges suggest that the Minneapolis market is more reliable as a hedging market for spring wheat than is the Chicago market when pricing grain in advance of production.

Pricing Spring Wheat Held in Storage

Farmers using the futures market to fix a price for grain in storage are concerned with the change in the basis during the storage period. Theoretically the cash price should increase relative to the futures price to provide inducement to store grain for sale at later dates.

The Minneapolis basis and Chicago basis were calculated by relating the 13 percent protein cash price in Minneapolis to the wheat futures quotations in both markets. Three storage periods were examined for each market. September was assumed to be the start of the wheat storage season as harvest is usually completed in most of North Dakota. The December, March, and May futures contracts represented the end of the three storage periods. Each of these contracts theoretically reflects the price of the crop previously harvested and is not significantly influenced by expectations for the new crop. Mid-week prices were obtained from the first week of September until the second week of December, March, and May respectively. An average basis was computed for each of the three storage periods using prices from the 1970-1971 storage season to the 1977-1978 season. The average basis value for each week of the storage period was defined as follows:

$$\text{Average Basis Value} = \sum_{1}^{n} (\text{Cash} - \text{Futures})_i \div n$$

where

Cash = mid-week price quotation for the specified cash commodity
Futures = mid-week futures quotation for the specified futures contract
i = particular week of the storage period
n = number of years the data were analyzed

Both the Minneapolis and the Chicago bases had a positive slope during the September - December storage period (Figures 4 and 5) indicating that positive returns to storage generally were earned by hedging during this storage period. Positive returns to storage were the result of the cash price for 13 percent protein spring wheat increasing relative to the futures quotation. A 90 percent confidence interval was calculated for each basis pattern to indicate the year to year variability in the weekly basis values. The average basis for hedges in the Minneapolis market started at $.02 under the December futures price in early September and increased to approximately $.09 over the December future in late November. Average results of the hedge were an $.11 per bushel storage return for carrying wheat from September to late November. The average Chicago basis increased from $.08 over the December future in early September to almost $.20 over the December future in late November for a $.12 per bushel storage return. The confidence intervals are wider for the Chicago market, however, indicating that the year-to-year behavior of the Chicago basis is more erratic than the Minneapolis basis. Both the Minneapolis and the Chicago markets are characterized by the basis decreasing sharply after a peak is reached in November. The basis decreases because the cash price for wheat has declined relative to the December futures price as a result of the close of the Great Lakes and other waterways used for shipping wheat. Buyers of wheat are not bidding as aggressively for cash wheat because they no longer have available the relatively inexpensive means to transport grain. Hedges in the December futures contract should be terminated in mid to late November when the cash price is at a maximum relative to the futures price so that the maximum return to storage can be earned.

The Minneapolis and the Chicago basis patterns (Figures 6 and 7) are positively sloped during the September - March storage period indicating that returns to storage can usually be earned during this period. The average

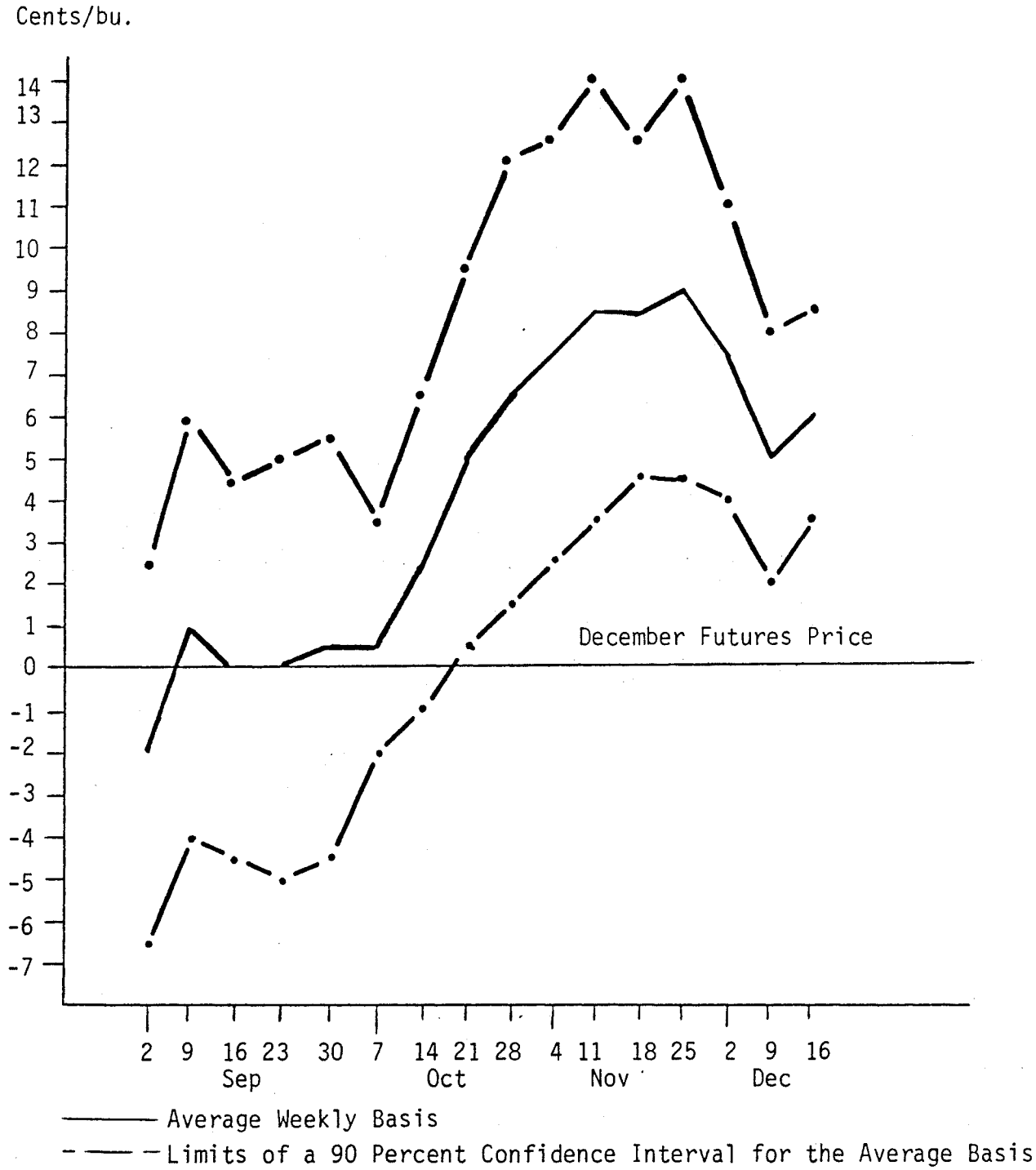

Figure 4. Average Weekly Basis of the Minneapolis December Futures Contract, 90 Percent Confidence Interval, 13 Percent Protein Cash Wheat, September-December, Years 1970-1977

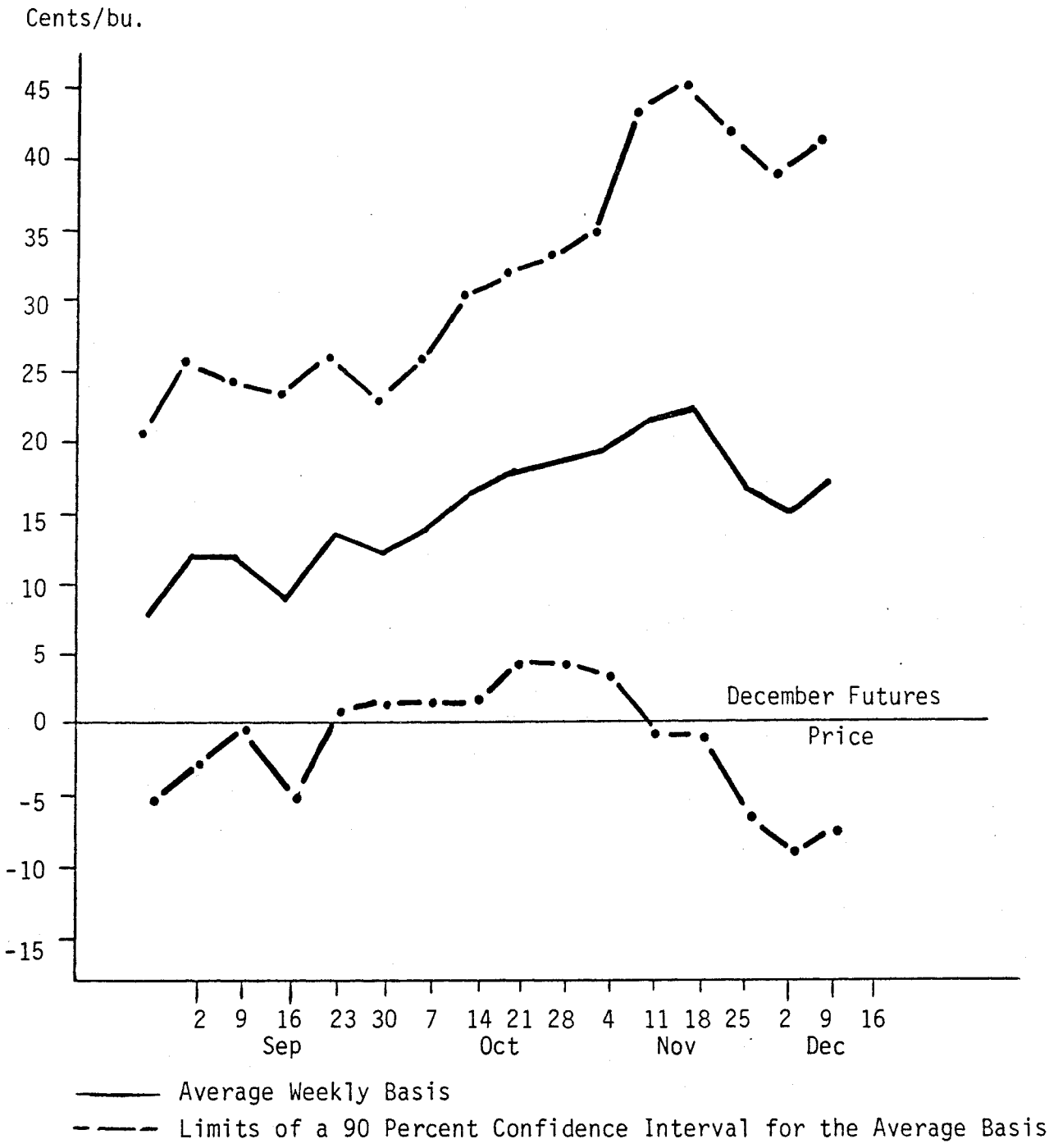

Figure 5. Average Weekly Basis of the Chicago December Futures Contract, 90 Percent Confidence Interval, 13 Percent Protein Cash Wheat, September-December, Years 1970-1977

Minneapolis basis was $.06 under the March futures price in September and increased to $.10 over the March futures price in the delivery month. In this analysis the market reflected a storage return of $.16 per bushel. A seasonal variation resulted in the basis peaking in mid-November at $.07 over the March futures price. An individual could earn $.13 of the $.16 of storage earnings by storing grain from September until only mid-November. The cause of the seasonal increase in the basis in November is the impending close of the Great Lakes and the Upper-Midwest river network. Buyers are bidding up the price of cash wheat because they have commitments to meet prior to the close of the shipping season. The confidence intervals are also wider in mid-November indicating greater variability in the year to year peak of the basis. The average Chicago basis began at $.03 over the March futures price in early September and increased to $.18 over the March futures price in the delivery month. The return to storage was approximately $.15 per bushel. The Chicago basis also peaked in mid-November at roughly $.18 over the March futures price. A farmer could earn just as much from his storage facilities by storing grain from September to November as he could by storing grain from September to March when using the Chicago futures market and the March futures contract. The confidence intervals for the Chicago basis widen from $.17 in September and October to almost $.30 after mid-November indicating that the basis values become more variable after November of each storage year.

The positive slope of the Minneapolis and Chicago basis during the September-May storage period (Figures 8 and 9) indicates that the cash price increased relative to the May futures price and that returns to storage were earned by hedging during the storage period. The average basis for hedges in the Minneapolis market was approximately $.05 under the May futures price in September and increased to $.11 over the May futures price in early May. The market reflected a storage return of $.16 per bushel for carrying wheat from September until May. The September - May storage period was characterized by a seasonal peak in the basis in late November of $.07 over the May futures price. Hedging wheat using the Minneapolis market from September until only the end of November would return an average of $.12 of the $.16 returned for storing grain from September to May. The peak basis value in November varies considerably from year to year as evidenced by the $.30 confidence interval at that time. The average Chicago basis began at $.06 over the May futures price at the start of the storage period and increased to $.30 over the May futures price at the end of the storage period. Average

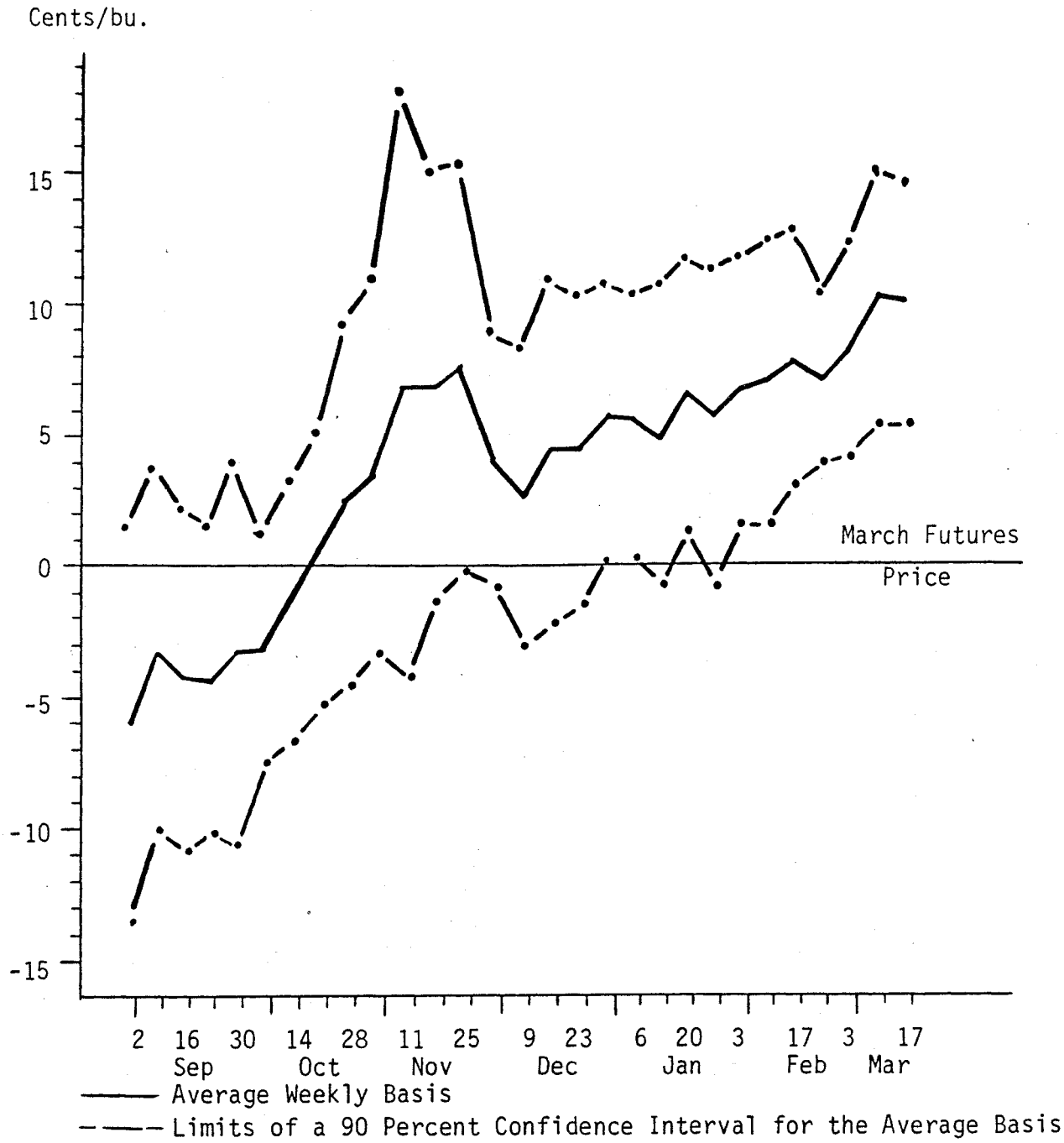

Figure 6. Average Weekly Basis of the Minneapolis March Futures Contract, 90 Percent Confidence Interval, 13 Percent Protein Cash Wheat, September-March, Years 1971-1978

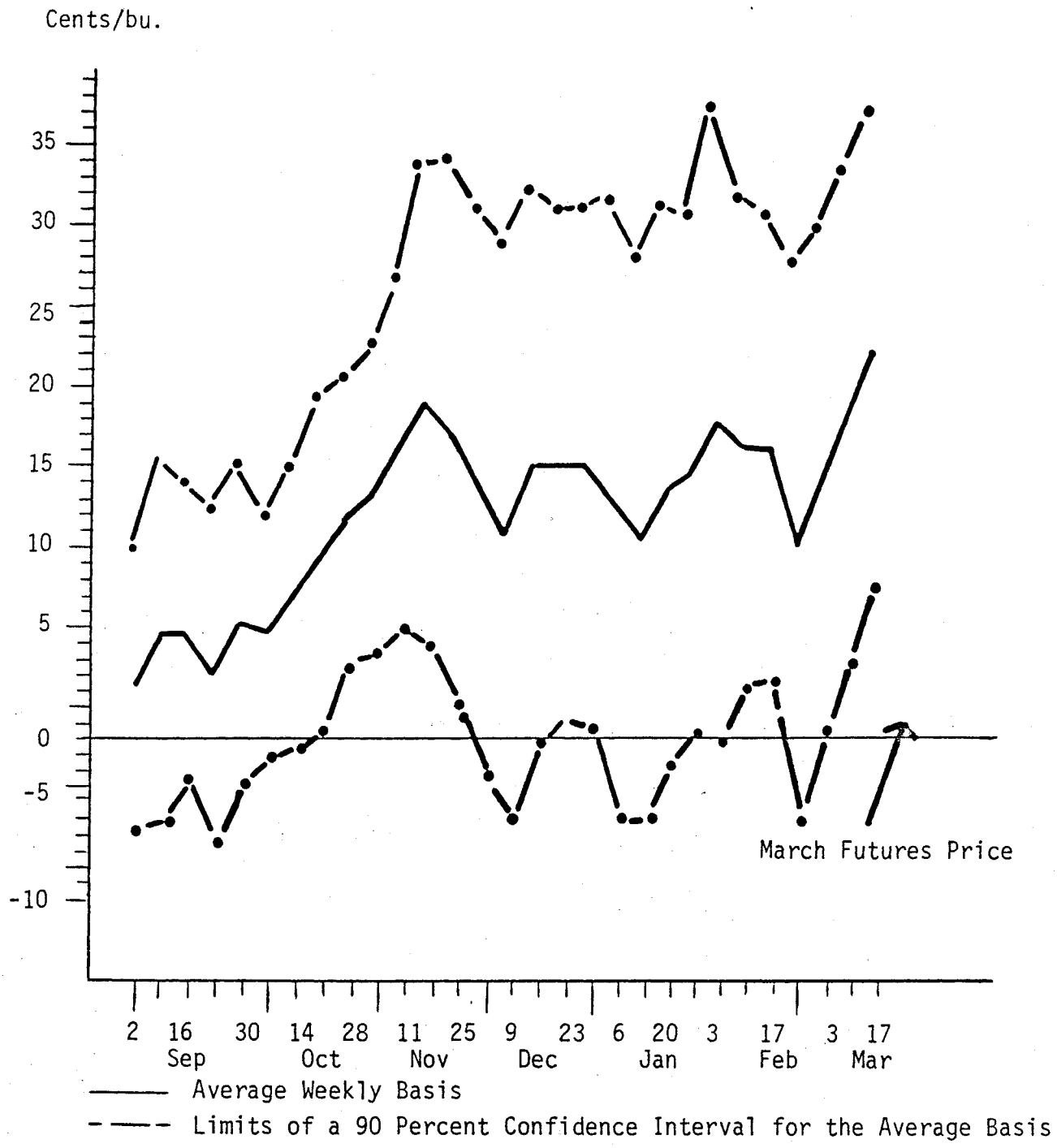

Figure 7. Average Weekly Basis of the Chicago March Futures Contract, 90 Percent Confidence Interval, 13 Percent Protein Cash Wheat, September-March, Years 1971-1978

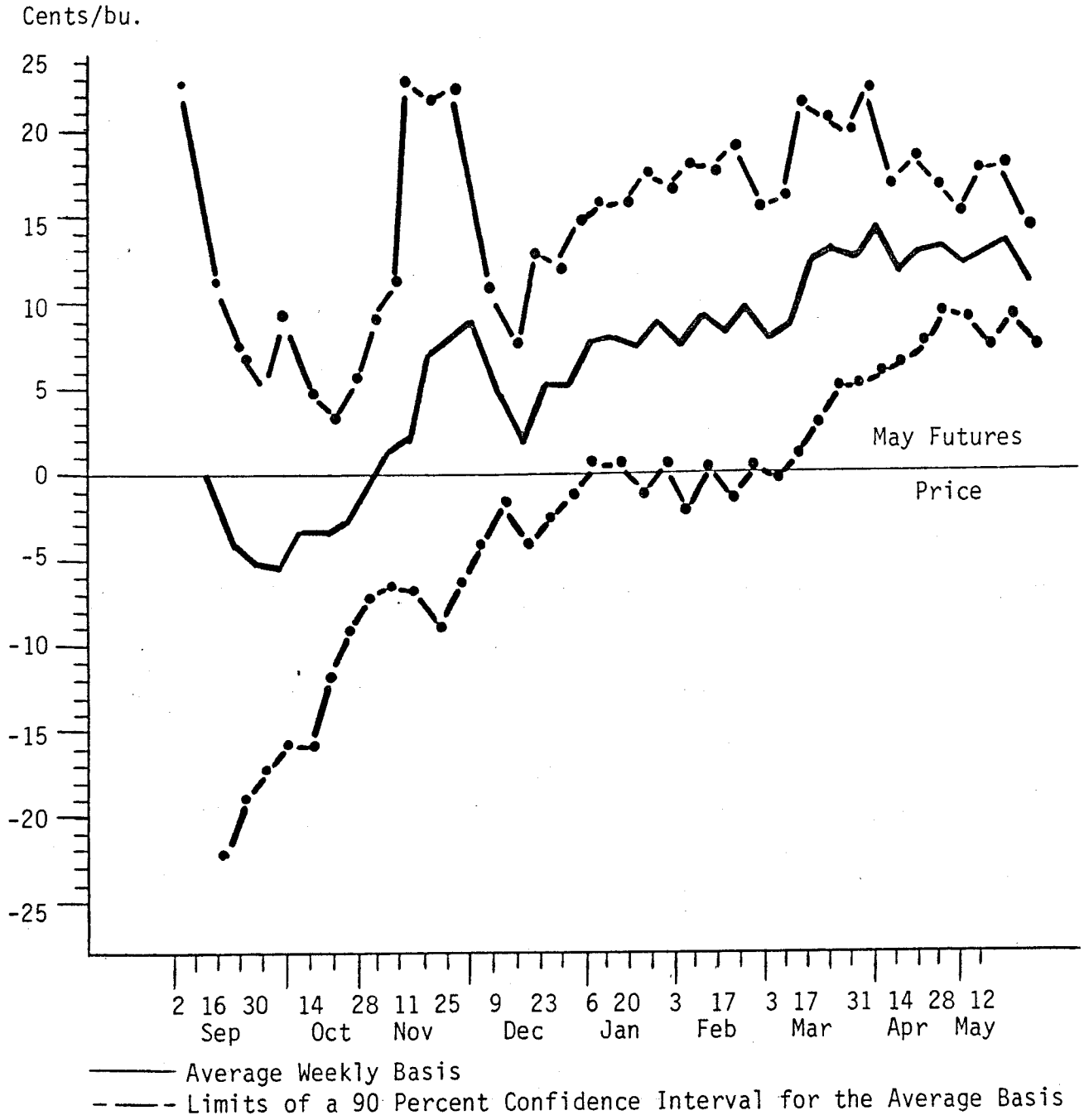

Figure 8. Average Weekly Basis of the Minneapolis May Futures Contract, 90 Percent Confidence Interval, 13 Percent Protein Cash Wheat, September-May, Years 1971-1978

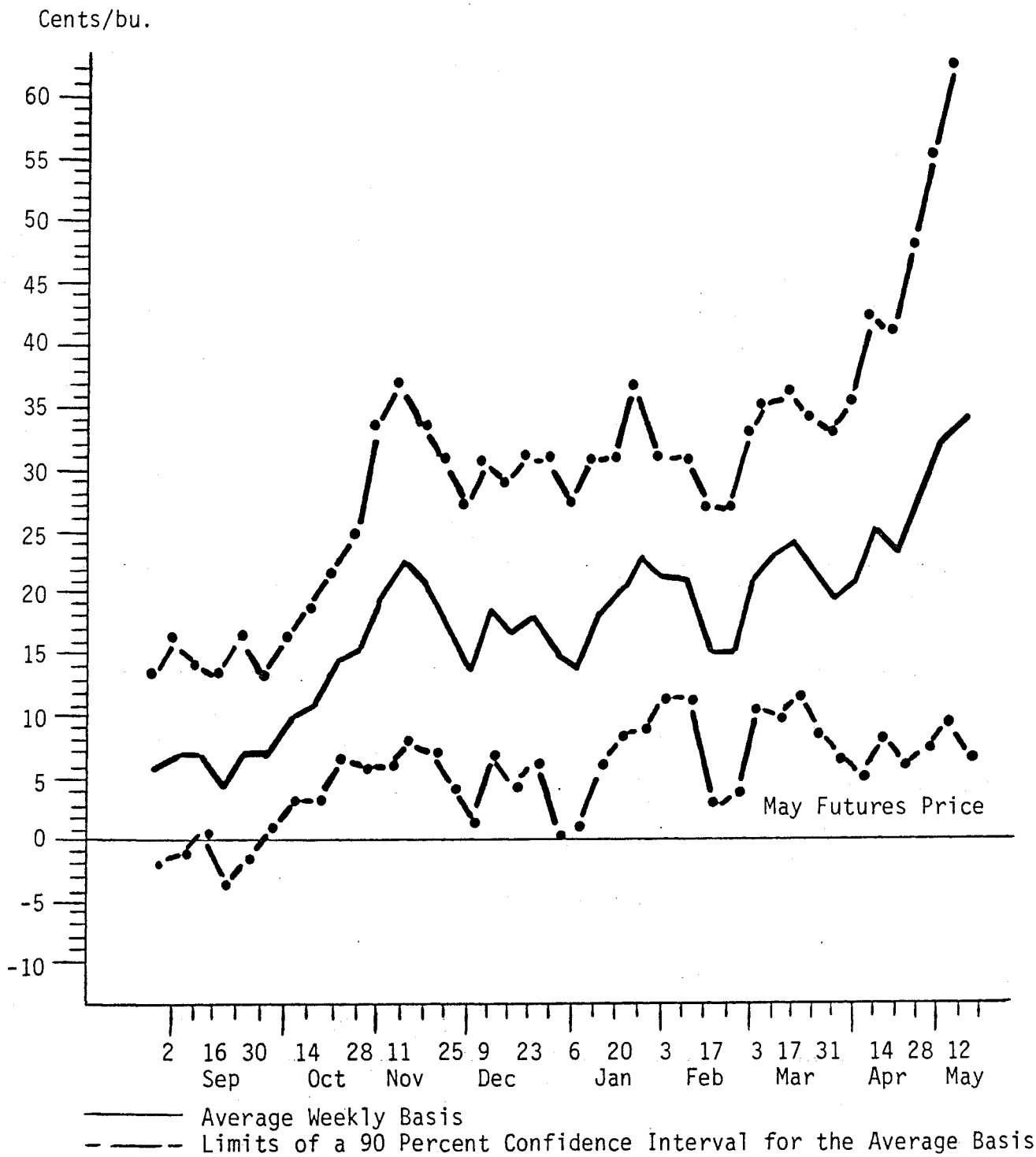

Figure 9. Average Weekly Basis of the Chicago May Futures Contract, 90 Percent Confidence Interval, 13 Percent Protein Cash Wheat, September-May, Years 1971-1978

results of the hedge were a $.24 per bushel storage return for carrying wheat from September to May. The Chicago basis peaked in November at $.22 over the May futures price, so $.16 of the $.24 of storage return could be earned by storing wheat from September until November. The confidence intervals calculated for the Chicago basis during the September - May period ranged from $.27 in November to $.56 in May implying great variability in year-to-year basis values. The analysis suggests forward pricing hard red spring wheat in storge using the Chicago market would result in highly unpredictable results because of the variability associated with the year-to-year basis values.

Theoretically a linear statistical relationship should exist between the value of the basis for a commodity and the length of time a commodity has been held in storage. The cash price for a commodity should increase relative to its futures price because of the storage costs incurred by the holder of an actual commodity. According to the mathematical definition given for the basis in this study (Basis = (Cash - Futures)), the basis should also increase during the same storage period if the cash price increases relative to the futures price. Regression analysis is a statistical tool that can measure how well the basis patterns in Figures 4 - 9 conform to the theoretical pattern of a steadily increasing linear basis. The dependent variable of the regression model is the average basis value for each week in a specific storage period. The independent variable is time in the storage period with the first week equal to one. For example, if the average basis values for the first five weeks of the September to December storage period were $.05, $.06, $.07, $.08, and $.09 over the December futures price, then the corresponding values for the independent variable would be $.01, $.02, $.03, $.04, and $.05 respectively. Measures of precision of an estimated linear regression line to the basis patterns described by the average basis data in Figures 4 - 9 are presented in Tables 6 and 7. Basis behavior during a storage period that can be accurately described by a regression line implies basis behavior consistent with theory and behavior suitable for use in forward pricing grain in storage using the futures markets.

The coefficient of determination, or R-square value, is the proportion of the variation of the actual basis value from the regression value that can be explained by variation in the independent variable which was time. An R-square value of almost one implies the basis data fit a linear relationship well. The standard error of estimate measures the deviation of the actual

TABLE 6. MEASURES OF THE GOODNESS OF FIT OF THE BEHAVIOR OF THE AVERAGE WEEKLY BASIS TO A THEORETICAL BASIS LINE, 13 PERCENT PROTEIN WHEAT, MINNEAPOLIS MARKET

Storage Period	Years	R-Square	Standard Error of Estimate	F-Value Significance	Regression Coefficient/ Significance	Intercept/ Significance
September-December	1970-1977	.92	1.19	.0001	.99/.0001	- 3.2/.0008
September-March	1971-1978	.93	1.28	.0001	.52/.0001	-5.07/.0001
September-May	1971-1978	.89	1.91	.0001	.47/.0001	-4.68/.0001

TABLE 7. MEASURES OF THE GOODNESS OF FIT OF THE BEHAVIOR OF THE AVERAGE WEEKLY BASIS TO A THEORETICAL BASIS LINE, 13 PERCENT PROTEIN WHEAT, CHICAGO MARKET

Storage Period	Years	R-Square	Standard Error of Estimate	F-Value Significance	Regression Coefficient/ Significance	Intercept/ Significance
September-December	1970-1977	.91	1.41	.0001	1.08/.0001	6.85/.0002
September-March	1971-1978	.74	2.58	.0001	.47/.0001	4.48/.0002
September-May	1971-1978	.81	3.05	.0001	.54/.0001	5.77/.0002

basis values from the predicted or regression basis values. A smaller standard error of estimate indicates a better fit between the actual basis data and the regression line. The F statistic provides a test of whether the regression line that is being compared to the average basis data actually has a positive slope or whether a line with zero slope would be more appropriate. A line with zero slope would imply that the basis was not increasing in value as the storage season progressed.

The average Minneapolis basis fit an increasing linear relationship over time for all three storage periods. The R-square values were in the .9 range, the standard errors of estimate were relatively small, and the estimated coefficients indicated a positively sloped relationship between the basis and the time variable. The Chicago basis fit an increasing linear relationship best in the September to December storage period. Values for the estimated coefficients did not support an increasing linear relationship between the basis values and the time variable in the other two storage periods.

An analysis of forward pricing grain in storage during three different time periods using the Minneapolis basis (Tables 8, 9, and 10) and the Chicago basis (Tables 11, 12, and 13) was made to determine the success to be expected from such hedging. Target prices were established at the beginning of each storage period by adding an average basis value that had historically occurred during the last days of the September to December, the September to March, and the September to May storage periods to the December, March, and May futures prices quoted at the beginning of each of the three storage periods. All target prices were established on a selected date in September, and the storage hedges were arbitrarily terminated on dates near the end of the three futures contracts. The hedging procedure was to sell either December, March, or May futures in September in an amount equal to the amount of wheat the farmer had in storage. At the end of the storage period the farmer would buy offsetting futures, sell cash wheat at the elevator, and then add or subtract the profits or losses from the futures transactions to the price received for the cash wheat. Hypothetical hedges are followed through for the September to December, the September to March, and the September to May storage periods.

The net price received minus the target price measures the difference between the actual price received by the hedger and the expected forward price; therefore, it is a measure of the accuracy of the forward price. Use of the Minneapolis December contract in the September to December storage

TABLE 8. PRICING HARD RED SPRING WHEAT HELD IN STORAGE FOR LATER DELIVERY AND HEDGED IN THE MINNEAPOLIS MARKET, TARGET PRICES, COMPARISON OF TARGET PRICES AND ACTUAL PRICES, AND GAIN REALIZED FROM STORAGE, 13 PERCENT PROTEIN WHEAT, SEPTEMBER - DECEMBER, 1970-1977

Storage Period	Date	Activity	Crop Year* 1970	1971	1972	1973	1974	1975	1976	1977
September-December	Sep 13	Dec Futures	187¢	159¢	206¢	474¢	476¢	459¢	329¢	263¢
		Ave. December Closing Basis	+8	+8	+8	+8	+8	+8	+8	+8
		Target Price	195	167	214	482	484	467	337	271
	Sep 13	Sell Dec Futures	187	159	206	474	476	459	329	263
	Nov 22	Buy Dec Futures	186	155	211	442	530	410	288	282
		Gain/Loss on Futures	+1	+4	-5	+32	-54	+49	+41	-19
	Nov 22	Sell Cash	194	160	217	456	537	410	300	291
		Net Price**	195	164	212	488	483	459	341	272
		Net Price Minus Target Price	0	-3	-2	+6	-1	-8	+4	+1
		Sep 13 Cash Price	190	156	198	487	482	457	326	271
		Net Price Realized	195	164	212	488	483	459	341	272
		Return to Storage***	+5	+8	+14	+1	+1	+2	+15	+1

*Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.
***Difference between the cash price offered at the beginning of the storage period and the net price actually received at the end of the storage period.

TABLE 9. PRICING HARD RED SPRING WHEAT HELD IN STORAGE FOR LATER DELIVERY AND HEDGED IN THE MINNEAPOLIS MARKET, TARGET PRICES, COMPARISON OF TARGET PRICES AND ACTUAL PRICES, AND GAIN REALIZED FROM STORAGE, 13 PERCENT PROTEIN WHEAT, SEPTEMBER - MARCH, 1971-1978

Storage Period	Date	Activity	Crop Year* 70-71	71-72	72-73	73-74	74-75	75-76	76-77	77-78
September-March	Sep 13	Mar Futures	188¢	163¢	211¢	474¢	478¢	469¢	340¢	269¢
		Ave. March Closing Basis	+8	+8	+8	+8	+8	+8	+8	+8
		Target Price	196	171	219	482	486	477	348	277
	Sep 13	Sell Mar Futures	188	163	211	474	478	469	340	269
	Feb 28	Buy Mar Futures	173	155	215	557	387	423	292	269
		Gain/Loss on Futures	+15	+8	-4	83	+91	+46	+48	0
	Feb 28	Sell Cash	176	158	225	574	393	422	299	380
		Net Price**	191	166	221	491	484	468	347	280
		Net Price Minus Target Price	-5	-5	+2	+9	-2	-9	-1	+3
		Sep 13 Cash Price	190	156	198	487	482	457	326	271
		Net Price Realized	191	166	221	491	484	468	347	280
		Return to Storage***	+1	+10	+23	+4	+2	+11	+21	+9

*Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.
***Difference between the cash price offered at the beginning of the storage period and the net price actually received at the end of the storage period.

TABLE 10. PRICING HARD RED SPRING WHEAT HELD IN STORAGE FOR LATER DELIVERY AND HEDGED IN THE MINNEAPOLIS MARKET, TARGET PRICES, COMPARISON OF TARGET PRICES AND ACTUAL PRICES, AND GAIN REALIZED FROM STORAGE, 13 PERCENT PROTEIN WHEAT, SEPTEMBER - MAY, 1973-1978

Storage Period	Date	Activity	Crop Year* 72-73	73-74	74-75	75-76	76-77	77-78
September-May	Sep 13	May Futures	212¢	465¢	480¢	473¢	346¢	273¢
		Ave. May Closing Basis	+11	+11	+11	+11	+11	+11
		Target Price	223	476	491	484	357	284
	Sep 13	Sell May Futures	212	465	480	473	346	273
	May 2	Buy May Futures	224	377	385	369	284	298
		Gain/Loss on Futures	-12	+88	+95	+104	+62	-25
	May 2	Sell Cash	231	387	406	383	292	315
		Net Price**	219	475	501	487	354	290
		Net Price Minus Target Price	-4	-1	+10	+3	-3	+6
		Sep 13 Cash Price	198	487	482	457	326	271
		Net Price Realized	219	475	501	487	354	290
		Return to Storage***	+21	-12	+19	+30	+28	+19

*Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.
***Difference between the cash price offered at the beginning of the storage period and the net price actually received at the end of the storage period.

TABLE 11. PRICING HARD RED SPRING WHEAT HELD IN STORAGE FOR LATER DELIVERY AND HEDGED IN THE CHICAGO MARKET, TARGET PRICES, COMPARISON OF TARGET PRICES AND ACTUAL PRICES, AND GAIN REALIZED FROM STORAGE, 13 PERCENT PROTEIN WHEAT, SEPTEMBER - DECEMBER, 1970-1977

Storage Period	Date	Activity	Crop Year* 1970	1971	1972	1973	1974	1975	1976	1977
September-December	Sep 13	Dec Futures	172¢	146¢	204¢	509¢	449¢	427¢	319¢	249¢
		Ave. December Closing Basis	+18	+18	+18	+18	+18	+18	+18	+18
		Target Price	190	164	222	527	467	445	337	267
	Sep 13	Sell Dec Futures	172	146	204	509	449	427	319	249
	Nov 22	Buy Dec Futures	171	161	232	480	472	357	264	273
		Gain/Loss on Futures	+1	-15	28	+29	-23	+70	+55	-24
	Nov 22	Sell Cash	194	160	217	456	537	410	300	291
		Net Price**	195	145	189	485	514	480	355	267
		Net Price Minus Target Price	+5	-19	-33	-42	+47	+35	+18	0
		Sep 13 Cash Price	190	156	198	487	482	457	326	271
		Net Price Realized	195	145	189	485	514	480	355	267
		Return to Storage***	+5	-11	-9	-2	+32	+23	+29	-4

*Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.
***Difference between the cash price offered at the beginning of the storage period and the net price actually received at the end of the storage period.

TABLE 12. PRICING HARD RED SPRING WHEAT HELD IN STORAGE FOR LATER DELIVERY AND HEDGED IN THE CHICAGO MARKET, TARGET PRICES, COMPARISON OF TARGET PRICES AND ACTUAL PRICES, AND GAIN REALIZED FROM STORAGE, 13 PERCENT PROTEIN WHEAT, SEPTEMBER - MARCH, 1971-1978

Storage Period	Date	Activity	Crop Year* 70-71	71-72	72-73	73-74	74-75	75-76	76-77	77-78
September-March	Sep 13	Mar Futures	175¢	147¢	208¢	499¢	461¢	439¢	330¢	259¢
		Ave. March Closing Basis	+16	+16	+16	+16	+16	+16	+16	+16
		Target Price	191	163	224	515	477	455	346	275
	Sep 13	Sell Mar Futures	175	147	208	499	461	439	330	259
	Feb 28	Buy Mar Futures	167	165	241	582	348	384	271	253
		Gain/Loss on Futures	+8	-18	-33	-83	+113	+55	+59	+6
	Feb 28	Sell Cash	176	158	225	574	393	422	299	280
		Net Price**	184	140	192	491	506	477	358	286
		Net Price Minus Target Price	-7	-23	-32	-24	+29	+22	+12	+11
		Sep 13 Cash Price	190	156	198	487	482	457	326	271
		Net Price Realized	184	140	192	491	506	477	358	286
		Return to Storage***	-6	-16	-6	+4	+24	+20	+32	+15

*Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.
***Difference between the cash price offered at the beginning of the storage period and the net price actually received at the end of the storage period.

TABLE 13. PRICING HARD RED SPRING WHEAT HELD IN STORAGE FOR LATER DELIVERY AND HEDGED IN THE CHICAGO MARKET, TARGET PRICES, COMPARISON OF TARGET PRICES AND ACTUAL PRICES, AND GAIN REALIZED FROM STORAGE, 13 PERCENT PROTEIN WHEAT, SEPTEMBER - MAY, 1971-1978

Storage Period	Date	Activity	Crop Year* 70-71	71-72	72-73	73-74	74-75	75-76	76-77	77-78
September-May	Sep 13	May Futures	173¢	145¢	207¢	477¢	458¢	440¢	338¢	264¢
		Ave. May Closing Basis	+26	+26	+26	+26	+26	+26	+26	+26
		Target Price	199	171	233	503	484	466	364	290
	Sep 13	Sell May Futures	173	145	207	477	458	440	338	264
	May 2	Buy May Futures	158	165	236	372	321	333	254	296
		Gain/Loss on Futures	+15	-20	-29	+105	+137	+107	+84	-32
	May 2	Sell Cash	173	158	231	387	406	383	292	315
		Net Price**	188	138	202	492	543	490	376	283
		Net Price Minus Target Price	-11	-33	-31	-11	+59	+24	+12	-7
		Sep 13 Cash Price	190	156	198	487	482	457	326	271
		Net Price Realized	188	138	202	492	543	490	376	283
		Return to Storage***	-2	-18	+4	+5	+61	+33	+50	+12

*Prices are expressed in cents per bushel.
**Selling price adjusted for gains or losses from futures transactions.
***Difference between the cash price offered at the beginning of the storage period and the net price actually received at the end of the storage period.

period resulted in being under the target price four times, over the target price three times, and equal to the target price once. Values ranged from $.08 under the target price to $.06 over the anticipated target price. The September to March storage hedge resulted in being under the target price five times and over the target price three times. Values ranged from $.09 under the target price in the 1975-76 crop year to $.09 over the target price in the 1973-74 crop year. The September to May storage period was analyzed for six crop years. The variation from the target price was equally divided as the net price received exceeded the target price three times and was less than the target price three times. Values ranged from $.04 under the target price to $.10 over the target price. Results of the analysis imply that the Minneapolis basis is relatively useful in hedging carrying charges during the three specific storage periods. The hedger received a price for his grain that was fairly close to the forward price he was anticipating in all three storage periods. The only way to anticipate which hedges will be more successful and which hedges will be less successful, however, is to examine the basis relationships that exist at the beginning of the desired storage period. If the cash price is low relative to the futures price, then the predicted return for carrying wheat will most likely be earned. A hedger must make a judgment as to the level of the cash price relative to the futures price when he decides to initiate the hedging strategy. Historical basis relationships are a helpful tool in determining the relative levels of the two prices.

The use of the Chicago basis resulted in more variable carrying charge earnings than the Minneapolis basis. Earnings varied from $.42 under the target price to $.47 over the target price during the September to December storage period. The September to March period similarly ranged from $.32 under to $.29 over the expected target price. Using the September to May storage hedge resulted in being $.33 under the target price in the 1971-72 crop year and in being $.59 over the target price in the 1974-75 crop year. The Chicago market is less useful in hedging carrying charges because the variation between the actual price received and the expected target price is so large. A farmer would have little confidence in the predicted results of his storage hedge.

The importance of the concept of storage hedges is that farmers can profit from the use of storage space even though the price of their commodity

may go down during the storage period. Assume that shortly after harvest a farmer looks at the existing cash price for his crop and decides it is a good time to sell because the price is more likely to go down than up. If the grain is sold, then the existing storage space will remain empty and will not provide a return until the next harvest. If the grain is not sold and the farmer does not use the futures markets in his marketing strategy, then the cash price for the grain must go up in order to earn a positive return from storage facilities. Using futures markets to fix a price for grain held in storage, however, allows for a return from storage facilities without the farmer being vulnerable to a price decline. Analyzing the hedging results from the Minneapolis market revealed that positive returns to storage were earned in 21 out of the 22 hypothetical hedging transactions. A positive return to storage occurred when the actual net price received by the hedger at the end of the storage period exceeded the cash price offered for the grain at the beginning of the storage period. The amount returned varied from $.01 per bushel to $.30 per bushel. The Chicago market was not quite as consistent. A total of 15 out of the 24 hypothetical hedges showed a positive return to storage. Values ranged from $.04 per bushel to $.61 per bushel. The decision whether to fix a forward price is a speculative decision. An individual must decide at the beginning of each specific storage period whether the target price that is readily available with the use of futures markets should be accepted or whether it is better to remain long in the market because of expectations that the current price level will go up. Each year will be different so the producer must make a decision based on the economic conditions existing during each particular time period.