THE EFFECTS OF USING WHEAT FUTURES IN FORWARD-PRICING AND POST-HARVEST MARKETING ALTERNATIVES

by

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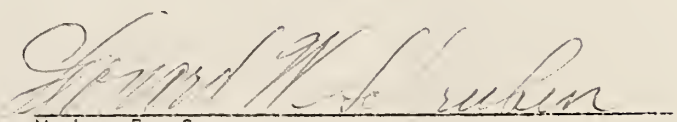

Major Professor

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Chapter I

INTRODUCTION

This study was undertaken to determine the potential for using the futures market to achieve more favorable risk-return relationships for investments made in the production and marketing of wheat.

Traditional investment theory describes a rational investor as requiring a return on potential investments equal to the return that could be earned on a risk-free investment of comparable liquidity, plus an additional premium for risk-bearing. The amount of additional compensation required for risk-bearing is dependent on (1) the riskiness of the investment, and (2) the degree of risk aversion expressed by the investor.

The degree of risk aversion expressed by an investor is dependent on his financial ability to withstand losses and his personality type. Wealthy investors, who are primarily investing "excess" equity capital, are usually less averse to risk than investors who must rely on borrowed capital to finance their investments. Furthermore, investors with identical financial resources may vary in their attitudes toward uncertainty. For example, if two investors each have a small amount of capital and the same investment opportunity a risk preferer may be of the opinion that his small investment is "nothing to lose", while a risk averter may consider it an opportunity to "lose everything".

If investments in agricultural production could be made under conditions of perfect knowledge of future events, farmers would have no uncertainty about future costs or revenues and risks would be non-existent. Farmers

would then simply invest in the productive activities offering maximum returns. Given real world conditions of imperfect knowledge of future events, farmers must consider risk-return relationships and how closely the expected relationships coincide with their individual objectives and preferences.

Risk may generally be described as the uncertainty associated with the outcome of future events; or more technically, as the potential distribution of outcomes relative to a particular expected outcome. The common quantitative measure of risk is the variation or standard deviation of an investment's return; although the frequency of negative or less-than-expected returns and the range of returns, in particular the magnitude of the greatest loss, are sometimes considered.

Three fundamental types of risk exist: (1) natural risk, existing because of the potential for such natural disasters as disease, fire, wind, drought; and because of varying biological responses; (2) human risk, reflecting potential for poor decision making, dishonesty, vandelism, etc., and (3) market or price risk due to changing prices, shifting market shares, etc.

Some portions of natural and human risk are insurable, allowing an individual to shift the risk of a potentially large, randomly occurring loss to a large number of insured participants. Human risk may be lessened through education and research, and both human and natural risk exposure may be reduced by diversifying activities and applying advanced technology to increase and stabilize production levels.

The focus of this study is directed toward market risk; more precisely, toward evaluating methods of decreasing market risk exposure relative to levels of returns.

Market risk measures the potential variation associated with prices in

the future of both finished commodities and production inputs. For individuals who are able to accurately predict price changes, price variability offers an opportunity to increase returns; but for those not so successful at predicting prices, increased price variability may increase overall levels of risk without a corresponding increase in returns.

Because price changes affect all participants in a given market simultaneously, market risk is noninsurable in the normal sense. Government price support programs allow a portion of the price risk to be shifted from farmers to all taxpayers, but are really effective only when supplies are plentiful and prices decline to or near support levels.[1] Various forms of collective and cooperative marketing, product differentiation, forward cash pricing agreements, and hedging on futures markets are all used within the private sector to shift market risk.

Hedging is the process of shifting price risk by establishing and holding an equal and opposite position in futures market commitments as is held, or anticipated in the actual commodity. By simultaneously taking equal and opposite positions, losses from adverse changes in cash prices may be offset by profits from favorable changes in futures prices. Conversely, gains realized from favorable cash price changes may be offset by losses from corresponding adverse futures prices changes.[2]

At this point a distinction should be made between long-run and short-run

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[1]Peter J. Barry and Donald R. Fraser, "Risk Management in Primary Agricultural Production: Methods, Distribution, Rewards, and Structural Implications," American Journal of Agricultural Economics, 58 (1976), 289.

[2]This example assumes perfect correlation between cash and futures price changes. Assumptions regarding necessary cash-futures price relationships and multiple uses for hedging will be considered in Chapter II.

views of risk. In the short-run, risk may be considered as the potential for actual returns in a given year to vary from the return that was expected when that year's production began. In the long-run, risk is considered in terms of the variation of annual returns from year to year relative to the annual average return.

Assuming that the long-run objective of producers is to increase and/or stabilize the return realized from their production, the general hypothesis evaluated by this analysis was: marketing alternatives created by using futures markets may be used to either (1) reduce variability of annual total returns per bushel, without a corresponding reduction in the level of returns, or (2) increase the level of returns without a corresponding increase in their variability.

Objectives

Specific objectives were:

1. To compare the returns and risk of production without forward-pricing with the results from using one of the following hedging practices to forward-price wheat during its production:

(a) routinely placing a forward-pricing hedge at 45, 40, 30, 20 or 10 weeks prior to harvest,

(b) placing forward-pricing hedges using criteria based on the relationship between government price support levels and futures prices,

(c) applying a managed hedge, allowing the hedge to be placed or lifted at opportune times during the production period.

2. To evaluate the results of performing the post-harvest marketing functions of storage and/or risk-bearing through:

(a) holding routinely hedged grain in storage for a specified length of time following harvest,

(b) selling the actual commodity at harvest while simultaneously purchasing futures contracts which are held for a specified length of time,

(c) holding unhedged grain in storage for a specified length of time,

(d) sequentially marketing unhedged grain in storage by selling equal portions of the inventory each week of a given marketing period,

(e) applying managed hedging to grain held in storage for a specified length of time,

(f) applying the principles followed in managed hedging to managed speculation where either net long or net short positions may be taken at opportune times throughout a given marketing period.

General methodology

Forward-pricing and post-harvest marketing alternatives were applied to wheat produced over an eight year period from 1971 through 1978. Annual returns atrributed to forward-pricing were determined by comparing the return realized at harvest (less applicable hedging costs) with the prevailing cash price at harvest. Annual returns to each post-harvest marketing alternative were measured as the difference between the cash price at harvest and the return realized by post-harvest marketing (less applicable interest, storage and hedging costs).

Variability of total annual returns (harvest cash prices plus returns to forward-pricing, and harvest cash prices plus post-harvest marketing returns) was used to compare risk levels; other factors, however, such as the frequency and size of losses were also indicated. In order for a forward-

pricing or marketing alternative to be considered superior to unhedged production and marketing at harvest, it must produce one or both of the following results: (1) reduce risk levels without a corresponding decline in returns, or (2) increase returns without a corresponding increase in risk.

Weekly cash prices from two Kansas cash market locations, Concordia and Garden City, were used.[3] Futures prices used for forward-pricing during production and post-harvest marketing were daily settlement prices for the July and May contracts, respectively, traded at the Kansas City Board of Trade.

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[3]Cash prices prior to March 31, 1976, were taken from daily newspapers at each location and represent local cash price quotations at, or near the close of futures trading each Wednesday (Thursday if Wednesday was a holiday) afternoon. Since that date, cash prices were collected weekly via direct quotation after the futures market closed.

Chapter II

A REVIEW OF LITERATURE ANALYZING FUTURES MARKETS AND THE HEDGING OF STORABLE COMMODITIES

Futures trading performs several important, though not always distinctly separate, functions in commodity marketing. Among them are guidance of inventory levels, establishment of forward prices, and the provision of a risk-shifting mechanism. In writing about characteristics of futures markets that stimulated their development, Roger Gray lists three perceived needs fulfilled by futures trading: (1) a need to shift market risk, (2) a need for liquidity in the market, and (3) a need for security to ensure compliance with contractural obligations.[1]

It is generally considered that two conditions must prevail in the relationship between cash and futures prices in order for hedging to be an effective method for shifting price risk. First, futures and cash prices must generally move in the same direction over a period of time. Second, they must be approximately equal at the par delivery location when the contract reaches maturity. Gerda Blau states in an early theoretical paper:

> Clearly, the effectiveness of hedging (i.e. the effectiveness of neutralizing price risks in the cash market by assuming opposite risks in the futures market) must be impared to the extent to which the movements of cash and futures prices diverge.[2]

The seller's right to fulfill his contractual obligation by making

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[1]Roger W. Gray, "Risk Management in Commodity and Financial Markets," American Journal of Agricultural Economics, 58 (1976), 283.

[2]Gerda Blau, "Some Aspects of the Theory of Futures Trading," Review of Economic Studies, 12 (1944-45), 7.

delivery of the actual commodity, and the buyers right to require that the actual commodity be delivered, make arbitrage possible between the cash and futures markets; and ensure that the necessary conditions for hedging exist.

Though only a very small percentage of futures contracts are actually closed by delivery of the commodity, the potential to make or require delivery is sufficient to keep prices within the prescribed relationship. As long as a commodity may be purchased in the cash market and kept in storage without a significant quality change, arbitrage will limit the discount of cash prices relative to futures prices to an amount equal to the sum of delivery and storage costs until the futures contract at the same market matures.

Arbitrage is less effective in controlling inversions, where cash prices rise above futures, or where near futures sell at a premium to distant futures. Unlike the discount situation, where the amount of discount is limited by established and calculable storage and delivery charges; the cash premium paid in an inverted market represents additional utility which stockholders derive from having inventories on hand, rather than taking delivery on the same inventories at some time in the future. Because there are no established rates for convenience yields, inversions will persist and increase until enough holders of the commodity determine that the premium being offered by the market (or negative storage payment) exceeds the utility derived from holding the stocks.[3]

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[3]The arbitrage potential is limited by the number of stockholders who are willing to release their stocks. While speculators can always buy or sell futures contracts, they cannot sell the actual commodity on the cash market without first having it in their possession.

Inversions will tend to weaken and disappear as supplies of the physical commodity become more available in market channels, and as futures contracts approach maturity, when they have potential of being converted into the actual commodity.

A potential for price variation is required before either hedgers or speculators have an incentive to participate in futures trading. Gray points to the near abandonment of futures trading in the butter market due to government pricing policies, and to the decreased activity in the wheat futures market during years when wheat prices were stabilized under the influence of large government owned wheat reserves, as examples of the necessity of price variation.[4]

Holbrook Working's hedging-market concept, a conclusion drawn from several earlier empirical and theoretical studies, states that futures markets owe their existence primarily to hedging rather than speculation.[5] However, unless the supply of contracts provided by hedgers wishing to sell is exactly matched at all times by hedgers demanding to purchase the same contracts, speculation is essential for the successful operation of the market. Liquidity in the market is provided by speculators, whose continual presence in the market allow hedgers to enter and leave at virtually any time they wish, without offering excessive premiums or discounts to attract individuals willing to assume opposite positions. Furthermore, in assuming

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[4]Gray, "The Characteristic Bias in Some Thin Futures Markets," Food Research Institute Studies, 1 (1960), 296; "The Seasonal Pattern of Wheat Futures Under the Loan Program," Food Research Institute Studies, 3 (1962), 23.

[5]Holbrook Working, "New Concepts Concerning Futures Markets and Prices," American Economic Review, 52 (1962), 432.

price risks, speculators supply risk capital and act as a type of capital market for hedgers.

Numerous studies have attempted to identify the qualitative and quantitative incentives for speculation. Keynes hypothesized that speculators were providers of price insurance for hedgers, and expected to receive an insurance premium for providing this service.[6] According to this theory, futures prices are not unbiased estimates of future cash prices; but are discounted relative to the cash price expected to prevail at the time the futures contract matures. It was assumed that the number of hedgers wishing to sell distant futures exceeded the number of hedgers wishing to buy distant futures, and that the futures price had to be discounted in order to attract speculators willing to purchase the excess supply of contracts. The difference between the prevailing futures and the expected future cash price represented the premium that speculators demanded for providing price insurance.

The extreme opposite view of speculators describes them as gamblers, who not only fail to require risk premiums, but are willing to assume risks solely on the basis of potentially great returns, even though the average returns are zero or less.[7] The central issue of this discussion is whether or not hedgers must pay speculators for assuming price risks.

Numerous studies have attempted to confirm or disprove the existence

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[6]J.M. Keynes, A Treatise on Money, 2 (London: Macmillian & Co., 1930), 142-47.

[7]Katherine Dusak, "Futures Trading and Investor Returns: An Investigation of Commodity Market Risk Premiums," Journal of Political Economy, 81 (1973), 1387-88, citing C. O. Hardy, Risk and Risk Bearing (Chicago: University of Chicago Press, 1940).

of futures price bias, and to determine whether or not the bias, if it does exist, is a reflection of speculator-required risk premiums.

Gray found that certain thin (little used) futures markets often did show a bias, which he attributed to an imbalance of hedging and a shortage of speculation. He also found that as markets developed, they often "outgrew" their bias.[8] Heifner and Leuthold both present data supporting the theory that live cattle futures underestimate future cash prices.[9] Whether the bias in live cattle futures is caused by speculators requiring risk premiums, by the inability of traders to correctly anticipate supply and demand relationships in the context of the cattle cycle, or a combination of these and other factors, remains unclear.

In an analysis of frozen concentrate orange juice futures, Ward and Dasse conclude that the speculative interest associated with the annual freeze potential causes a biased futures price; which they attribute to disproportionate buying pressure in the cash and futures market.[10] Most of the work involving grain commodities, however, has failed to provide any support for a continued bias in futures prices. The conclusion has been drawn that futures prices are unbiased estimates of future cash prices in

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[8]Gray, "The Characteristic Bias in Some Thin Futures Markets," p. 311.

[9]Richard G. Heifner, "Optimal Hedging Levels and Hedging Effectiveness in Cattle Feeding," Agricultural Economics Research, 24 (1972), 30-31; Raymond M. Leuthold, "The Price Performance on the Futures Market of a Nonstorable Commodity: Live Beef Cattle," American Journal of Agricultural Economics, 56 (1974), 276.

[10]Ronald W. Ward and Frank A. Dasse, "Empirical Contributions to Basis Theory: The Case of Citrus Futures," American Journal of Agricultural Economics, 59 (1977), 71.

most well developed grain futures markets.[11]

Hedgers are sometimes stereotyped as being risk averters whose only concern is shifting price risk to speculators. Working described hedgers as having two primary motives for hedging: (1) a desire to shift price risk, and (2) a desire to profit from changes in relative price levels.[12]

Attempts to profit from relative price changes by means of selective hedging, anticipatory hedging, or other similar strategies tend to confuse the theoretically clear distinction between hedging and speculation. To the extent that hedgers make hedging decisions reflecting their expectations about changes in either absolute or relative prices, they are becoming risk selectors and, in that sense, speculators.

Price determination and supply of storage theory

The amount that cash prices are above or below and futures prices for a commodity at any point in time is called the basis. Three types of commodities are traded in futures markets: (1) continuous inventory, (2) discontinuous inventory, and (3) noninventory. Continuous inventory commodities include grains which have inventories that are carried from one production year to the next. Discontinuous inventory commodities include crops like potatoes which are storable during the crop year, but are not carried from one year to the next. Noninventory commodities include livestock commodities

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[11]Contributing to this conclusion: Dusak, p. 1401; Gray, "The Search for a Risk Premium," Journal of Political Economy, 69 (1961), 254; Lester G. Telser, "The Supply of Speculative Services in Wheat, Corn, and Soybeans," Food Research Institute Studies, 7 (1967), 175.

[12]Working, "New Concepts Concerning Futures Markets and Prices," p. 437.

which normally cannot be held for a significant period of time without a corresponding change in quality. The method of determining cash and futures prices, and the behavior of the resulting basis differ for each type of commodity.

Futures trading developed first for seasonally produced, continuous inventory commodities. In these markets, futures and cash prices each reflect traders' evaluations of current supply and demand conditions in conjunction with their expectations about future conditions. The difference between futures and cash prices does not imply that traders in the two markets have differing evaluations of supply and demand conditions, or that one market reflects the impact of expected changes in supply and demand to a greater degree than the other. According to Tomek and Gray, "The element of expectations is imparted to the whole temporal constellation of price quotations, and futures prices reflect essentially no prophecy that is not reflected in the cash price and in that sense already fulfilled."[13] The prevailing basis does represent a dynamic market-determined payment for carrying stocks during the period of time that will elapse before the futures contract matures.

Discontinuous inventory price determination is identical to that in continuous inventory markets, with one major exception; futures prices for commodities in production are not influenced by the supply and demand conditions that prevail during the preceeding crop year. Without the inventory carryover to make interyear arbitrage possible, new crop futures prices are formulated entirely by evaluation expectations for future supply

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[13]William G. Tomek and Roger W. Gray, "Temporal Relationships Among Prices on Commodity Futures Markets: Their Allocative and Stabilizing Roles," American Journal of Agricultural Economics, 52 (1970), 373.

and demand and are not highly correlated with prices from the preceeding year.[14]

Unlike inventory carrying markets, noninventory markets formulate cash prices and futures prices independently. Prior to the delivery period, cash and futures prices are correlated only to the extent that the prevailing supply and demand conditions are correlated with expectations about supply and demand conditions that will exist when the contract matures. Because cash-futures arbitrage is possible during the delivery period, cash and futures prices will come reasonably close together at contract maturity. However, until the delivery period approaches, changes in the basis tend to be erratic.[15]

Supply of storage theory emerged in an attempt to explain the role of the basis in inventory markets. The objective of supply of storage theory was to explain the relationship between the size of the basis and the level of inventories carried; and in particular, to explain why stocks would be carried even during times when the basis was inverted. Incentive to hold inventories exists when the expected yield exceeds the expected cost of stockholding.

Two factors were considered in determining the cost of carrying stocks: (1) the cost of physical storage facilities, insurance, interest, and quality

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[14]Ibid., p. 376.

[15]It has been proposed that the most consistent cash-futures relationship in the cattle market is the relationship between the live cattle futures price and the price of cash feeder cattle. Supply of storage theory is applied to the level of feeder cattle prices, but not to the number of cattle placed on feed. See R. L. Ehrich, "Cash-Futures Price Relationships for Live Beef Cattle," American Journal of Agricultural Economics, 51 1969), 38-39.

maintenance, and (2) the existence of a positive convenience yield derived from having stocks on hand.[16] If the positive convenience yield exceeded the cost of storage, the net cost of storage would be negative. Stocks would be held until the "negative storage payment" associated with an inverted basis reached an absolute value greater than the net storage cost. Both the size of the convenience yield and the storage cost were assumed to be functions on inventory levels. Convenience yields were assumed to increase at an increasing rate as inventories declined below a minimum level, and storage costs were assumed to increase at an increasing rate as inventory levels increased beyond the capacity of existing storage facilities.

In an effort to account for discrepancies between the observed basis behavior and the basis behavior predicted by Working's supply of storage theory, Brennan hypothesized that inventory holders require a risk premium that also increases as the total level of inventories increase.[17] Brennan, however, rejected earlier theories that imputed a risk premium to the hedger-speculator imbalance, and attempted to distinguish between those and his own theory. Gray concluded that Brennan's work did not establish the existence of any other risk premium, but instead, simply disproved previous risk premium theories.[18]

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[16]Nicholas Kaldor, "Speculation and Economic Stability," Review of Economic Studies, 7 (1939-40), 3; Working, "Theory of the Inverse Carrying Charge in Futures Markets," Journal of Farm Economics, 30 (1948), 17-21.

[17]Michael J. Brennan, "The Supply of Storage," American Economic Review, 47 (1958), 54.

[18]Gray, "The Search for a Risk Premium," Journal of Political Economy, 69 (1961), 253.

In a more recent study, Paul also rejected Brennan's risk premium theory, and introduced his own theory on the pricing of binspace. Instead of assuming that storage costs remain relatively constant until the available storage space is filled, Paul suggests that empty binspace, having alternative handling and storage uses, commands an increasing convenience yield as inventories increase beyond minimum levels.[19]

The effectiveness of hedging in inventory markets

Obviously, hedgers who are able to accurately predict changes in future prices will be able to increase their total profits through the use of selective and anticipatory hedging. However, even hedgers who do not attempt to predict future prices benefit from the use of hedging if a portion of their price risk can be shifted without reducing returns to unacceptable levels. Because individuals' risk-return tradeoff preferences vary, most attempts to evaluate the effectiveness of hedging have considered only its risk-shifting potential; without regard to the resulting relative level of returns. In addition, conclusions about the risk-shifting effectiveness of hedging differ according to the definition of, and the method used for measuring risk.

In an early empirical study, Truman Graf measured the risk-shifting effectiveness of hedging in terms of the correlation between cash and futures price changes. Hedges were considered most effective when the loss (gain) resulting from changes in cash prices were exactly offset by the gain (loss) resulting from changes in futures prices. Graf concluded

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[19]Allen B. Paul, "The Pricing of Binspace - A Contribution to the Theory of Storage," American Journal of Agricultural Economics, 52 (1970), 1-3.

that grain storage hedging averaged only 50 to 60 percent effective in shifting price risk.[20]

Working criticized Graf's method of evaluating the effectiveness of hedging by stating:

> ...the basic idea that complete effectiveness of hedging depends on parallelism of movement of spot and futures prices is false, and an improper standard by which to test the effectiveness of hedging. The effectiveness of hedging intelligently used with commodity storage, depends on inequalities between the movements of spot and futures prices and on reasonable predictability of such inequalities.[21]

In other words, Working acknowledged that changes in relative prices should be somewhat predictable because of supply of storage theory; and that hedgers incur risk, not because the basis changes, but because the basis changes are not identical to predicted basis changes.

In a more recent empirical study, Heifner measures the risk shifting effectiveness of hedging in terms of its potential for reducing the variation of net hedging profits over a period of time. Using this definition of risk (variance of net profits), Heifner found that routine hedging practices were able to shift about 1/3 to 2/3 of the total price risk involved in grain storage.[22] The study also showed that hedging generally became a less effective means of stabilizing annual returns to storage as the distance between the cash market and futures delivery point increased.

In addition to shifting risk involved in carrying inventories, hedging

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[20]Truman F. Graf, "Hedging-How Effective Is It?" Journal of Farm Economics, 35 (1953), 402-13.

[21]Working, "Hedging Reconsidered," Journal of Farm Economics, 35 (1953), 547-49.

[22]Heifner, Hedging Potential in Grain Storage and Livestock Feeding, U.S. Department of Agriculture, Economic Research Service, Agricultural Economic Report No. 238, (1973), 1-16.

can be used to forward price commodities in production. Tomek and Gray point out that noncontinuous inventory futures markets provide an effective means for locking in a price prior to production and for stabilizing prices received from year to year.[23] In reference to continuous inventory markets, they note that new crop futures prices are closely correlated to the prices of the previous crop year. As a result, producers are able to shift their price risk in any given year by forward pricing, but there is little opportunity to stabilize prices from year to year.

In a separate study of the corn market, Heifner tested the predictability of basis changes following harvest, given the cash-futures price relationship at harvest. Basis changes were found to be much more predictable than cash price changes. In addition, he found that using predicted basis relationships with conditional storage rules to make corn storage decisions offered potential for increasing and stabilizing storage returns.[24]

In recent years attention has been directed toward developing selective and managed hedging techniques; where the outcome of hedging decisions either depends on certain factors coinciding with a set of conditional hedging rules, or else placing and lifting of the hedge is permitted during the hedging period in response to changing market conditions.

Robert Price found that hedges managed with variations of 3-and-10 day, and 5-and-10 day moving averages resulted both greater and more stable

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[23] Tomek and Gray, p. 376.

[24] Heifner, "The Gains from Basing Grain Storage Divisions on Cash-Future Spreads," Journal of Farm Economics, 48 (1966), 1491-95.

net profits when applied to commercial cattle feeding.[25] Richard Pottorff used a variation of 3-and-10 day working averages in applying a managed hedged to wheat production and storage for the years 1965 to 1976. Although he found it did produce greater average returns than the corresponding unhedged alternatives, the results were termed inconclusive.[26] The futures profits earned by using a number of different moving average strategies between 1971 and 1978 were examined by Roy Frederick.[27] Although substantial futures profits were realized during the eight year period, no attempt was made to determine the results of applying the moving averages to actual hedging situations.

It is the intent of this analysis to continue the investigation of the effectiveness of managed forward-pricing and hedging alternatives, as well as to determine the effectiveness of using more traditional marketing alternatives to improve the risk-return relationships available to individuals investing in the production and marketing of wheat.

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[25]Robert V. Price, "The Effects of Traditional and Managed Hedging Strategies for Cattle Feeders," Unpublished M.S. Thesis, Kansas State University, 1976.

[26]Richard C. Pottorff, "Hedging Wheat (An Analysis of a Marketing Tool)," Unpublished Technical Paper, Colorado State University, 1978.

[27]Roy Frederick, "Building a Market Strategy," Unpublished Paper, Kansas State University, 1978.

Chapter III

UNHEDGED AND ROUTINELY FORWARD-PRICED PRODUCTION

Introduction

Wheat may be forward-priced any time during or prior to its actual production by selling a new crop futures contract. Although futures obligations may be met by delivering the actual commodity, the vast majority of futures obligations are met by making offsetting futures transactions. A forward-pricing hedge would thus be closed by repurchasing a futures contract of the same option when wheat is sold in the cash market.

Forward-pricing would be considered successful if it resulted in either increased returns without a corresponding increase in risk, or decreased risk without a corresponding decrease in returns. Routine forward-pricing will increase returns if futures contracts can be sold prior to harvest at prices that are, on the average, higher than prices commanded by the same contracts after harvest.[1] The existence of consistent price behavior in this manner, however, contradicts traditional unbiased market theories. Whenever consistent yearly trends in futures prices are verified, it is assumed that ever-ready speculators will exploit the opportunity until the potential for consistent profits disappear. Routine use of forward-pricing hedges would therefore not be expected to increase long-run average returns.

Producers may have several objectives regarding the control of price

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[1]Assuming zero hedging costs; otherwise the preharvest futures price must exceed futures prices at harvest by some amount greater than per bushel hedging costs.

risk, including: (1) reducing the variability of the expected return, or more specifically, the probability of a decline in price during a given year; and (2) reducing the variation on annual returns from year to year.

Forward-pricing hedges may be used to successfully meet the first objective to the extent that consistent and predictable cash-futures price relationships exist when hedges are lifted. Relative price behavior is generally much more consistent than the behavior of absolute prices, enabling hedgers to predetermine, with a reasonable amount of confidence, future returns.

Although forward-pricing is an effective means of stabilizing annual returns in the production of discontinuous inventory commodities, there is little empirical or theoretical reason to believe that it would produce similar results for producers of continuous inventory commodities such as wheat. New crop continuous inventory futures prices must approximate, within the constraints of basis theory, the prevailing cash and co-existing old crop futures prices. Therefore, new crop futures prices should have approximately the same variability during the production period as do cash prices; and prices established by routine forward-pricing would be expected to vary as much from year to year as cash prices at harvest.

The objective of this analysis was to empirically compare a strategy of routinely forward-pricing at various times during the production period, with a strategy of never forward-pricing; in terms of the effect on the average return and variability of annual returns for the eight production years 1970-71 through 1977-78.

Methodology

Eight production years, 1970-71 through 1977-78 and two cash market locations were used. This and subsequent analyses made the following

assumptions:

1. cash market transactions take place only on Wednesdays (Thursday if Wednesday is a holiday) at the cash price prevailing at or near the close of futures trading,

2. harvest takes place on the first Wednesday in July, and all cash sales at harvest are completed at that time,

3. hedges placed to forward-price production are lifted at the closing futures price on the day wheat is sold in the cash market,

4. all hedges are placed on the Kansas City Board of Trade; hedges to forward-price production use July futures, storage hedges use May futures.

Five variations of routine forward-pricing were used. Variations A, B, C, D and E represent hedges placed at closing Wednesday futures prices 45, 40, 30, 20 and 10 weeks prior to harvest respectively.

Net returns attributable to the use of hedging to forward-price production are independent of cash market prices, as the difference between forward-priced and nonforward-priced returns is the net profit or loss on the futures position:

$$(1) \quad FP = F_{h-w} - F_h - HC$$

Where: FP = the net profit from the futures position,

F_{h-w} = the closing futures price when the hedge is placed on Wednesday, w weeks prior to harvest,

F_h = the closing futures price the hedge is lifted at harvest,

w = the number of weeks the hedge is in effect,

HC = per bushel hedging costs, defined:

$$(2) \quad HC = CM + (R(MR(7(w/365)))$$

Where: CM = round turn commission costs per bushel,

R = annual interest rate,

MR = initial futures margin required per bushel.

Although actual margin requirements change from time to time, this study assumed initial per bushel margin was ten percent of the contract's settlement price on the day hedges were placed. Commission charges and interest rates used are given in Table 3.1.

Table 3.1. Hedging costs applied to the study period.

Date effective	Commission per 5000 bu. contract	Interest rate
July 1, 1970	$30.00	6%
July 7, 1971	35.00	6
July 5, 1972	35.00	8
July 5, 1973	40.00	8
July 2, 1975	45.00	8
July 6, 1977	50.00	8
July 5, 1978	50.00	9

Variability of total returns was used as a measure of the risk associated with various marketing plans; where total annual returns were calculated as:

$$(3) \quad TRP = FP + CP_h$$

Where: TRP = total annual return to production,

CP_h = cash price at harvest.

Unhedged production

Weekly cash prices at Concordia (solid line) and Garden City (broken line) including years 1970 through 1978, are shown in Figure 3.1. Throughout the latter 1960's, and until mid-1972, large carryover supplies tended to stabilize prices at relatively low levels. Local prices, from January 1970 through July 1972, were confined to a range of $1.20 to $1.40 per bushel. Increased export activity in 1972 caused prices to increase rapidly,

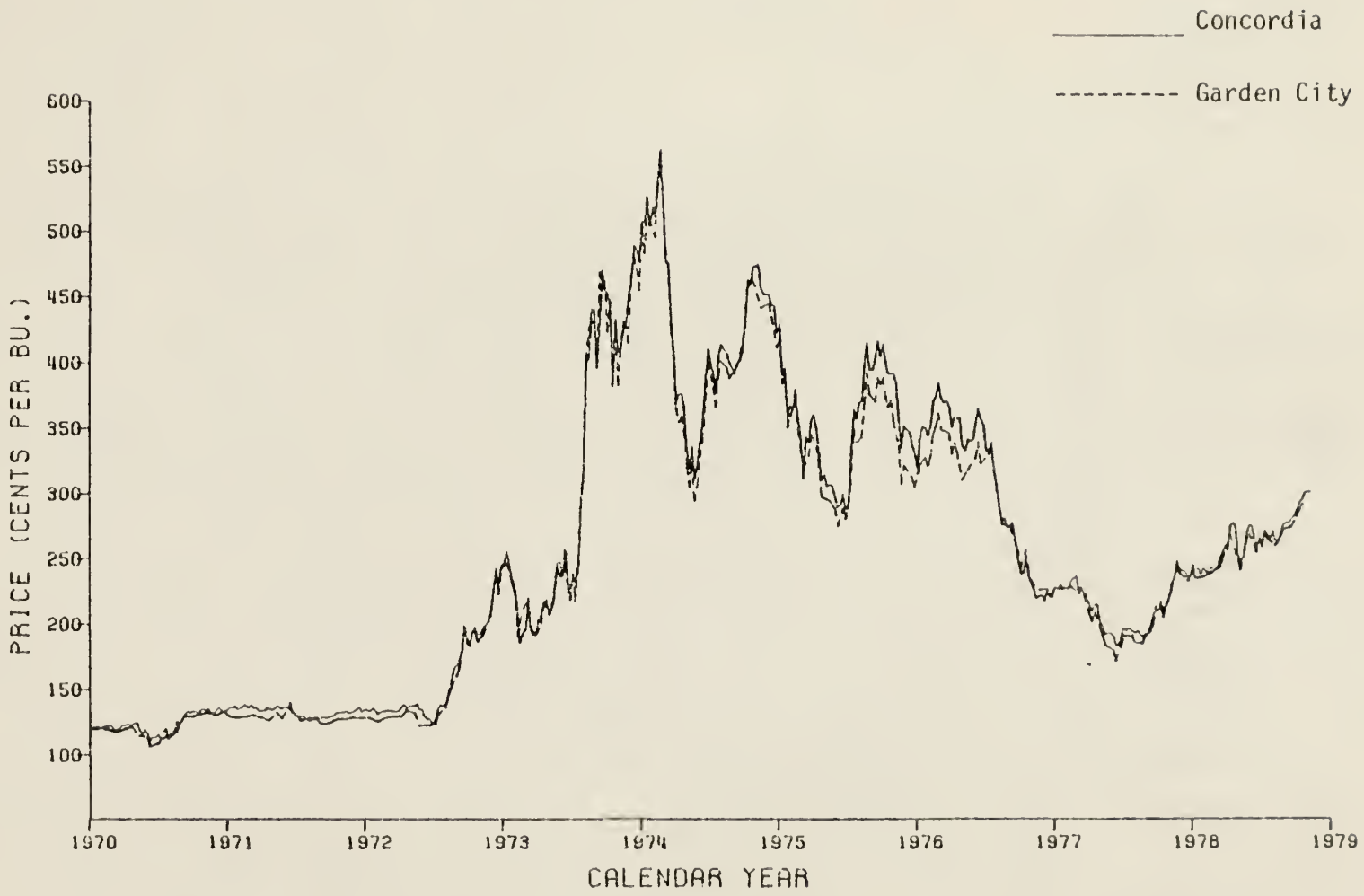

Figure 3.1. Weekly cash wheat prices at Concordia and Garden City, 1970-1978.

surpassing $5.50 per bushel in February 1974. Increased production followed, resulting in generally declining, though highly variable prices until levels below $2.00 were reached in the summer of 1977. From that point through December 1978, prices again rose, though much less dramatically than in previous years.

Since this study is concerned with determining the benefits of using the futures market versus never using the futures market, it was assumed that returns realized from unhedged production are simply the prevailing cash prices at harvest (Table 3.2); although it is recognized that other cash market alternatives, such as cash contracting, may be used to give different results. Unhedged returns ranged from $1.27 to $3.99 and from $1.23 to $3.89 for Concordia and Garden City respectively. The eight year average return was $2.470 at Concordia and $2.426 at Garden City, with respective standard deviations of 95.119 and 92.875 cents per bushel.[2]

Table 3.2. Local cash prices at harvest (cents per bushel).

Date	Concordia	Garden City
July 7, 1971	130	128
July 5, 1972	127	123
July 5, 1973	237	238
July 3, 1974	399	389
July 2, 1975	287	280
July 7, 1976	331	324
July 6, 1977	194	190
July 5, 1978	271	269
Average	247.0	242.625
Std. Dev.	95.119	92.875

Routine forward-pricing

Routine forward-pricing resulted in positive average futures profits

[2]All average returns reported in the text are rounded to the nearest tenth of one cent.

Table 3.3. Annual net futures market returns from routinely placing forward-pricing hedges of various times prior to harvest; 1971 to 1978, (cents per bu.).

Production year	Variation (A) 45 wks	(B) 40 wks	(C) 30 wks	(D) 20 wks	(E) 10 wks
1970-71	3.122	4.950	5.001	1.615	-2.641
1971-72	-10.904	-10.826	-5.438	-5.774	0.631
1972-73	-77.246	-73.375	-45.708	-66.557	-41.292
1973-74	-91.696	-25.835	-17.735	68.147	-32.670
1974-75	137.614	136.466	163.030	83.500	25.283
1975-76	60.483	45.381	-14.092	9.651	-12.465
1976-77	114.142	73.667	39.809	50.458	15.209
1977-78	-66.955	-42.665	-37.023	-44.075	-18.202
Average	8.570	13.470	10.980	12.121	-8.268
Std. Dev.	87.850	68.318	66.790	52.764	22.646

Table 3.4. Annual total returns to production routinely hedged at various times prior to harvest at Concordia and Garden City; 1971 to 1978, (cents per bu.).

Variation	Concordia Average	Concordia Std. Dev.	Garden City Average	Garden City Std. Dev.
(A) 45 wks.	255.570	118.786	251.195	116.344
(B) 40 wks.	260.470	119.369	256.095	116.622
(C) 30 wks.	257.980	116.433	253.606	113.856
(D) 20 wks.	259.121	123.471	254.746	120.488
(E) 10 wks.	238.732	89.225	234.357	86.638

for all variations except E, hedging 10 weeks before harvest (Table 3.3). Variation B resulted in the greatest average profit of $0.135 per bushel, while variation E produced an average loss of -$0.083. Statistically none of the routine forward-pricing methods produced average futures returns that were significantly greater than zero (α=.05).

Routine forward-pricing was ineffective in stabilizing annual returns (Table 3.4). Increased average returns associated with variations A, B, C and D had greater standard deviations than did unhedged marketing at harvest.

Variation E reduced the standard deviation of total returns only slightly relative to unhedged production. Again, none of the variances were significantly greater or less than the variance of unhedged returns (α=.05).

Although routine forward-pricing may prove beneficial by allowing producers to know in advance the approximate return that they will receive in any given year, the above results provide little reason to believe that it would be superior to unhedged production in terms of increasing or stabilizing annual returns in the long run.

Had a statistically significant increase in average annual returns resulted from routine forward-pricing, one of two conclusions could be drawn: (1) the null hypothesis, that futures profits equal zero, was rejected when it should have been accepted; or (2) a seasonality in the price of July futures contracts does exist, indicating a biased futures market.

Forward-pricing seems to offer its greatest potential for increasing returns through selective, rather than routine, application. Price variability may offer producers able to predict price trends an opportunity to earn substantially greater returns. The major objective then becomes determination of appropriate criteria for use in making predictions and hedging decisions.

Chapter IV

SELECTIVE FORWARD-PRICING

Introduction

Ideally, forward-pricing hedges would be in effect any time futures prices declined, but would not be used during price declines. Selective forward-pricing decisions are based on the relationship between market conditions and some predetermined criteria for hedging, which theoretically indicate probable price trends and/or reflect the hedger's specific forward-pricing objectives.

The objective of this analysis was to determine the effectiveness of basing selective hedging decisions on the relationship between futures prices and the national average loan rate for Commodity Credit Corporation (CCC) sponsored nonrecourse loans. Use of nonrecourse loans will tend to establish a floor for prices by isolating grain from market channels when prices are at relatively low levels. These loans will be effective in supporting prices as long as (1) there is adequate producer participation in the loan program, and (2) adequate storage facilities are available at competitive prices. If these conditions are met, local cash prices will generally not fall below established loan rates by more than the cost of storing grain until loan maturity (Figure 4.1).

Although loan program may be somewhat less effective in supporting prices of distant futures contracts, individuals may choose not to hedge production when prices are low relative to the loan rate because they believe there is little possibility of a substantial price decline. In

Figure 4.1. Relationship between Concordia cash wheat price and Cloud County loan rate, 1970-1978.

other words, producers would be willing to risk a small, though perhaps more probable price decline, in order to be in a position to benefit from potentially large but less probable price increases. Following this rationale would have prevented losses resulting from routine forward pricing in 1972-73 and 1977-78, when futures prices increased during the production period from levels near the loan rate.

In developing decision making criteria for selective hedging, a price level is determined where it is felt that the disutility of potential price declines equals the utility of potential price increases. More risk averse hedgers will be less willing to risk price declines and will more readily forgo potential gains from price increases than will the less risk averse, or risk preferrers. In others words, for any given year, the less risk averse a producer is the more selective he will be in his hedging decisions. Developing a hedging criterion based on the futures price-loan rate relationship is simply a matter of selecting how far future prices must exceed the loan rate before hedging takes place.

Methodology

Six variations of selective hedging criteria were tested. The minimum price at which hedges were placed was referred to as the decision price. Decision prices were constructed (1) as a percentage of the national average loan rate, and (2) by adding a fixed premium to the national average loan rate. Variations A, B and C were based on decision prices equal to 150, 175 and 200 percent of the loan rate respectively, while variations D, E and F used decision prices equal to the loan rate plus $1.00, $1.50 and $2.00. Because loan rates applying to crops in production may not be known until after harvest, loan rates applying to the previous crop were used to determine decision prices. Loan rates and corresponding decision prices used

are given in Table 4.1.

Forward-pricing hedges were placed whenever the daily settlement price exceeded the predetermined decision price:

$$(1) \qquad F_t \geq DP$$

Where: F_t = futures settlement price on day "t",

DP = the predetermined decision price.

Hedges, once placed, remained in effect until harvest regardless of subsequent price behavior.

Table 4.1. Selective hedging criteria and corresponding decision prices (cents per bushel).

Production year	Loan rate	150% (A)	175% (B)	200% (C)	+$1.00 (D)	+$1.50 (E)	+$2.00 (F)
1970-71	125	187.5	218.75	250	225	275	325
1971-72	125	187.5	218.75	250	225	275	325
1972-73	125	187.5	218.75	250	225	275	325
1973-74	125	187.5	218.75	250	225	275	325
1974-75	137	205.5	239.75	274	237	287	337
1975-76	137	205.5	239.75	274	237	287	337
1976-77	225	337.5	393.75	450	325	375	425
1977-78	225	337.5	393.75	450	325	375	425

Results of selective forward-pricing

No hedges were placed in 1970-71, 1971-72, and 1977-78 as futures prices remained below all decision prices during those years. Because selective hedges were placed at the first occurrance of futures prices exceeding the decision price, the difference between returns from routinely hedging at a fixed time and returns from selectively hedging may be due to either (1) the prevention of, or (2) the timing of hedging activity. By not hedging instead of routinely hedging at 40 weeks before harvest, $0.056 per bushel was forfeited in 1970-71; however losses of $0.102 and $0.410 per bushel were avoided in 1971-72 and 1977-78 respectively (Table 4.2).

In 1973-74, selective hedges were placed at or shortly after the beginning of trading in the new July futures. As prices continued to rise during the life of the contract, substantially greater losses resulted from selective hedges than from hedges routinely placed at later dates. The opposite situation occurred in 1976-77 when futures prices were high enough in the early part of contract trading to cause hedges to be placed under four of the selective alternatives. Subsequent price declines resulted in much higher futures profits for the selective hedges than for the later routine hedges. An exception is noted in variations C and F where futures prices did not reach the decision prices. As a result, no hedges were placed and no futures profits were earned, in spite of the subsequent price declines.

Average futures returns to selective hedging ranged from -$0.039 to $0.212, but none were significantly greater than zero (α=.05). Standard deviations of total returns were slightly higher for selectively hedged compared to unhedged production (Table 4.3); however again, none were significantly different from the unhedged (α=.05).

While it could not be concluded from these results that use of any of the six selective hedging variations was superior to unhedged marketing on the basis of increased or stabilized returns, the futures price-loan rate relationship may provide information useful in conjunction with other criteria to make selective hedging decisions. A hedger may conclude that prices at or within a predetermined distance of the loan rate constitute a "no hedging zone." The decision of whether or not to hedge when prices are above this zone would consider more than the fact that prices are above the minimum hedging level. This indicates the futures price-loan rate

Table 4.2. Annual net futures market returns from selective hedging; 1971 to 1978, (cents per bu.).

Production year	Variation (A) 150%	(B) 175%	(C) 200%	(D) +$1.00	(E) +$1.50	(F) +$2.00
1970-71	a	a	a	a	a	a
1971-72	a	a	a	a	a	a
1972-73	-77.213	-45.708	-11.448	-32.259	17.085	a
1973-74	-154.448	-154.448	-154.448	-154.448	-154.448	-106.774
1974-75	119.409	119.409	119.409	119.409	119.409	119.409
1975-76	14.916	14.916	14.916	14.916	14.916	14.916
1976-77	172.280	172.280	a	172.280	172.280	a
1977-78	a	a	a	a	a	a
Average[b]	9.368	13.306	-3.943	14.987	21.159	3.444
Std. Dev.[b]	102.313	99.059	74.010	98.023	96.160	60.695

[a]No hedges were placed.

[b]Based on eight years.

Table 4.3. Annual total returns to selectively hedged production at Concordia and Garden City; 1971 to 1978, (cents per bushel).

Variation	Concordia Average	Concordia Std. Dev.	Garden City Average	Garden City Std. Dev.
(A) 150%	256.743	110.546	251.993	108.480
(B) 175%	260.681	107.106	255.931	105.219
(C) 200%	243.432	98.302	238.682	96.342
(D) +$1.00	262.362	105.961	257.612	104.159
(E) +$1.50	268.534	103.540	263.748	102.092
(F) +$2.00	250.819	99.499	246.069	97.293

criterion may have greater usefulness in indicating certain times when hedges should not be placed, than in indicating when they should be placed.

Although little benefit was realized by selective hedging using these particular criteria, the number of potential hedging criteria are almost limitless and there is much room for more applied analysis.

Chapter V

MANAGED FORWARD-PRICING HEDGES

Introduction

The objective of managed hedging is to enhance the probability of taking hedging positions appropriate for actual price movements. Short hedging involves continuous application of price predicting and/or trading criteria in an effort to be covered by hedging when prices decline, but to be unhedged when prices rise. Hedges applied in this manner may be placed and lifted several times during the life of the contract or hedging period.

Again, the basic prerequisite for successful managed hedging is an ability to accurately predict, and be in a position to benefit from price movements. Different price predicting approaches used by commodity analysts may be generally classified as either fundamental or technical analysis. Conclusions of fundamental analysis are based on analysis and interpretation of underlying supply and demand conditions. Its successful use depends on (1) the quality, quantity and timeliness of available information, and (2) skillful interpretation and application to prevailing market situations. Although it is pivotal in price determination, and often provides first indications of significant price movements, the quantity of data and expertise required for fundamental analysis prevent most individuals from doing a great deal of related primary research.

Pure technical analysis does not consider whan the supply and demand conditions are, but rather the market's response. It is characterized by various methods of charting prices, volume and open interest. Data required

for technical analysis is readily available, and with a small amount of effort producers are often able to use it with about the same degree of effectiveness as professional market analysts. The objective of this analysis was to evaluate the effectiveness of applying technical analysis in the form of moving averages to managing a production hedge.

Moving averages represent an established and accepted speculative trading approach, however only in recent years has its use been directed toward managed hedging. Moving average trading developed as a means for recognizing and following trends in price movements, as opposed to predicting specific price changes. In its simplest form, the system requires only a comparison between the averages of a shorter and a longer series of the most recent prices. An upward trend is supposedly indicated when the short series average exceeds the long series average; declining trends being indicated by the opposite relationship. "Tops" and "bottoms" in the market should then be recognized as the short average crosses the long average from above to below, and from below to above respectively.

Averages tend to smooth out the impact of individual price fluctuations without disregarding their significance. Single, or even a few observations contrary to presumed trends do not cause a reversal of trading positions unless the observations are sufficiently large enough to result in the short average crossing the long average.

The responsiveness of moving average trading to changes in prices is determined by (1) the sensitivity of individual moving averages to the most recent price changes, and (2) the relative position of the two moving averages when the changes take place. As fewer prices are included in computing a moving average, the average becomes increasingly sensitive to the most recent price movements; regardless of whether the movements represent an actual

change in long-term trends or simply intermittent fluctuations.

Contrast between the long and short moving average values is determined by (1) the relationship between the number of days included in computing each average, and (2) patterns of price movement. Increased contrast between the long and short averages results in less responsive behavior with fewer "cross-overs" (Figures 5.1 and 5.2).

Consequences of this are two-fold: (1) a reduced number of "false signals," where temporary price reversals cause a crossover and the reversal of trading positions even though the long term trend remains unchanged, and (2) a greater time lag between beginnings of actual trends and crossover indications. A trade-off of some degree exists between eliminating false signals and responding at the earliest opportunity to bonafide profit opportunities.

Many variations of simple moving averages can be used. Apart from varying lengths of price series, the calculation of averages may be altered using weighting factors. Tolerances, specifying a minimum amount by which the short average must penetrate the long before action is taken, are often used to eliminate false signals. Averages of three price series are sometimes used, where trading signals are given only when the medium average is less (greater) than the long average and the short average is less (greater) than the medium average.

Methodology

Four commonly used moving average strategies were tested; 5-and-20 day, 5-and-15 day, 3-and-10 day, and a 4-and-9-and-18 day. Seven tolerances were applied with each strategy (Table 5.1). Tolerances used with the 4-and-9-and-18 day strategy were applied to the 4-and-9 day relationship, but not to the 9-and-18 day. This means the 4 day average must be above

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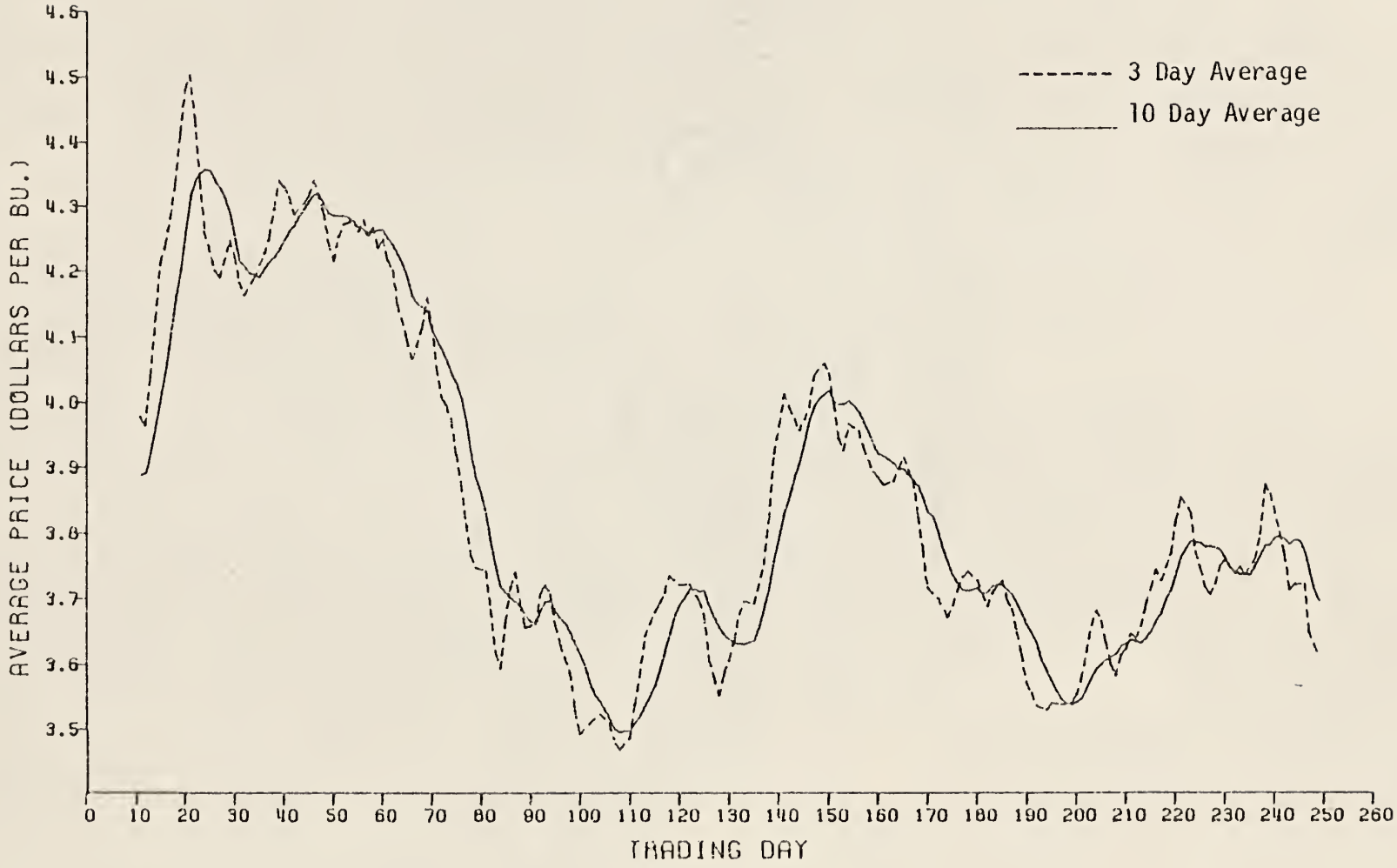

Figure 5.1. Relationship between 3-and-10 day moving averages during the life of the Kansas City wheat futures contract expiring in July 1976.

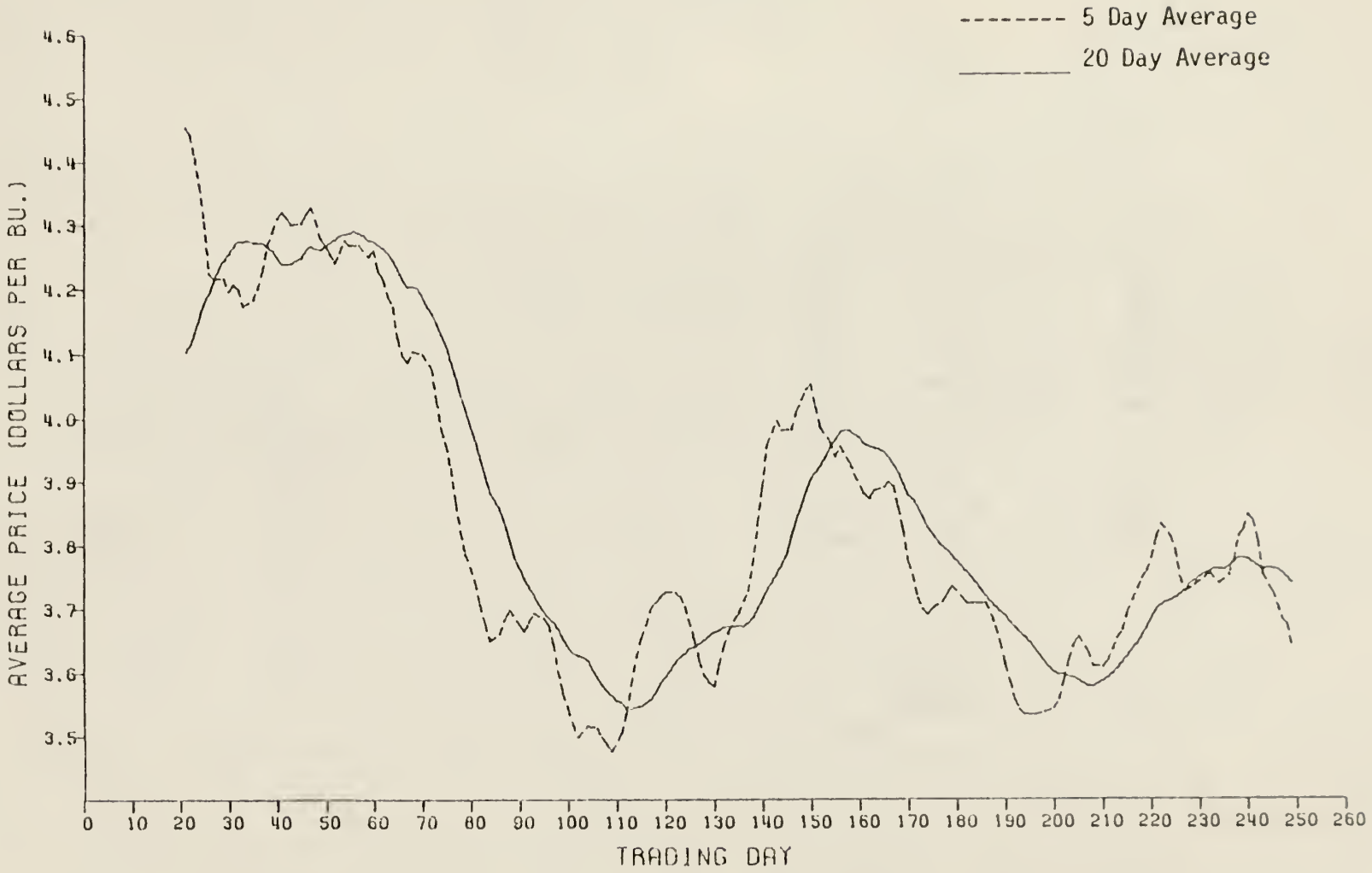

Figure 5.2. Relationship between 5-and-20 day moving averages during the life of the Kansas City wheat futures contract expiring in July 1976.

(below) the 9 day average by at least the amount of the tolerance, and the 9 day average must be above (below) the 18 day average before a long (short) trade is indicated.

Table 5.1. Moving average alternatives and corresponding crossover tolerances (cents per bushel).

Alternative	Tolerance (A)	(B)	(C)	(D)	(E)	(F)	(G)
5-and-20	1.0	1.5	2.0	2.5	3.0	3.5	4.0
5-and-15	1.0	1.5	2.0	2.5	3.0	3.5	4.0
3-and-10	1.0	2.0	3.0	4.0	5.0	6.0	7.0
4-and-9-and-18[a]	0.0	1.0	2.0	3.0	4.0	5.0	6.0

[a]Tolerance applied to the 4-and-9 day relationship.

Moving averages were computed by summing daily settlement prices of the relevant price series and dividing by the number of days included:

$$(1)\quad MAP_t = \left(\sum_{i=t-s}^{t} F_i\right)/s$$

Where: MAP_t = moving average price at the close of futures trading on day "t",

F_i = settlement futures price on day "i",

s = number of days included in the price series.

Annual net profit on the futures position was expressed by:

$$(2)\quad NFP = SFP - HC$$

Where: NFP = net futures profit; with SFP and HC being:

$$(3)\quad SFP = \sum_{i=1}^{m} (F_{t,i} - F_{t+d,i})$$

Where: SFP = gross profit from short futures position,

m = the number of hedges placed,

$F_{t,i}$ = the closing futures price on day "t" when hedge "i" was placed,

$F_{t+d,i}$ = the closing futures price on day "t+d" when hedge "i" was lifted,

d = number of days the hedge is in effect,

$$(4) \quad HC = \sum_{i=1}^{m} CM_i + (R(MR(330/365)))$$

Where: HC = hedging costs,

CM_i = commission costs for round turn "i",

R,MR = as defined in (2) of Chapter III.

Commission charges per round turn and interest rates were the same as used in Chapter III. Special consideration for computing hedging costs include: (1) if no hedges were placed, no hedging costs were imputed, and (2) as long as at least one hedge was placed, interest on futures margin was charged for 330 days and margin requirements were calculated at ten percent of the settlement price on the first day that the contract was quoted; regardless of when or how many hedges were placed. Although these costs may not exactly equal the actual charges, it is believed that they are sufficiently accurate to evaluate the effectiveness of the forward-pricing alternatives.

Total annual returns to production were computed as in equation (3) of Chapter III.

Results of forward-pricing with moving averages

The eight year average and standard deviation of net annual futures profits for each variation of the four moving average strategies are given in Table 5.2.[1] Each variation resulted in positive average returns to the short futures positions, however only the 4-and-9-and-18 day moving average with a tolerance of 2.0 cents produced an average profit that was significantly greater than zero (α=.05). Highest average returns, ranging from

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[1]Appendix Table A.1. gives annual futures profits earned by each managed forward-pricing alternative.

$0.376 to $0.480 per bushel, resulted from the use of 5-and-20 day moving averages. The 4-and-9-and-18 day, and the 5-and-15 day strategies produced average returns ranging from $0.339 to $0.419, and from $0.313 to $0.347 per bushel respectively. Returns to the 3-and-10 day were by far the lowest, from $0.094 to $0.282 per bushel.

Effects on average futures profits due to the use of various crossover tolerances were most notable with 3-and-10 day moving averages and least with 5-and-15 day. As greater tolerances were used, the total number of 'round-turns' made during the eight years decreased (Table 5.3). Only the 5-and-20 day moving average placed hedges in 1970-71 and 1971-72 when the tolerance used reached 3.0 cents; and it failed to hedge when tolerances reached 3.5 cents in 1970-71.

None of the managed forward-pricing alternatives reduced the variability of total returns relative to the variability of returns from unhedged production (Table 5.2). In fact, variability of total returns was increased by the use of managed forward-pricing in each case; although the only statistically significant (α=.05) differences were observed when 5-and-20 day moving averages were used with 1.5 and 2.0 cent tolerances at Concordia, and with a 1.5 cent tolerance at Garden City.

With minor exceptions, variability of total returns parallel the level of average returns; with total returns to 5-and-20 day moving averages having the greatest variability and total returns to the 3-and-10 day the least.

Table 5.2. Net annual futures market returns earned by forward-pricing with managed hedging, and total returns realized at Concordia and Garden City, 1971 to 1978; (cents per bu.).

MANAGED HEDGING ALTERNATIVE	ANNUAL RETURNS FROM FUTURES MARKET: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	ANNUAL TOTAL RETURNS: CONCORDIA AVERAGE	CONCORDIA STD.DEV.	GARDEN CITY AVERAGE	GARDEN CITY STD.DEV.
5-AND-20 DAY										
(A) 1.0 TOL.	4	132.253	4	-33.229	37.650	66.230	284.650	131.706	280.275	128.923
(B) 1.5 TOL.	4	135.430	4	-30.108	48.044	72.023	295.044	147.054*	290.669	144.218 *
(C) 2.0 TOL.	5	153.930	3	-28.858	45.402	73.327	292.413	146.006*	288.038	143.237
(D) 2.5 TOL.	5	122.836	3	-38.608	43.632	69.969	290.632	141.903	286.257	139.090
(E) 3.0 TOL.	4	122.836	4	-55.358	38.188	71.673	285.188	140.631	280.813	137.872
(F) 3.5 TOL.	4	156.480	3	-59.358	43.844	79.214	290.844	148.971	286.469	146.196
(G) 4.0 TOL.	4	156.480	3	-58.358	40.663	78.151	287.663	147.393	283.288	144.623
5-AND-15 DAY										
(A) 1.0 TOL.	5	123.203	3	-29.729	34.557	55.098	281.557	124.846	277.182	122.104
(B) 1.5 TOL.	4	126.703	4	-21.029	34.694	53.215	281.694	124.999	277.319	122.326
(C) 2.0 TOL.	4	138.103	4	-13.329	33.794	54.628	280.794	122.936	276.419	120.354
(D) 2.5 TOL.	5	140.253	3	-13.379	33.657	56.123	280.656	122.513	276.281	119.928
(E) 3.0 TOL.	4	143.403	2	-28.358	34.579	59.461	281.579	120.156	277.204	117.531
(F) 3.5 TOL.	4	134.153	2	-30.608	32.861	60.636	279.860	124.345	275.485	121.570
(G) 4.0 TOL.	4	134.153	2	-41.350	31.261	60.476	278.260	122.127	273.885	119.387
3-AND-10 DAY										
(A) 1.0 TOL.	4	92.253	4	-53.979	13.663	51.158	260.663	103.245	256.288	100.689
(B) 2.0 TOL.	4	90.653	4	-40.079	11.557	56.233	258.557	103.996	254.182	101.658
(C) 3.0 TOL.	3	103.103	3	-51.379	12.548	54.720	259.548	102.505	255.173	99.900
(D) 4.0 TOL.	3	93.853	3	-52.108	9.392	53.718	256.392	104.417	252.017	101.663
(E) 5.0 TOL.	4	129.003	2	-55.608	21.551	66.540	268.510	115.604	264.135	112.877
(F) 6.0 TOL.	4	140.403	2	-41.929	28.179	64.267	275.179	115.641	270.804	112.991
(G) 7.0 TOL.	2	146.803	4	-36.329	24.817	75.466	271.817	112.557	267.442	110.182
4-AND-9-AND-18 DAY										
(A) 0.0 TOL.	4	126.003	4	-29.327	34.326	65.835	281.325	131.974	276.950	129.236
(B) 1.0 TOL.	5	123.536	3	-26.608	40.382	62.918	287.388	133.321	283.013	130.569
(C) 2.0 TOL.	4	117.253	3	-30.358	38.904*	57.025	285.904*	127.819	281.529*	125.001
(D) 3.0 TOL.	4	132.153	2	-45.608	41.873	68.148	288.873	137.803	284.498	135.008
(E) 4.0 TOL.	4	129.230	2	-67.858	33.879	73.993	280.879	138.325	276.504	135.486
(F) 5.0 TOL.	4	128.903	2	-45.979	41.767	69.269	288.767	138.388	284.392	135.476
(G) 6.0 TOL.	4	138.803	2	-81.329	35.542	78.782	282.542	139.222	278.167	136.295

*Statistically significant (α=.05) relative to unhedged production.

Table 5.3. Total number of trades and percentage of trades with futures market profits resulting from using various tolerance levels with managed forward-pricing hedges.

Moving Average		Variation (A)	(B)	(C)	(D)	(E)	(F)	(G)
5-and-20 day	Tolerance	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	No. Trades	38	35	32	28	26	22	21
	% Profitable	39.5	40.0	43.8	46.4	42.3	50.0	47.6
5-and-15 day	Tolerance	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	No. Trades	56	42	38	34	29	28	27
	% Profitable	37.5	45.2	42.1	41.2	41.4	39.3	37.0
3-and-10 day	Tolerance	1.0	2.0	3.0	4.0	5.0	6.0	7.0
	No. Trades	72	55	44	42	34	30	26
	% Profitable	43.1	45.5	43.2	38.1	38.2	43.3	38.5
4-and-9-and-18 day	Tolerance	0.0	1.0	2.0	3.0	4.0	5.0	6.0
	No. Trades	45	33	26	21	19	16	12
	% Profitable	37.8	39.4	38.5	47.6	36.8	43.8	50.0

Chapter VI

BASIC RETURNS TO STORAGE AND RISK-BEARING

Introduction

Functions performed in grain marketing may be classified in three general ways: (1) exchange activities of buying and selling; (2) physical flow, involving storage and transportation; and (3) facilitation through financing, risk-bearing, provision of information, and standardization and grading. Though producers contribute in varying degrees to the performance of several marketing functions, two of particular interest to this analysis are storage and risk-bearing.

Because individuals have the option of performing storage and/or risk-bearing functions, four basic marketing alternatives are assumed (Table 6.1).[1] Producers have the option of (1) selling the commodity in the cash market or (2) storing for later sale; plus they may choose whether to (1) speculate on commodity price changes or (2) accept the current price.[2] This analysis evaluates the results of routinely performing storage and/or risk bearing functions as they apply to each of these basic alternatives.

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[1] Additional alternatives, or variations of the mentioned alternatives made possible by participation in cooperative marketing pools or other cash contract agreements are not considered.

[2] The current price established by hedging may vary within the constraints of basis theory as market payments for storage vary; however, this is distinguished as "basis risk" rather than "price risk".

As indicated in Table 6.1, returns to storage may be isolated from returns to risk-bearing by considering the alternative of hedged storage. Returns to storage accrue in two ways: (1) as direct market payments for storage realized as cash prices increase seasonally relative to futures following harvest, and (2) as indirect convenience yields.

Table 6.1. Basic grain marketing alternatives created by optional storage and risk-bearing functions.

Storage function	Risk-bearing function	Basic Alternative*
don't store	set price	sell grain at harvest
store	speculate	store grain unhedged
don't store	speculate	sell grain and purchase futures
store	set price	store grain hedged

*Using cash and futures markets without participation in marketing pools or cash contracts.

Convenience yields might be earned through participation in Commodity Credit Corporation loan programs, income flow and tax management, etc.

"Normal" basis behavior theory describes cash prices as increasing overtime relative to the price of a given futures contract (Figure 6.1). Whenever cash prices increase (decrease) relative to futures, positive (negative) returns are earned by inventory holders. The size of and changes in the cash-futures basis are determined by a number of factors including:

- supply and demand for the commodity at the futures market relative to cash market locations.
- availability and cost of transportation
- availability and cost of storage facilities
- premiums and discounts associated with quality differences between the commodity and the specifications of a futures contract

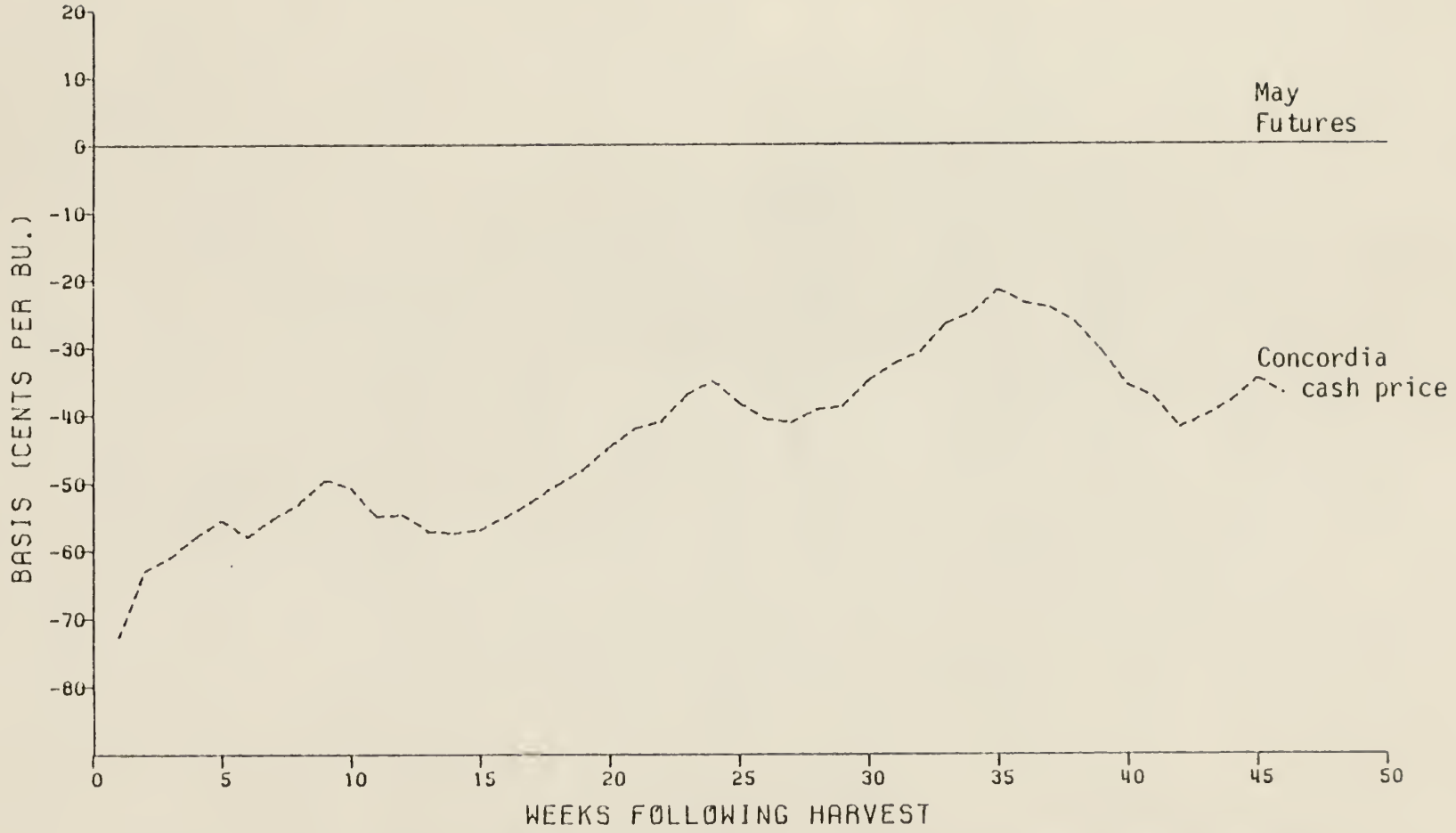

Figure 6.1. Concordia cash wheat price relative to Kansas City May futures during the 1977-78 marketing year.

- transaction costs
- interest rates
- commodity price levels
- time until maturity of the relevant futures contract
- prices of substitutable commodities

As long as storage facilities are available, arbitrage theoretically limits the maximum discount of cash prices at par delivery points relative to futures to the sum of inventory financing and storage costs required to hold the commodity until futures contract maturity. Profits exceeding carrying charges are earned only if (1) the increase in cash prices relative to futures exceeds carrying charges incurred to that time, or (2) convenience yields are realized.

In order for arbitrage to effectively limit discounting of cash prices relative to futures at nondelivery points (local cash markets), adequate storage and/or transportation facilities are required. Unavailability or overloading of handling facilities, particularly at harvest time, may put localized pressure on cash prices causing them to be abnormally depressed relative to futures. If this happens, profits may be realized by isolating grain from market channels until handling facilities become more available and the basis responds accordingly. On the other hand, transportation shortages and/or increased transportation costs occurring later in the storage period may reduce returns to storage by preventing cash prices from increasing relative to futures as much as anticipated.

Also influencing local basis behavior is the relationship between local supply and demand conditions and supply and demand at the futures market location. If transportation is available, the resulting price differential should not exceed the cost of that transportation. However,

all other factors being equal, local cash prices may exceed or fall below delivery point cash prices by any amount up to that differential. Locational differences directing grain movement from local to futures market locations depress cash prices relative to futures; while grain movement into the local market area, or from both markets toward a third where grain from the local market has an advantage in transportation costs, will cause cash prices to increase relative to futures.

In the long-run, delivery point basis changes are expected to provide a payment for inventory holding equal to the sum of interest and storage costs less convenience yields. Part one of this analysis determines the profitability of routinely storing wheat for given periods of time following harvest by comparing basis changes at two cash market locations with interest, storage, and hedging costs.

The second part of this analysis proceeds to measure the returns and risk involved in routinely performing the risk-bearing function. In order to isolate returns to risk-bearing from returns to storage, the alternative of holding a long futures position is considered.[3] This type of analysis essentially attempts to empirically evaluate theoretical risk-premium and biased versus unbiased market theories; though it is recognized, an eight year sample is probably too small to allow confirmation of either theory.

Unhedged storage of grain following harvest combines storage and risk bearing functions. Two variations of this alternative will be considered:

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[3]Until Chapter VIII, risk-bearing is considered only in terms of the risk involved in holding inventories, or a net long position in the market.

(1) routinely storing unhedged grain until a given marketing week when it is sold in the cash market; and (2) sequential marketing for a given period of time, where equal amounts of grain are sold weekly until the inventory is entirely liquidated by last week of the established period.[4] Obviously, the objective of unhedged storage is to combine returns to storage and risk-bearing. The objective of sequential marketing is to reduce the risk exposure while still realizing the benefits of unhedged storage.

Methodology

A 44 week marketing period was assumed to begin with harvest of each, 1971 through 1978, with harvest and marketing week one being the first Wednesday in July.[5] Weekly (Wednesday) cash prices were used for all cash market transactions. Daily futures prices were taken from the Kansas City May option as Wednesday of the last marketing week occurred between April 27 and May 3. Cash prices from both Concordia and Garden City were used in determining market payments for storage; however for simplicity, all subsequent analysis uses local cash prices from Concordia only.

Storage profits were calculated weekly, reflecting the net profit earned by placing a storage hedge at harvest and lifting it during the given marketing week. Prevailing commercial storage rates were used to measure storage costs (Table 6.2).

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[4]For instance, sequential marketing for a ten week marketing period would require that ten percent of the original inventory be sold in each of the ten marketing weeks.

[5]A twenty-five week marketing period, ending December 20, was used for 1978-79.

Table 6.2. Commercial storage rates used during the study period

Marketing year	Daily storage rate (per bushel)
1971-72	$0.0003
1972-73	0.0003
1973-74	0.0003
1974-75	0.0008
1975-76	0.0006
1976-77	0.0006
1977-78	0.0006
1978-79	0.0007

Marketing profits to storage (net profits from hedged storage) were defined as:

(1) $MPS_n = (F_1 - CP_1) - (F_n - CP_n) - SC(n-1) - HC - I$

Where: MPS_n = marketing profit to storage through week n,

F_1 = closing futures price at harvest (marketing week one),

CP_1 = cash price at harvest,

F_n = closing futures price on Wednesday of marketing week "n",

CP_n = cash price on Wednesday of marketing week "n"

SC = weekly per bushel storage cost,

n = marketing week number

HC = hedging costs per bushel,

I = interest cost per bushel of commodity in storage.

Hedging costs were defined as:

(2) $HC = CM + R(MR(7(n-1)/365))$

Where: CM, R and MR were defined as in (2) of Chapter III, and per bushel futures margin requirements were ten percent of F_1.

Interest on the commodity in storage was computed as:

(3) $I = R(CP_1(7(n-1)/365))$

Returns to risk bearing, the net profit earned by replacing the commodity with a long futures position were defined as:

$$(4)\quad MPRB_n = F_n - F_1 - HC$$

Where: $MPRB_n$ = marketing profit to risk-bearing through week n.

Returns to unhedged storage, without sequential marketing were defined as:

$$(5)\quad MPUS_n = CP_n - CP_1(n-1(SC)) - I$$

Where: $MPUS_n$ = marketing profit to unhedged storage through week n.

Returns to unhedged storage using sequential marketing were defined as:

$$(6)\quad MPUS_n^1 - (\sum_{i=1}^{n} MPUS_i)/n$$

Where: $MPUS_n^1$ = marketing profit to sequentially marketed unhedged storage through week n.

Results of storage hedging

Summaries of annual returns to routine storage hedging at Concordia and Garden City are shown in Tables 6.3 and 6.4 respectively. Tables A.4 and A.5 present weekly storage hedging profits year by year.

During the first 32 weeks of the marketing period, only two average hedging profits, both at Concordia, were significantly greater than zero (α=.05); none were significantly negative. Storage hedging resulted in an average loss for each of the last 12 weeks at both locations as the frequency and magnitude of annual losses increased. In several instances during the final weeks losses were statistically significant (α=.01).

The existence of variation in hedging profits indicates that hedgers are susceptable to uncertainty about basis behavior; however it is small relative to the variation in total annual returns (hedging profits plus

Table 6.3. Net marketing returns to routine storage hedging from harvest until the indicated marketing week, and standard deviations of the resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	0	0.0	8	-1.000	-0.850	0.120	95.074
2	5	18.188	3	-3.077	2.638	7.268	97.242
3	6	9.276	2	-2.807	3.595	4.721	96.946
4	3	14.857	5	-3.879	3.443	8.207	95.054
5	4	19.452	4	-8.872	5.244	11.011	95.486
6	5	56.129	3	-15.093	7.185	21.791	96.618
7	5	12.014	3	-11.021	2.220	7.994	95.506
8	4	45.401	4	-12.200	6.193	17.857	96.144
9	5	24.786	3	-17.196	1.869	14.056	94.426
10	3	14.165	5	-10.931	-1.612	8.062	94.535
11	4	9.155	4	-9.735	-1.436	6.403	95.443
12	5	8.646	3	-5.073	0.709	5.142	93.467
13	4	10.330	4	-6.237	0.869	6.410	93.247
14	4	9.561	4	-11.982	0.264	7.645	92.390
15	5	11.045	3	-13.227	-0.452	8.360	91.565
16	4	10.531	4	-22.472	-1.838	10.813	89.942
17	5	10.872	3	-15.717	0.212	9.272	93.263
18	6	29.259	2	-19.961	2.576	13.997	92.340
19	5	34.644	3	-19.206	3.986	15.150	91.337
20	6	38.029	2	-20.451	5.083	16.622	92.445
21	5	18.416	3	-21.945	1.900	12.240	90.321
22	7	19.801	1	-18.440	3.247	11.367	90.557
23	5	18.041	3	-16.185	3.048	10.848	91.562
24	4	19.281	4	-6.929	3.459	9.193	94.043
25	5	15.272	3	-5.100	2.619	6.890	97.310
26	6	12.012	1	-4.381	4.817*	5.503	102.919*
27	5	11.909	2	-9.112	2.752	7.643	101.188
28	2	11.994	5	-6.024	0.831	7.100	99.923
29	4	11.734	3	-3.337	3.337	6.177	100.667
30	5	14.725	2	-4.139	3.522	6.697	101.289
31	6	16.465	1	-3.267	4.046	7.281	101.027
32	2	17.456	5	-5.894	1.464	8.262	99.423
33	2	20.946	5	-12.662	-0.172	10.743	105.373
34	2	21.687	5	-27.841	-3.220	15.107	107.421
35	1	24.427	6	-42.683	-9.392	20.026	104.483
36	1	21.668	6	-49.298	-12.438	21.861	98.493
37	1	20.158	6	-46.412	-10.271	19.521	104.363
38	1	17.149	6	-39.027	-8.443	16.486	104.175
39	1	12.139	6	-40.640	-10.079	15.840	105.114
40	1	6.380	6	-46.755	-11.609	16.592	105.052
41	1	3.870	6	-44.870	-11.710*	15.494	102.767
42	0	0.0	7	-40.983	-11.703*	13.622	102.634
43	0	0.0	7	-43.098	-14.143*	14.245	102.587
44	1	1.091	6	-44.711	-15.743*	14.257	103.173

*Statistically significant (α=.05) relative to selling at harvest.

Table 6.4. Net marketing returns to routine storage hedging from harvest until the indicated marketing week, and standard deviations of the resulting total returns; Garden City, 1971 to 1978; (cents per bu.)

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	0	0.0	8	-1.000	-0.850	0.120	92.828
2	4	8.618	4	-13.916	-1.105	7.119	95.334
3	5	9.243	3	-5.794	2.109	5.096	94.380
4	4	12.853	4	-5.988	1.088	6.597	91.684
5	3	18.237	5	-8.505	1.520	9.423	91.031
6	4	57.121	4	-13.406	4.469	22.868	94.096
7	4	35.005	4	-22.308	1.635	16.964	93.433
8	4	28.390	4	-19.208	1.490	13.966	94.195
9	4	17.224	4	-29.110	-1.203	15.378	93.852
10	5	13.220	3	-22.011	-2.426	10.468	94.348
11	4	30.542	4	-24.413	1.881	15.499	95.699
12	3	7.714	5	-20.813	-2.718	9.224	91.922
13	4	16.311	4	-19.715	-0.301	10.526	92.469
14	3	5.606	5	-21.805	-4.525	10.356	91.597
15	5	8.079	3	-19.517	-1.983	9.855	91.648
16	5	7.464	3	-23.419	-2.988	12.106	89.717
17	4	9.386	4	-16.470	-2.180	11.059	92.289
18	3	14.403	5	-27.221	-5.436	14.238	91.699
19	4	31.616	4	-25.122	0.731	13.781	91.004
20	3	30.000	5	-25.159	1.460	17.516	90.969
21	3	17.385	5	-22.924	-1.716	16.470	90.095
22	3	14.724	5	-22.326	-3.737	13.938	89.704
23	4	18.176	4	-14.727	1.070	13.429	89.855
24	4	20.423	4	-14.129	-0.513	11.721	91.043
25	3	16.420	5	-17.079	-2.596	11.977	95.418
26	4	10.166	3	-17.931	-1.433	11.854	100.657
27	4	9.069	3	-20.832	-1.062	11.046	99.864
28	4	9.160	3	-28.925	-5.262	14.476	100.333
29	4	15.225	3	-20.885	0.251	12.229	98.693
30	5	11.903	2	-18.035	2.301	10.598	99.731
31	4	15.650	3	-14.937	-0.025	12.105	99.926
32	2	16.646	5	-19.389	-3.315	12.869	102.608
33	2	20.143	5	-21.990	-3.801	13.934	100.447
34	2	20.890	5	-24.620	-6.269	15.373	100.310
35	1	21.637	6	-43.735	-9.577	20.644	97.746
36	1	18.883	6	-39.351	-10.331	18.336	98.723
37	1	18.380	6	-49.468	-13.300	20.735	97.898
38	1	13.377	6	-46.084	-10.893	18.695	100.346
39	1	7.373	6	-45.699	-13.808 *	16.650	101.156
40	1	3.620	6	-53.815	-17.330 *	18.105	103.068
41	1	2.116	6	-67.931	-18.709 *	22.833	101.650
42	1	1.984	6	-59.046	-16.839 *	20.095	98.190
43	0	0.0	7	-62.162	-20.271 *	20.370	98.473
44	0	0.0	7	-61.779	-22.579 *	20.286	96.289

*Statistically significant (α=.05) relative to selling at harvest.

corresponding cash prices at harvest). Variation in total returns was influenced by the correlation between annual hedging profits and cash prices at harvest. In some cases, negative correlation reduced the variance of total returns relative to the variance of harvest cash prices, though no reductions were statistically significant (α=.05). Storage hedging caused only small changes in standard deviations of total returns; however in one instance at the Concordia market, a standard deviation of 102.919 cents per bushel was statistically significant (α=.05).[6]

Results of holding long futures

Annual net returns earned by selling wheat at harvest while simultaneously purchasing and holding May futures are given in Table A.6, and are summarized in Table 6.5. Average net returns to risk-bearing ranged from -$0.114 to $0.376 per bushel, with average profits occurring in all but the first three and last two weeks of the marketing period. None of the average returns, however, were statistically significant (α=.05).

Holding a long futures position during this period appears to have involved substantially more risk, in terms of the range and variability of marketing returns, than did holding a hedged storage position. Again, lack of perfect positive correlation between marketing profits and harvest cash prices lessened increases in total return variation so that, even though total returns were somewhat more variable than harvest cash prices, none were increased significantly (α=.05).

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[6]Due to very high correlation between total returns to storage hedging and harvest cash prices, standard deviations of total returns may show a statistically significant difference even though that difference is relatively small and may even be less than other differences which are non-significant.

Table 6.5. Net marketing returns to holding long futures positions in place of inventories from harvest through the indicated marketing week, and standard deviations of the resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	0	0.0	8	-1.000	-0.850	0.120	95.074
2	3	21.050	5	-12.871	-0.801	11.088	92.852
3	2	63.999	6	-28.942	-0.472	28.859	92.891
4	4	50.949	4	-29.091	3.593	26.870	98.042
5	4	57.542	4	-39.155	6.579	35.590	100.296
6	4	102.002	4	-55.468	12.674	52.408	102.683
7	3	147.462	5	-58.282	22.426	69.693	111.615
8	3	151.423	5	-65.346	24.990	75.940	112.687
9	3	171.383	5	-70.660	25.601	80.467	114.759
10	3	156.343	5	-66.473	23.618	74.073	108.290
11	3	191.304	5	-76.537	29.354	84.081	112.880
12	3	217.264	5	-91.351	35.121	95.382	119.126
13	3	197.225	5	-107.164	29.748	91.621	116.913
14	5	195.685	3	-104.978	34.140	89.633	121.159
15	4	191.145	4	-90.292	37.642	84.911	123.362
16	6	125.106	2	-108.605	28.941	73.520	114.245
17	6	172.066	2	-123.919	33.177	86.733	122.210
18	6	128.027	2	-129.983	27.975	78.373	116.351
19	6	124.987	2	-136.796	25.602	79.305	116.010
20	5	141.947	3	-142.610	22.166	81.302	109.914
21	6	159.908	2	-140.174	21.137	83.721	110.888
22	6	177.868	2	-145.488	24.201	89.912	114.138
23	6	192.828	2	-139.801	27.362	93.607	113.847
24	5	220.789	3	-142.865	29.188	103.572	115.011
25	5	231.749	3	-143.929	24.565	105.446	115.325
26	4	212.710	3	-135.742	26.543	107.459	113.207
27	4	248.670	3	-137.806	30.945	118.088	124.943
28	4	253.630	3	-132.620	31.634	122.098	122.042
29	4	263.591	3	-136.183	30.751	125.054	126.783
30	4	241.551	3	-138.747	20.046	122.789	117.599
31	4	258.511	3	-141.311	19.717	126.834	124.381
32	4	253.472	3	-133.874	19.209	122.657	124.139
33	4	285.432	3	-132.938	26.897	132.210	136.737
34	3	316.393	4	-131.002	32.425	145.581	143.746
35	3	304.853	4	-142.816	28.506	145.545	142.716
36	4	262.813	3	-138.879	22.177	133.371	125.126
37	4	258.274	3	-144.693	20.062	130.284	125.578
38	4	206.234	3	-146.757	10.714	116.109	109.779
39	4	185.195	3	-153.570	8.831	109.404	104.605
40	5	152.655	2	-160.134	6.413	102.906	92.863
41	5	155.115	2	-156.948	7.565	104.157	92.571
42	5	150.576	2	-157.511	4.182	107.296	88.729
43	5	142.036	2	-172.075	-2.469	111.505	87.687
44	5	112.997	2	-175.889	-11.387	103.814	79.570

Results of unhedged storage

Average net returns to unhedged grain storage ranged from -$0.217 to $0.402 for the Concordia market (Tables A.7 and 6.6). As expected, unhedged storage profits at any given time equal the sum of profits from storage hedging and from holding a long futures position for the same period of time, plus twice the futures transaction costs. Again, none of the returns to unhedged storage were significantly greater than or less than zero (α=.05).

Standard deviations of marketing returns to unhedged storage were not equal to the sum of the standard deviations of the profits to storage hedging and holding long futures. Generally the variances of both marketing returns and total returns from unhedged storage were very similar to the corresponding variances in returns from holding long futures. Standard deviations of total returns were again increased, in most cases, relative to the standard deviation harvest cash prices; however none were significantly greater (α=.05).

Results of sequential marketing of unhedged storage

Average returns to sequential marketing of unhedged grain ranged from $0.018, for marketing routinely spread over a two week interval, to $0.314 for marketing spread throughout a twenty-nine week span (Tables A.8 and 6.7); none, however, were significantly greater than zero (α=.05).

Selling grain weekly throughout a given marketing period did reduce the range and variability of annual marketing profits relative to 'one-shot' selling at the end of the same period. Total annual returns were still more variable than harvest cash prices, though not significantly (α=.05).

Table 6.6. Net marketing returns to storing unhedged inventories until sold in the indicated marketing week, and standard deviations of the resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	0	0.0	0	0.0	0.0	0.0	95.119
2	4	41.138	4	-9.174	3.627	15.997	95.574
3	3	75.277	5	-23.348	5.004	30.512	95.325
4	4	66.415	4	-30.788	11.007	32.654	99.573
5	4	78.554	4	-45.717	13.884	43.245	103.229
6	4	160.127	4	-60.646	22.011	67.739	110.681
7	3	161.552	5	-58.575	26.888	71.588	113.111
8	3	198.978	5	-66.505	33.516	85.443	119.060
9	3	198.403	5	-66.434	29.893	82.944	116.405
10	3	152.828	5	-64.363	24.520	70.101	105.156
11	4	184.254	4	-78.292	30.522	81.463	111.426
12	4	226.679	4	-93.222	38.525	97.531	119.838
13	5	210.105	3	-106.151	33.402	93.393	117.061
14	6	207.530	2	-107.080	37.279	92.357	121.295
15	6	198.955	2	-96.009	40.156	86.307	121.812
16	6	135.381	2	-110.938	30.159	73.291	109.839
17	6	185.806	2	-117.868	36.536	86.460	120.750
18	6	160.232	2	-122.797	33.788	81.424	115.945
19	6	162.657	2	-130.726	32.915	83.623	115.626
20	6	183.082	2	-130.655	30.667	86.778	111.232
21	6	181.508	2	-130.585	26.545	85.858	108.512
22	6	200.933	2	-135.514	31.047	92.831	112.903
23	6	212.358	2	-128.443	34.299	95.340	112.590
24	5	237.784	3	-134.372	35.426	105.501	116.272
25	5	234.209	3	-136.302	31.054	104.008	116.431
26	4	224.635	3	-128.231	35.203	109.160	116.254
27	4	235.060	3	-131.160	37.628	119.162	123.789
28	4	253.485	3	-128.089	36.482	121.600	120.381
29	4	272.911	3	-132.018	38.193	126.815	123.084
30	4	249.336	3	-132.946	27.761	123.356	118.254
31	4	263.761	3	-134.877	28.044	126.873	124.267
32	4	255.187	3	-129.806	26.041	122.613	122.607
33	4	286.612	3	-128.735	31.180	129.792	137.389
34	4	306.037	3	-127.665	31.748	139.119	141.302
35	4	266.463	3	-140.594	23.745	131.884	130.129
36	4	217.888	3	-137.523	14.486	123.549	110.471
37	4	216.314	3	-143.452	14.596	117.010	113.374
38	4	171.739	3	-145.382	7.164	106.281	101.538
39	4	149.165	3	-154.311	3.732	99.554	97.741
40	4	110.590	3	-160.240	-0.129	93.406	86.014
41	4	115.015	3	-156.169	1.011	96.336	84.907
42	4	114.441	3	-157.098	-2.278	100.856	82.313
43	4	103.866	3	-171.028	-11.281	104.888	80.306
44	4	73.292	3	-174.957	-21.713	96.145	71.764

Table 6.7. Net marketing returns to storage of unhedged inventories with sequential (weekly) selling during the indicated period, and standard deviations of the resulting total returns; Concordia, 1971 to 1978. (cents per bu.).

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	0	0.0	0	0.0	0.0	0.0	95.119
2	4	20.569	4	-4.587	1.814	7.998	95.011
3	3	38.805	5	-10.841	2.877	15.318	94.491
4	3	45.707	5	-11.644	4.910	18.308	95.225
5	3	52.277	5	-18.458	6.704	22.443	96.161
6	3	56.513	5	-25.490	9.256	28.511	96.829
7	3	64.848	5	-30.216	11.775	34.364	98.063
8	3	81.614	5	-34.752	14.492	40.514	99.407
9	3	94.590	5	-38.272	16.203	44.975	100.314
10	3	100.414	5	-40.881	17.035	47.424	100.496
11	3	108.036	5	-44.282	18.261	50.437	101.025
12	3	117.923	5	-48.361	19.950	54.242	101.833
13	3	125.014	5	-52.806	20.985	57.131	102.487
14	3	130.908	5	-56.683	22.148	59.543	103.486
15	4	135.444	4	-59.305	23.349	61.135	104.482
16	5	135.440	3	-62.532	23.775	61.585	104.601
17	5	138.403	3	-65.787	24.525	62.811	105.316
18	6	139.616	2	-68.954	25.040	63.594	105.697
19	6	140.828	2	-72.205	25.464	64.390	105.991
20	6	142.941	2	-75.128	25.715	65.226	105.974
21	6	144.778	2	-77.768	25.755	65.690	105.806
22	6	147.330	2	-80.393	25.995	66.905	105.858
23	6	150.157	2	-82.482	26.356	67.931	105.865
24	6	153.808	2	-84.644	26.734	69.274	105.909
25	6	157.024	2	-86.711	26.907	70.406	105.996
26	5	159.625	2	-88.308	30.684	76.341	114.191
27	5	163.159	2	-89.895	30.941	77.636	114.157
28	5	166.385	2	-91.259	31.139	78.969	113.930
29	5	170.059	2	-92.664	31.382	80.453	113.997
30	5	172.701	2	-94.007	31.262	81.674	113.731
31	5	175.638	2	-95.325	31.158	82.960	113.680
32	5	173.124	2	-96.403	30.967	84.056	113.655
33	4	181.412	3	-97.383	30.973	85.324	114.089
34	4	185.077	3	-98.273	30.996	86.753	114.503
35	4	187.402	3	-99.483	30.789	87.920	114.641
36	4	188.249	3	-100.539	30.335	88.685	114.203
37	4	189.008	3	-101.699	29.910	89.339	114.001
38	4	188.553	3	-102.849	29.311	89.637	113.541
39	4	187.543	3	-104.168	28.655	89.771	113.057
40	4	185.619	3	-105.570	27.936	89.629	112.273
41	4	183.897	3	-106.804	27.279	89.555	111.490
42	4	182.243	3	-108.001	26.575	89.555	110.653
43	4	180.421	3	-109.467	25.695	89.629	109.791
44	4	177.986	3	-110.955	24.617	89.479	108.824

Chapter VII

MANAGED STORAGE HEDGING

Introduction

Risk-bearing would obviously become more profitable and less risky if price movements could be accurately forecast. Inventory holders would be willing to perform risk-bearing functions if prices were expected to increase, but would not do so if prices were expected to decline.

Moving averages may be applied to meeting price prediction objectives for storage hedging in much the same manner as for forward pricing production (Chapter V). This analysis (1) compares the results of applying various moving average strategies to storage hedging for the duration of the eight marketing periods; and (2) determines for each week of the forty-four week marketing period, the results of routinely applying a moving average storage hedge to inventories held from harvest through that week.

Methodology

The same four basic moving averages used for managed production hedging, 5-and-20 day, 5-and-15 day, 3-and-10 day, and a 4-and-9-and-18 day, were applied to managed storage hedging. Seven crossover tolerances applied to each strategy were also identical to those used for production hedges (Table 5.1, page 39).

Futures prices were again from the Kansas City May option. Calculation of moving averages began prior to harvest with the initial quotations of new crop May futures. Hedging was allowed to begin whenever the first

downward trend was indicated and all hedged positions were liquidated on Wednesday of the final marketing week.

Daily moving average prices were computed as in (1) of Chapter V.

Annual marketing profits to managed hedging were expressed as:

(1) $MPMH_n = SFP_n + MPUS_n - HC_n$

Where: $MPMH_n$ = marketing profits to managed storage hedging through week n,

SFP_n = short futures profit through week n, defined as in (2) of Chapter V,

$MPUS_n$ = marketing profit to unhedged storage through week n, defined in (5) of Chapter VI, and

HC_n = hedging costs through week n, defined as:

(2) $NC_n = \sum_{i=1}^{m} CM_i + (R(MR(7(n-1)/365))$

Where: CM_i, R and MR were defined as in (3) of Chapter V.

Again, no hedging costs were imputed if moving averages failed to initiate a hedge. Per bushel futures margin requirements were based on the May settlement price at harvest.

Results of managed storage hedging

Results of using each variation of the four moving average alternatives to manage storage hedges on grain held for the duration of each marketing period are given in Table 7.1.[1]

Returns earned from futures trading alone were generally greatest for variations of the 5-and-20 day and the 4-and-9-and-18 day moving averages. Average futures returns to each ranged from $0.499 to $0.532, and from $0.464 to $0.545 respectively; all being significantly greater than zero (α=.05).

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[1]The 1978-79 marketing period was terminated with the twenty-fifth week, so average returns from Table 7.1 will not necessarily be identical to average returns at the forty-fourth week.

The lowest futures returns were earned by variations of the 3-and-10 day alternative, with the exception of the variation using a 7.0 cent crossover tolerance which had a statistically significant (α=.05) average futures profit of $0.452.

Returns to marketing, however, combine returns from both futures and cash positions. Corresponding returns on the cash position averaged -$0.194 for inventories held until the last marketing week in each of the eight years; causing returns to marketing to average that much less than returns to futures trading. Although average marketing returns for all but the 3-and-10 day alternative still ranged from $0.228 to $0.350 per bushel, none were statistically significant (α=.05). Negative average marketing returns were earned by using the 3-and-10 day alternative with tolerances of 4.0 cents or less.

Three variations of the 3-and-10 day moving averages reduced variability of total returns slightly without reducing average returns. In all other instances, variability of total returns either increased slightly or decreased along with the average returns. None of the total returns had a variance significantly different from the variance of cash prices at harvest (α=.05).

The magnitude of the greatest annual futures loss was, in most instances, considerably less than the average annual futures return; perhaps indicating that managed hedging could be an effective means of reducing the size of losses. Again however, returns from cash market positions must be included before greatest annual losses from managed hedging are directly comparable to greatest annual losses from other marketing alternatives.

Holding grain under managed hedging only until the twenty-fifth market-

Table 7.1. Summary of net annual futures returns, marketing returns, and total returns earned by using various moving averages to manage storage hedges for the duration of each marketing period; Concordia, 1971 to 1978; (cents per bu.).

MANAGED HEDGING ALTERNATIVE	ANNUAL RETURNS FROM FUTURES MARKET PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	ANNUAL MARKETING RETURN AVERAGE	MARKETING RETURN STD.DEV.	ANNUAL TOTAL RETURN AVERAGE	TOTAL RETURN STD.DEV.
5-AND-20 DAY										
(A) 1.0 TOL.	6	137.161	2	-25.583	49.943 *	69.936	30.567	76.498	277.567	108.983
(B) 1.5 TOL.	6	147.311	2	-21.033	51.067 *	69.320	31.691	73.278	278.690	107.314
(C) 2.0 TOL.	6	146.561	2	-22.744	51.813 *	67.303	32.437	70.423	279.437	106.210
(D) 2.5 TOL.	4	146.311	4	-18.744	50.944 *	67.345	31.568	68.648	278.568	106.956
(E) 3.0 TOL.	5	145.561	3	-2.265	52.026 *	61.555	32.649	71.172	279.649	101.651
(F) 3.5 TOL.	5	148.961	3	-2.515	53.216 *	62.737	33.839	66.786	280.839	101.777
(G) 4.0 TOL.	6	147.961	2	-9.015	50.232 *	60.412	30.856	69.695	277.855	99.157
5-AND-15 DAY										
(A) 1.0 TOL.	5	178.697	3	-26.139	42.162	75.732	22.786	98.643	269.786	115.505
(B) 1.5 TOL.	5	170.497	3	-32.139	46.815	82.377	27.439	91.841	274.430	119.350
(C) 2.0 TOL.	5	170.997	3	-31.639	50.131	84.097	30.755	90.562	277.755	119.715
(D) 2.5 TOL.	5	168.497	3	-22.044	51.575	77.355	32.199	88.344	279.198	115.805
(E) 3.0 TOL.	4	152.961	4	-14.294	45.144	71.739	25.767	74.535	272.767	104.420
(F) 3.5 TOL.	3	148.961	5	-8.320	43.972	69.092	24.596	69.585	271.596	101.571
(G) 4.0 TOL.	3	148.961	5	-12.765	44.862	71.371	25.486	72.795	272.486	103.696
3-AND-10 DAY										
(A) 1.0 TOL.	4	95.161	4	-42.303	5.445	43.225	-13.931	58.907	233.069	56.948
(B) 2.0 TOL.	6	103.311	2	-50.889	12.559	45.310	-6.818	60.430	240.102	60.317
(C) 3.0 TOL.	3	93.800	5	-42.089	15.631	47.412	-3.745	56.414	243.255	76.669
(D) 4.0 TOL.	4	121.850	4	-46.389	18.319	59.052	-1.058	50.175	245.942	86.734
(E) 5.0 TOL.	4	104.661	4	-35.765	23.456	52.306	4.080	54.172	251.080	86.394
(F) 6.0 TOL.	5	124.211	3	-11.139	33.769	51.508	14.392	51.309	261.392	82.999
(G) 7.0 TOL.	6	156.611	2	-0.889	45.187 *	61.503	25.811	45.908	272.811	89.876
4-AND-9-AND-18 DAY										
(A) 0.0 TOL.	6	146.597	2	-13.744	46.446 *	66.945	27.070	84.047	274.070	106.400
(B) 1.0 TOL.	6	152.597	2	-11.544	48.025 *	67.360	28.649	86.393	275.648	107.168
(C) 2.0 TOL.	5	145.597	3	-4.094	52.244 *	68.719	32.867	80.846	279.867	107.583
(D) 3.0 TOL.	4	138.961	4	-21.389	50.906 *	71.272	31.530	81.338	278.530	111.542
(E) 4.0 TOL.	6	147.611	2	-26.889	54.544 *	66.489	35.167	82.020	282.167	104.698
(F) 5.0 TOL.	6	148.111	2	-45.389	54.356 *	72.995	34.980	75.287	281.980	107.595
(G) 6.0 TOL.	6	148.111	2	-43.139	49.169 *	72.256	29.792	70.845	276.792	104.997

*Significantly significant (α=.05) relative to zero.

Table 7.2. Summary of net annual futures returns, marketing returns, and total returns earned by using various moving averages to manage storage hedges until the 25th week of each marketing period; Concordia, 1971 to 1978; (cents per bu.).

MANAGED HEDGING ALTERNATIVE	ANNUAL RETURNS FROM FUTURES MARKET: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	ANNUAL MARKETING RETURN AVERAGE	ANNUAL MARKETING RETURN STD.DEV.	ANNUAL TOTAL RETURN AVERAGE	ANNUAL TOTAL RETURN STD.DEV.
5-AND-20 DAY										
(A) 1.0 TOL.	5	125.071	3	-25.583	21.630	47.307	52.684	91.303	299.684	125.423
(B) 1.5 TOL.	5	125.071	3	-21.833	21.594	46.615	52.647	88.480	299.647	122.666
(C) 2.0 TOL.	5	126.071	3	-27.905	22.759	48.563	53.812	86.107	300.812	124.167
(D) 2.5 TOL.	4	126.071	4	-14.505	22.715	47.276	53.769	81.848	300.769	120.619
(E) 3.0 TOL.	5	128.071	3	-14.505	22.965	48.286	54.019	81.982	301.019	118.641
(F) 3.5 TOL.	4	128.071	4	-13.005	24.855	49.066	55.909 *	78.393	302.908	119.881
(G) 4.0 TOL.	5	127.071	3	-13.005	23.746	50.416	54.800 *	80.101	301.800	117.973
5-AND-15 DAY										
(A) 1.0 TOL.	3	93.021	5	-25.083	10.996	42.510	42.050	107.967	289.050	124.761
(B) 1.5 TOL.	4	110.771	4	-31.083	16.436	46.318	47.490	103.678	294.490	129.552
(C) 2.0 TOL.	4	122.771	4	-30.583	18.259	49.212	49.312	101.340	296.312	130.288
(D) 2.5 TOL.	4	111.171	4	-13.755	17.040	43.170	48.894	101.300	295.894	126.466
(E) 3.0 TOL.	4	127.071	4	-13.755	16.671	46.942	47.725	92.939	294.725	121.994
(F) 3.5 TOL.	5	127.071	3	-14.755	18.053	46.061	49.106	86.213	296.106	120.307
(G) 4.0 TOL.	3	127.071	5	-16.005	16.265	46.515	47.319	86.653	294.319	120.534
3-AND-10 DAY										
(A) 1.0 TOL.	2	82.721	6	-113.051	-20.942	59.000	10.111	65.074	257.111	75.628
(B) 2.0 TOL.	2	88.471	6	-67.902	-15.407	50.150	15.646	76.854	262.646	88.842
(C) 3.0 TOL.	1	59.971	7	-54.451	-12.435	34.748	18.619	79.877	265.619	99.570
(D) 4.0 TOL.	2	72.871	6	-45.651	-1.710	37.170	29.344	80.079	276.344	107.300
(E) 5.0 TOL.	2	81.521	6	-43.651	-0.197	36.841	30.856	75.884	277.856	105.332
(F) 6.0 TOL.	2	93.671	6	-38.651	6.559	38.360	37.612	75.324	284.612	103.669
(G) 7.0 TOL.	3	126.071	5	-38.651	15.253	49.625	46.306	70.663	293.306	105.747
4-AND-9-AND-18 DAY										
(A) 0.0 TOL.	4	113.821	4	-20.205	13.080	41.805	44.134	82.344	291.134	114.908
(B) 1.0 TOL.	6	113.821	2	-16.005	15.853	40.672	46.906	83.979	293.906	114.038
(C) 2.0 TOL.	5	113.821	3	-16.005	17.471	40.999	48.525	81.078	295.525	118.272
(D) 3.0 TOL.	3	117.071	5	-20.333	19.490	47.748	50.544	81.386	297.543	120.016
(E) 4.0 TOL.	4	117.071	4	-25.833	19.953	47.059	51.006	83.128	298.006	117.382
(F) 5.0 TOL.	3	117.571	5	-44.333	21.603	52.831	52.656	86.925	299.656	123.517
(G) 6.0 TOL.	3	117.571	5	-42.083	20.634	53.441	51.687	83.776	298.687	121.503

* Statistically significant (α=.05) relative to zero.

ing week decreased average returns to futures trading, but substantially increased returns to marketing (Table 7.2); due to average returns on the cash position being $0.311 instead of -$0.194.

Variations of 5-and-20 day moving average managed hedging produced average marketing returns ranging from $0.526 to $0.559 while average marketing returns to variations of 5-and-15 day and 4-and-9-and-18 day moving averages ranged from $0.421 to $0.527. The only average marketing return statistically significant (α=.05) was earned by using a 3.5 cent tolerance with the 5-and-20 day alternative. Total returns were again generally more variable than cash prices at harvest, however none were significantly different (α=.05).

Because both the observed differences and sample size (number of years included) are small, it would be impossible to conclude that any of the four basic moving average alternatives produce the "best" managed hedging results. The relative performance of each moving average may vary from year to year in response to different patterns of price movement, etc. The only alternative offering apparent reason for discrimination is the 3-and-10 day moving average, which produced generally small and/or negative futures and marketing returns when tolerances of less than 5.0 cents were used. Increasing the size of the tolerance was most effective in increasing returns when applied to 3-and-10 day moving averages, but had minimal effect on the 5-and-20 day.

To facilitate comparison between managed storage hedging and previously examined marketing alternatives, and to further investigate the effect that length of marketing period has on managed hedging effectiveness, annual returns to managed hedging using a 5-and-20 day moving average with a 3.0

Table 7.3. Net marketing returns to using 5-and-20 day moving averages with a 3.0 cent tolerance to manage storage hedges from harvest until the indicated marketing week, and standard deviations of resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	1	3.550	1	-14.800	-1.406	5.553	94.880
2	5	41.088	3	-12.415	3.051	16.597	95.473
3	4	75.176	4	-23.490	4.739	30.210	95.459
4	5	66.264	3	-29.035	7.690	31.628	92.419
5	5	78.352	3	-19.872	14.601	36.762	96.316
6	4	146.629	4	-24.024	25.354	58.161	102.750
7	5	148.014	3	-28.269	30.327	62.673	104.898
8	5	185.401	3	-42.313	36.418	77.184	110.123
9	5	184.786	3	-47.558	33.906	74.221	106.280
10	5	139.171	3	-46.803	27.848	61.824	98.198
11	5	170.558	3	-42.547	34.708	71.993	104.382
12	5	212.943	3	-44.292	42.696	83.922	108.914
13	6	196.330	2	-42.537	38.201	76.082	104.330
14	6	167.915	2	-20.782	38.558	65.358	102.847
15	7	163.800	1	-20.301	38.767	60.142	105.293
16	7	166.187	1	-17.043	39.255	59.432	103.820
17	7	169.572	1	-9.037	41.525*	58.835	108.454
18	7	187.959	1	-7.780	45.919*	64.385	110.462
19	7	193.344	1	-9.022	47.018*	65.911	110.316
20	6	196.729	2	-3.265	47.240*	68.415	107.326
21	6	182.116	2	-6.345	43.201*	64.447	104.067
22	6	201.501	2	-5.502	46.960	70.561	107.471
23	6	212.886	2	-4.244	49.980	74.876	108.663
24	5	238.273	3	-7.237	55.593	84.078	114.569
25	5	234.658	3	-8.231	54.019	81.982	119.641
26	5	225.045	2	-8.473	62.239*	82.325	122.721
27	5	255.430	2	-8.716	64.299	92.980	129.209
28	5	253.815	2	-5.709	62.938	92.317	129.277
29	5	273.201	2	-9.701	66.105	99.685	135.235
30	5	249.587	2	-10.695	62.272	91.519	129.770
31	5	263.972	2	-11.588	63.132	96.831	132.769
32	5	252.559	2	-15.080	59.342	93.567	128.829
33	5	251.944	2	-15.073	58.760	91.807	132.348
34	4	271.329	3	-13.067	56.427	100.550	136.604
35	4	231.716	3	-26.060	50.587	89.449	125.524
36	4	183.101	3	-30.517	41.054	76.857	108.309
37	4	185.188	3	-28.195	41.372	72.874	114.039
38	4	194.573	3	-28.189	44.474	75.997	115.382
39	5	190.960	2	-30.181	43.927	74.267	117.131
40	5	184.845	2	-29.674	46.488	71.139	114.199
41	4	186.630	3	-29.167	46.462	73.346	110.706
42	4	190.617	3	-29.409	45.708	77.443	109.543
43	4	188.502	3	-30.281	41.589	78.470	109.817
44	4	192.389	3	-29.396	38.042	75.088	109.681

*Statistically significant (α=.05) relative to selling at harvest.

cent tolerance were computed and summarized for each marketing week (Tables A.9 and 7.3).

Again, marketing weeks one to twenty-five include returns from eight years while the remaining weeks do not reflect marketing returns for 1978-79. Even so, it appears that average returns increase steadily until the twenty-fifth week and then begin to decline from about the thirty-fifth week through the end of the period. The size of the greatest annual loss in any given week is generally small relative to its corresponding average return and greatest profit; and the ratio of annual profits to losses is also favorable, though because of the small sample firm conclusions that managed hedging does improve that ratio are unappropriate.

Chapter VIII

TWO-WAY SPECULATION

Introduction

Risk-bearing has, to this point, been considered only from the perspective of maintaining a net long position in either the cash or futures market. Alternatives have included (1) routine hedging where risk-bearing is never performed, (2) managed hedging where it is performed on a selective basis, and (3) routine risk-bearing by holding either long futures positions or unhedged inventories.

The objective of this section was to determine the results of routine risk-bearing when its definition is expanded to include holding either net long or net short positions in the market. Its purpose is not to advocate speculation, but simply to compare the results of risk-bearing in this manner with results of more conventional methods of risk-bearing. For simplicity, alternatives limiting risk-bearing to net long positions will be called "one-way", while alternatives allowing risk-bearing to be performed by holding either net long or net short positions will be termed "two-way."

The apparent advantage offered by two-way risk-bearing is that participants who are able to foresee price declines will be able not only to avoid losses, but to actually profit from such declines. On the other hand, it would seem that exposure to risk would also be magnified, perhaps more than offsetting any advantage associated with increased returns.

Individuals could attain net short positions in the cash market by contracting to sell grain they do not have title to, however, futures trading offers a much simpler alternative. Two-way risk-bearing may be performed in conjunction with storage functions by following managed hedging procedures identical to those for one-way risk-bearing, except that short futures positions will be twice as large.[1] Ideally, the commodity will remain unhedged when prices rise, but a short position twice the size of the actual cash position will be taken if tures prices are expected to decline. This marketing practice will be referred to in this writing as "two-way storage speculation."

If storage functions are not performed, the commodity is sold in the cash market at harvest and "two-way speculation" is pursued by taking either long and short positions in the futures market. Theoretically, returns to the two speculative strategies will differ only by the amount of market payment for storage.

Methodology

A 5-and-20 day moving average with 3.0 cent crossover tolerance was used to predict price trends and select corresponding long and short positions.

Marketing profits realized by two-sided storage speculation were defined as:

$$(1) \quad MPSMS_n = MPUS_n + 2(SFP_n - HC_n)$$

Where: $MPSMS_n$ = marketing profit to storage and managed speculation through marketing week n,

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[1] Net long positions would be maintained by simply holding unhedged inventories; net short positions would be established by selling futures contract so that short futures commitments were twice as great as the inventory held.

SFP_n and HC_n = as defined in (3) of Chapter V, and (2) of Chapter VII, respectively.

Marketing profits to two-sided specualtion alone were defined as:

(2) $MPMS_n = SFP_n + LFP_n - (HC_n + \sum_{i=1}^{m} CM_i)$

Where: $MPMS_n$ = marketing profit to managed speculation through week n,

LFP_n = long futures profit through week n,

CM_i = round turn commission costs for long trade "i",

m = number of long futures positions taken.

LFP_n is defined as:

(3) $LFP_n = \sum_{i=1}^{m} (F_{t+d,i} - F_{t,i})$

Where: $F_{t,i}$ = the closing futures price on day "t" when position "i" was taken,

$F_{t+d,i}$ = the closing futures price on day "t+d" when position "i" was liquidated,

d = the number of days the long position was maintained.

Two-sided speculation with storage

Annual marketing returns earned for each marketing week by using a 5-and-20 day moving average with a 3.0 cent tolerance to manage two-sided storage speculation for the Concordia cash market are given in Table A.10 and are summarized in Table 8.1.

Average marketing returns were very similar to those from managed storage hedging with the same moving average strategy during the early marketing weeks (Table 7.3, page 65). After the first fifteen to eighteen weeks, average returns to two-sided storage speculation increased substantially relative to corresponding returns from managed hedging. There also appeared to be less tendency for average marketing returns to fall off in

the final weeks of the period; as profits earned from declines in futures prices during this time offset losses that would have accrued through both declining absolute price levels and declining market payments for storage. All marketing returns after the fifteenth week were significantly greater than zero (α=.05); with two of them significant at (α=.01).

Little difference was observed between the standard deviation of marketing returns to managed hedging and to two-sided storage speculation. Two-sided storage speculation had a slightly greater ratio of marketing profits to losses, however the difference was slight and no conclusions should be drawn from it. Standard deviations of total returns were generally greater for two-sided storage speculation, however only in one instance was it significantly greater than the standard deviation of harvest cash prices (α=.05).

The size of greatest annual losses provides indication of the additional risk involved with two-sided speculation relative to managed hedging. Although two-sided speculation reduced corresponding greatest losses in some instances, it increased them in others; reflecting its potential to double the either net profits or losses from futures trading.

Two-sided speculation without storage

As expected, two-sided speculation without storage produced results very similar to two-sided storage speculation (Tables A.11 and 8.2). Differences in average returns between the two alternatives reflect principally net profits or losses earned by performing the storage function, which were generally not significantly different from zero (α=.05) until the final weeks of the period (Table 6.2, page 50).

Again, all average marketing returns for weeks fifteen through forty-four were significantly greater than zero (α=.05). Standard deviations

Table 8.1. Net marketing returns to "two-way storage speculation" until the indicated marketing week (5-and-20 day moving average and 3.0 cent tolerance), and standard deviations of resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	1	7.100	1	-29.600	-2.812	11.105	94.965
2	4	41.037	4	-18.254	2.474	17.456	95.424
3	4	75.075	4	-23.632	4.474	31.113	95.976
4	6	66.112	2	-59.548	4.373	37.005	87.194
5	7	78.150	1	-46.862	15.317	36.674	91.704
6	7	133.131	1	-52.178	23.697	54.887	98.491
7	6	134.477	2	-56.494	33.766	60.267	100.569
8	6	171.823	2	-76.410	39.320	76.234	106.191
9	6	171.169	2	-81.726	37.920	74.242	103.183
10	6	125.515	2	-74.042	31.176	61.678	96.447
11	6	156.862	2	-72.356	38.893	71.768	103.906
12	6	199.207	2	-76.672	46.868	81.539	106.952
13	7	182.554	1	-78.988	42.999	76.134	104.919
14	7	128.300	1	-57.304	39.836	57.277	98.537
15	7	128.646	1	-26.620	37.378*	47.955	99.243
16	7	196.993	1	-31.936	48.352*	69.295	112.256
17	7	153.338	1	-19.252	46.514*	57.682	113.240
18	7	215.685	1	-20.566	58.051*	76.106	122.848
19	7	224.031	1	-19.882	61.120*	78.356	124.469
20	7	210.377	1	-40.198	63.812*	82.035	124.758
21	6	182.723	2	-40.214	59.856*	77.353	122.203
22	6	202.069	2	-32.430	62.873*	79.912	124.091
23	6	213.415	2	-26.746	65.660*	82.492	124.982
24	6	238.762	2	-3.614	75.760*	86.967	131.485
25	6	235.107	2	-7.184	76.984*	85.368	138.774
26	6	225.454	1	-2.761	89.274*	80.696	146.557
27	6	255.800	1	-3.156	90.969*	90.487	150.546
28	6	254.146	1	-4.550	89.393*	88.017	156.277
29	5	273.492	2	-2.944	94.016*	94.290	158.963
30	5	249.838	2	-4.339	96.782*	86.932	160.371
31	6	264.184	1	-7.733	98.220*	89.739	159.778
32	6	249.931	1	-7.128	93.644*	83.878	150.736
33	6	217.276	1	-6.522	86.339*	72.779	146.432
34	6	236.622	1	-6.917	81.105*	80.215	151.404
35	6	196.969	1	-6.311	77.429*	66.146	142.656
36	6	148.315	1	-7.705	67.652**	52.915	132.319
37	6	154.062	1	-8.100	68.148**	53.308	138.282*
38	6	217.407	1	-8.494	81.785*	72.122	146.806
39	6	232.754	1	-8.889	84.123*	78.075	151.200
40	6	259.100	1	-6.283	93.104*	85.385	156.728
41	6	258.246	1	-4.678	91.913*	83.604	151.041
42	6	266.792	1	-7.072	93.694*	87.482	151.835
43	6	273.138	1	-6.467	94.460*	92.511	157.743
44	6	292.485	1	-6.861	97.798*	98.784	163.137

*Statistically significant (α=.05) relative to selling at harvest.

**Statistically significant (α=.01).

Table 8.2. Net marketing returns to "two-way speculation" without storage until the indicated marketing week (5-and-20 day moving average and 3.0 cent tolerance), and standard deviations of resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

MKT. WEEK	ANNUAL RETURNS TO MARKETING FUNCTIONS: PROFITS NO.	PROFITS GREATEST	LOSSES NO.	LOSSES GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	STD.DEV. OF TOTAL RETURNS
1	3	3.550	2	-14.800	-2.537	7.139	94.540
2	3	9.050	5	-7.041	-0.614	5.123	96.209
3	2	51.999	6	-17.111	0.410	22.325	96.278
4	5	38.949	3	-47.313	0.633	27.401	88.937
5	6	45.742	2	-36.684	9.479	27.223	92.558
6	5	90.202	3	-35.755	21.605	39.105	95.646
7	6	135.662	2	-43.826	31.201	57.503	102.837
8	6	139.623	2	-63.696	32.759	66.563	104.129
9	6	159.583	2	-63.767	34.026	68.060	103.827
10	6	144.543	2	-56.838	32.403	63.231	102.473
11	5	179.504	3	-59.409	39.948	74.410	109.598
12	6	205.464	2	-61.980	45.778	80.516	111.628
13	6	185.425	2	-62.351	41.536	74.766	109.546
14	6	133.085	2	-34.922	41.454*	56.904	106.099
15	6	137.545	2	-9.028	37.536*	49.253	107.227
16	7	203.506	1	-3.583	49.809*	69.661	120.583
17	7	156.466	1	-3.889	45.927*	57.139	118.416
18	8	200.427	0	0.0	55.094*	69.203	124.973
19	7	203.387	1	-2.750	56.753*	71.313	126.915
20	6	186.347	2	-9.348	58.347*	71.089	124.413
21	6	177.508	2	-8.861	57.675*	71.441	126.260
22	6	195.468	2	-10.417	59.369*	74.633	128.125
23	7	210.428	1	-9.472	62.480*	78.295	128.720
24	6	238.389	2	-2.778	72.238*	84.462	134.382
25	6	249.349	2	-4.083	74.146*	88.322	142.344
26	5	230.310	2	-2.211	84.474*	82.739	150.756
27	5	266.270	2	-7.317	88.444*	95.716	158.158
28	5	271.230	2	-7.358	88.391*	96.249	165.626
29	5	281.190	2	-12.899	90.397*	99.370	166.034
30	5	259.151	2	-15.690	93.139*	93.061	167.369*
31	5	276.111	2	-10.231	94.038*	96.471	166.470
32	5	266.272	2	-8.522	92.430*	91.354	160.464
33	5	234.232	2	-8.313	86.632*	81.387	152.351
34	5	264.392	2	-6.604	86.338*	90.735	157.335
35	5	252.853	2	-3.736	86.599*	86.442	156.089
36	5	210.813	2	-11.686	80.034*	74.510	149.971
37	5	214.474	2	-4.727	78.426*	74.436	150.807
38	6	268.434	1	-1.287	90.032*	90.329	159.181
39	6	287.395	1	-0.434	94.213*	96.543	163.491
40	7	319.855	0	0.0	104.723*	105.166	170.278
41	7	317.215	0	0.0	103.582*	102.786	163.388
42	7	321.776	0	0.0	105.439*	103.953	165.364
43	7	330.236	0	0.0	108.659*	109.323	171.573
44	7	335.196	0	0.0	114.280*	117.440	177.976

*Statistically significant (α=.05) relative to selling at harvest.

of both marketing returns and total returns were slightly greater for two-sided speculation without storage than for two-sided speculation with storage; however only in one instance were total returns significantly more variable than annual harvest cash prices (α=.05).

Chapter IX

SUMMARY AND CONCLUSIONS

Forward-pricing

A comparison of the outcomes from the use of each forward-pricing strategy is shown in Table 9.1. Expressions of net futures profits and losses represent the difference between returns realized by using each strategy and the return that would have been realized by selling at harvest cash prices without any forward-pricing. Net futures losses do not necessarily imply that total returns were less than either the cost of production, or the total return expected when the production process began. Net futures losses do indicate that total returns from forward-priced production were less than the return that would have been received at harvest for unhedged wheat. In the same way, net futures profits indicate additional returns earned by forward-pricing, but do not necessarily imply that a production loss was avoided or that cash prices declined during the production period.[1]

Three factors provide useful information for comparing levels of risk: (1) variance of total returns; (2) the ratio of annual futures profits and losses; and (3) the size of annual futures losses, in an absolute sense, and relative to the size of profits.

None of the forward pricing alternatives succeeded in either increasing

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[1] It may be very probable that cash prices declined; however, within the constraints of basis theory, it is possible for futures prices to decline independently.

Table 9.1. Summary of results from all forward pricing alternatives with annual net futures market returns and standard deviations of resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

FORWARD-PRICING ALTERNATIVE	ANNUAL FORWARD-PRICING RETURNS FROM FUTURES MARKET: PROFITABLE YEARS NO.	PROFITABLE YEARS AVERAGE	PROFITABLE YEARS GREATEST	LOSING YEARS NO.	LOSING YEARS AVERAGE	LOSING YEARS GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	ALL YEARS C.V.[a]	ANNUAL TOTAL RETURNS STD.DEV.	ANNUAL TOTAL RETURNS C.V.[a]
UNHEDGED PROD.	*	*	*	*	*	*	*	*	*	95.119	39
ROUTINE HEDGING											
(A) 45 WKS.	4	78.840	137.614	4	-61.700	-91.696	8.570	87.850	1025	118.786	46
(B) 40 WKS.	4	65.116	136.466	4	-38.175	-73.375	13.470	68.318	507	119.369	46
(C) 30 WKS.	3	69.280	163.030	5	-23.999	-45.708	10.980	66.790	608	116.433	45
(D) 20 WKS.	5	42.674	83.500	3	-38.802	-66.557	12.121	52.764	435	123.471	48
(E) 10 WKS.	3	13.078	25.283	5	-21.454	-41.292	-8.268	22.646	274	89.225	37
SELECTIVE HEDG.											
(A) 150%(LOAN)	3	102.202	172.280	2	-115.830	-154.448	9.368	102.313	1092	110.546	43
(B) 175%(LOAN)	3	102.202	172.280	2	-100.078	-154.448	13.306	99.059	744	107.106	41
(C) 200%(LOAN)	2	67.162	119.409	2	-82.948	-154.448	-3.943	74.010	1876	98.302	40
(D) LOAN+$1.00	3	102.202	172.280	2	-93.354	-154.448	14.987	98.160	655	105.961	40
(E) LOAN+$1.50	4	80.922	172.280	1	-154.448	-154.448	21.159	96.160	454	103.540	39
(F) LOAN+$2.00	2	67.162	119.409	1	-106.774	-106.774	3.444	60.995	1762	99.499	40
MANAGED HEDGING 5-AND-20 DAY											
(A) 1.0 TOL.	4	92.630	132.253	4	-17.330	-33.229	37.650	66.230	176	131.706[b]	46
(B) 1.5 TOL.	4	112.993	135.430	4	-16.904	-30.108	48.044	72.023	150	147.706[b]	50
(C) 2.0 TOL.	5	84.494	153.930	3	-19.752	-28.858	45.402	73.327	162	146.006[b]	50
(D) 2.5 TOL.	5	83.904	122.836	3	-23.489	-38.608	43.632	69.969	160	141.903	49
(E) 3.0 TOL.	4	97.343	122.836	4	-20.967	-55.358	38.188	71.673	188	140.631	49
(F) 3.5 TOL.	4	107.580	156.480	3	-26.522	-59.358	43.844	79.214	181	148.971	51
(G) 4.0 TOL.	4	101.718	156.480	3	-27.189	-58.358	40.663	78.151	192	147.393	51

[a] Coefficient of variation.

[b] Statistically significant (α=.05) relative to unhedged production.

Table 9.1. (continued).

FORWARD-PRICING ALTERNATIVE	ANNUAL FORWARD-PRICING RETURNS FROM FUTURES MARKET: PROFITABLE YEARS NO.	PROFITABLE YEARS AVERAGE	PROFITABLE YEARS GREATEST	LOSING YEARS NO.	LOSING YEARS AVERAGE	LOSING YEARS GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	ALL YEARS C.V.[a]	ANNUAL TOTAL RETURNS STD.DEV.	ANNUAL TOTAL RETURNS C.V.[a]
5-AND-15 DAY											
(A) 1.0 TOL.	5	64.524	123.203	3	-15.389	-29.729	34.557	55.098	159	124.846	44
(B) 1.5 TOL.	4	78.343	126.703	4	-8.954	-21.029	34.694	53.215	154	124.999	44
(C) 2.0 TOL.	4	76.706	138.103	4	-9.117	-13.329	33.794	54.628	162	122.936	44
(D) 2.5 TOL.	5	61.644	140.253	3	-12.989	-13.379	33.657	56.123	167	122.513	44
(E) 3.0 TOL.	4	78.606	143.403	2	-18.894	-28.358	34.579	59.461	172	120.156	43
(F) 3.5 TOL.	4	80.918	134.153	2	-30.394	-30.608	32.861	60.636	185	124.345	44
(G) 4.0 TOL.	4	78.418	134.153	2	-31.794	-41.358	31.261	60.476	193	122.127	44
3-AND-10 DAY											
(A) 1.0 TOL.	4	48.170	92.253	4	-20.844	-53.979	13.663	51.178	374	103.245	40
(B) 2.0 TOL.	4	52.020	106.086	4	-29.206	-40.079	11.557	56.233	487	103.996	40
(C) 3.0 TOL.	3	71.197	103.103	3	-37.736	-51.379	12.548	54.720	436	102.505	39
(D) 4.0 TOL.	3	63.947	93.858	3	-38.902	-52.108	9.392	53.718	572	104.417	41
(E) 5.0 TOL.	4	68.018	129.003	2	-49.994	-55.608	21.511	66.540	309	115.604	43
(F) 6.0 TOL.	4	72.868	140.403	2	-33.108	-41.929	28.179	64.267	228	115.641	42
(G) 7.0 TOL.	2	145.220	146.803	4	-22.976	-36.329	24.817	75.466	304	112.557	41
4-AND-9-AND-18 DAY											
(A) 0.0 TOL.	4	87.268	126.003	4	-18.616	-29.327	34.326	35.835	192	131.974	47
(B) 1.0 TOL.	5	76.344	123.563	3	-19.555	-26.608	40.382	62.918	156	133.321	46
(C) 2.0 TOL.	4	87.780	117.253	3	-13.296	-30.358	38.904[b]	57.025	147	127.819	45
(D) 3.0 TOL.	4	98.080	132.153	2	-28.668	-45.608	51.873	68.148	163	137.803	48
(E) 4.0 TOL.	4	90.530	129.230	2	-45.544	-67.858	33.879	73.993	218	138.325	49
(F) 5.0 TOL.	4	102.806	128.930	2	-38.544	-45.979	51.767	69.269	166	138.388	48
(G) 6.0 TOL.	4	94.256	138.803	2	-46.344	-81.329	35.542	78.782	222	139.222	49

[a] Coefficient of variation.

[b] Statistically significant (α=.05) relative to unhedged production.

average total returns without increasing variability, or in decreasing variability without decreasing average returns. Variability of total returns from forward-pricing exceeded the variability of returns to unhedged production for all alternatives except routine hedging ten weeks prior to harvest, which had an average futures loss. None of the returns were significantly more variable than returns from unhedged marketing at harvest (α=.05).

Little evidence was found to indicate that routine forward-pricing could be used to improve either long-run returns or risk levels relative to unhedged production; although short-run risk-shifting benefits may be realized by knowing, in advance, prices that will be received at harvest.

Although selective forward-pricing has great theoretical appeal, its effectiveness is entirely dependent on the development of appropriate decision criteria. The average futures returns from selective hedging reported in Table 9.1, represent average returns for the eight year period, even though hedges were never applied in all eight years. Again, no significant differences were found (α=.05), relative to unhedged marketing at harvest, when selective criteria were based on futures price-loan rate relationships. There is obviously much room for additional work in the area of developing selective hedging criteria. However, as the amount of fundamental data incorporated in developing decision criteria increases, individual producers will probably have to rely much more heavily on the analysis of professional market advisory services.

Managed forward-pricing hedges were most effective, of the alternatives tested, at increasing annual returns; although only the 4-and-9-and-18 day moving average with a 2.0 cent tolerance produced a significant increase over unhedged returns (α=.05).

The greatest average returns were produced by 5-and-20 day and 4-and-9-and-18 day moving averages. Average returns from 5-and-15 day moving averages were somewhat less, but were also less variable. Three-and-ten day moving averages appeared to be least effective of the four. Results from varying the size of crossover tolerances indicate that the larger tolerances were often associated with greater average losses and more variable futures returns; although each moving average tends to respond differently to tolerance changes.

Managed hedges, particularly those using a 5-and-15 day moving average, appeared to be effective in limiting both the absolute and relative size of losing futures positions. They were not effective, however, at reducing the variability of total annual returns. Variability increased relative to unhedged production for each managed forward-pricing alternative, in a couple of instances increasing to statistically significant levels (α=.05).

Conclusions regarding the superiority of a particular moving average alternative would be impossible to make at this point. Even definite conclusions about the effectiveness of managed forward-pricing in general, would probably be premature considering the observed differences relative to the small sample size.

Post-harvest marketing

Table 9.2 compares returns earned by routinely using each basic post-harvest marketing alternative for 10, 25 and 40 weeks following harvest. None of the alternatives effectively reduced the variability of total annual returns relative to selling at harvest. Standard deviations of total returns generally increased as average total returns increased, however none of the returns were significantly more variable than harvest cash prices (α=.05).

Table 9.2. Summary of results from various post harvest marketing alternatives at the 10th, 25th and 40th marketing weeks, showing annual marketing returns and standard deviations of resulting total returns; Concordia, 1971 to 1978; (cents per bu.).

POST-HARVEST ALTERNATIVE	ANNUAL POST-HARVEST MARKETING RETURNS: PROFITABLE YEARS NO.	PROFITABLE YEARS AVERAGE	PROFITABLE YEARS GREATEST	LOSING YEARS NO.	LOSING YEARS AVERAGE	LOSING YEARS GREATEST	ALL YEARS AVERAGE	ALL YEARS STD.DEV.	ALL YEARS C.V.[a]	ANNUAL TOTAL RETURNS STD. DEV.	ANNUAL TOTAL RETURNS C.V.[a]
SELL AT HARVEST	*	*	*	*	*	*	*	*	*	95.119	39
STORAGE HEDGING											
WEEK 10	3	6.271	14.165	5	-6.341	-10.931	-1.612	8.062	500	94.535	39
WEEK 25	5	6.369	15.272	3	-3.632	-5.100	2.619	6.890	263	97.310	39
WEEK 40	1	6.380	6.380	6	-14.607	-46.755	-11.609	16.592	143	105.052	45
HOLD LONG FUT.											
WEEK 10	3	103.152	156.343	5	-24.102	-66.473	23.618	74.073	314	108.290	40
WEEK 25	5	69.229	231.749	3	-49.875	-143.929	24.565	105.446	429	115.325	42
WEEK 40	5	58.517	152.655	2	-123.850	-160.134	6.413	102.906	1605	92.863	37
UNHEDG. STORAGE ONE-TIME SALE											
WEEK 10	3	97.142	152.828	5	-19.053	-64.363	24.520	70.101	286	105.156	39
WEEK 25	5	78.678	234.209	3	-48.320	-136.302	31.054	104.008	335	116.431	42
WEEK 40	4	63.040	110.590	3	-84.353	-160.240	-0.129	93.406	72408	86.014	35
UNHEDG. STORAGE SEQUENTIAL SALE											
WEEK 10	3	65.471	100.414	5	-12.026	-40.881	17.035	47.424	278	100.496	38
WEEK 25	6	51.001	157.024	2	-45.376	-86.711	26.907	70.406	262	105.996	39
WEEK 40	4	81.201	185.619	3	-43.085	-105.570	27.936	89.629	321	112.273	41

[a] Coefficient of variation (percent).

Table 9.2. (continued).

POST-HARVEST ALTERNATIVE	ANNUAL POST-HARVEST MARKETING RETURNS: PROFITABLE YEARS NO.	AVERAGE	GREATEST	LOSING YEARS NO.	AVERAGE	GREATEST	ALL YEARS AVERAGE	STD.DEV.	C.V.[a]	ANNUAL TOTAL RETURNS STD.DEV.	C.V.[a]
MANAGED STORAGE HEDGING											
WEEK 10	5	57.411	139.171	3	-21.423	-46.803	27.848	61.824	222	98.198	36
WEEK 25	5	89.997	234.658	3	-5.945	-8.231	54.019	81.982	152	118.641	39
WEEK 40	5	72.450	184.845	2	-18.418	-29.674	46.488	71.189	153	114.199	39
TWO-WAY SPEC. WITH STORAGE											
WEEK 10	6	55.181	125.515	2	-40.836	-74.042	31.176	61.678	198	96.447	35
WEEK 25	6	104.403	235.107	2	-5.276	-7.184	76.984[b]	85.368	111	138.774	43
WEEK 40	6	109.668	259.100	1	-6.283	-6.283	93.104[b]	85.385	92	156.728	46
TWO-WAY SPEC. W/O STORAGE											
WEEK 10	6	55.177	144.543	2	-35.919	-56.838	32.403	63.231	195	95.816	34
WEEK 25	6	99.969	249.349	2	-3.323	-4.083	74.146[b]	88.322	119	134.299	42
WEEK 40	7	104.723	319.855	0	0.0	0.0	104.723[b]	105.166	100	155.435	44

[a] Coefficient of variation (percent).

[b] Statistically significant (α=.05) relative to selling at harvest.

Routine storage hedging results indicate that individuals who perform storage functions for up to approximately 30 weeks following harvest, in the long run, earn market payments through basis changes that equal the sum of interest, commercial storage and hedging costs. Market payments to storage were generally less than these costs when grain was stored longer than 30 weeks. Inventory holders may still benefit by storing grain, through storage hedging or otherwise, if (1) they have access to storage facilities where storage costs are lower than commercial rates, or (2) they realize convenience yields through income flow management, etc. Additional study is needed to develop methods of predicting basis changes, which would allow selective storage decisions to be made by comparing predicted basis changes with expected carrying costs.

Returns to routine risk-bearing, performed by establishing and holding a long futures position following harvest, returned an average profit for the eight year period. However the hypothesis that long-run returns to routine risk-bearing are zero, could not be rejected.

Average returns to unhedged storage, equal to the sum of corresponding returns from hedged storage and from routine risk-bearing, were likewise generally positive but not significantly greater than zero (α=.05). Risk levels of unhedged storage were very similar to holding long futures positions, in terms of both the range and standard deviation of marketing returns.

Sequential marketing, by selling equal portions of the unhedged inventory each week, did decrease both the range and variability of marketing returns relative to "one-time" marketing of unhedged production. Returns from sequential marketing were comparable to returns from unhedged marketing; but, despite their reduced variability, none were statistically significant (α=.05).

Managed storage hedging again appears to be an attractive alternative to both selling at harvest and to unhedged storage. Statistical evidence, however, fails to satisfactorily substantiate the superiority of managed hedging using the 5-and-20 day moving average with a 3.0 cent tolerance; as only 5 of the 44 marketing weeks produced returns significantly greater than zero (α=.05).[2] In terms of risk, managed hedging increased the variability of total annual returns relative to selling at harvest, but reduced the variability of marketing returns and the size of marketing losses relative to unhedged storage. Again, the relatively small sample size coupled with only marginally different returns, prevent declaring managed hedging as a superior marketing alternative. The differences were sufficient, however, to indicate the potential benefits of managed hedging could not be readily discounted.

The same problem arises when drawing conclusions about the results of two-way speculation, although these strategies present the strongest statistical evidence for superiority. Average marketing returns were significant (α=.05) from the 15th through 44th weeks in each alternative. Standard deviations of total annual returns were increased relative to selling at harvest, but the difference was significant (α=.05), only in one marketing week. Despite the statistical results, endorsement of two-way speculation should not be assumed.

Table 9.3 provides an indication of the risk and/or effectiveness of each marketing alternative from a qualitative standpoint. It reflects the number of opportunities to earn marketing profits created annually by

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[2]For a comparison of results from hedges managed with other moving average strategies, the reader is referred to Chapter VII and Tables 7.1 and 7.2.

Table 9.3. The number of marketing weeks each year where positive net marketing returns were earned by the indicated marketing alternative, (43 possible 1971-72 through 1977-78, 24 possible 1978-79).

Marketing Alternative	Marketing Year							
	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79
Routine Storage Hedging*	17	9	26	10	17	16	41	20
Routine Storage Hedging**	5	11	20	14	3	26	40	12
Holding Long Futures	6	43	41	15	43	0	28	7
Unhedged Storage* (one-time sale)	0	43	42	15	43	1	35	11
Unhedged Storage* (sequential sale)	0	43	42	15	43	1	31	8
Managed Storage Hedging*	23	43	41	17	43	1	42	11
Two-way Speculation* (w/storage)	24	43	41	20	43	41	41	10
Two-way Speculation (w/o storage)	26	40	41	26	43	43	28	1

*At Concordia

**At Garden City

each alternative, without considering profits or losses quantitatively. An alternative would be considered most effective by creating profit opportunities each week (forty-three annually), and least effective if no profit opportunities are created.

Only in three years were at least fifty percent of the marketing opportunities profitable when routine storage hedging was used; however, profitable opportunities were always available for at least nine weeks. As would be expected, the number of profit opportunities created by routine (one-way) risk-bearing alternatives varies greatly from year to year as price trends change. Two-way speculative alternatives generally produced the most numerous and most consistent number of profit opportunities, with less than twenty opportunities for profit occurring only during the 1978-79 marketing period.

The first half of the tested hypothesis, that marketing alternatives created by using futures markets may be used to reduce the variability of total annual returns without a corresponding reduction in the level of annual returns, would have to be rejected (α=.05). None of the forward-pricing or post-harvest marketing alternatives were found to be effective at reducing the variability of total annual returns.

With reference to the second half of the hypothesis, that the level of returns could be increased without a corresponding increase in variability, the results were less conclusive. Managed forward-pricing, managed storage hedging and two-way speculation each produced at least one instance where annual returns were increased significantly (α=.05), while increases in the variability of annual returns were not significant (α=.05). However, only the two-way speculative alternatives achieved this result with any consistency.

Although this study reflects actual results of using various forward-pricing and post-harvest marketing alternatives for the given eight year period, these results could be misleading in several ways when used to formulate expectations about returns in future years. First, results earned in a given year by using a particular strategy may differ considerably from the average results earned by using the same strategy over a period of several years. For example, using a 5-and-20 day moving average with a 3.0 cent tolerance to manage storage hedges until the 25th marketing week produced an average marketing profit of $0.540; however, the strategy produced net losses in 3 of the 8 years. Secondly, there is reason to believe that the behavior of prices during future years will resemble price behavior during this eight year period; implying that both the average and range of future returns could be considerably different from their historic counterparts.

Finally individuals should consider unique problems and secondary effects that may result from using a particular marketing alternative. For example, income tax treatment of futures profits (losses) earned by different alternatives may vary as to whether they are treated by the Internal Revenue Service (IRS) as ordinary or capital gains (losses). IRS treatment of losses from managed hedging may make a significant difference in its profitability.

Additionally individuals should have a thorough understanding of futures market operations and terminology. Misunderstandings involving stop-loss orders, capital requirements, risk calculations, etc. can lead to disastrous conclusions.

Although this study could be continued indefinitely by attempting to analyze all possible variations of marketing alternatives, this writer would

expect little additional benefit to be gained by such effort until a longer price series is available and/or a fundamental change in market conditions takes place.

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APPENDIX

Statistical Procedure

Because annual returns from selling unhedged wheat in the cash market at harvest were correlated with annual returns earned by using the various alternatives, often significant correlation at (α=.05) and (α=.01), the ordinary F-test was invalid for determining significance of variance. Instead, significance of variance was determined by testing for significant correlation between D and S for each pair of returns, R_1 and R_2, defined as:

$$(1)\quad D = R_2 - R_1, \text{ and}$$

$$(2)\quad S = R_2 + R_1$$

Where: R_1 = the annual return earned by selling unhedged production at harvest cash prices, and

R_2 = the annual return earned by using the applicable forward-pricing and post-harvest marketing alternative.

The formula used for computing the correlation between D and S was:

$$(3)\quad r_{DS} = (F-1)/\sqrt{(F+1)^2-4r^2F}$$

Where: r_{DS} = sample correlation coefficient between D and S,

F = (variance of R_2 / variance of R_1), and

r = the sample correlation between R_2 and R_1.

The significance of differences in average annual returns was determined by using an ordinary t-distribution test:

$$(4)\quad t = \frac{\bar{x}-u}{s/\sqrt{n}}$$

Where: $\bar{x}$ = the mean observed difference between returns,

μ = zero, the hypothesised difference,

s = standard deviation of the difference, and

n = the number of observations (years in this case).

Table A.1. Futures market returns earned annually during the study period by managing forward-pricing hedges.

MOVING AVG. ALTERNATIVE	FUTURES MARKET RETURNS IN PRODUCTION YEAR 1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	AVERAGE	STD.DEV.
5-AND-20 DAY										
(A) 1.0 TOL.	-2.102	-7.129	-33.229	78.280	123.286	36.703	132.253	-26.858	37.650	66.231
(B) 1.5 TOL.	-0.552	-13.129	-23.829	135.430	112.036	76.503	128.003	-30.108	48.044	72.024
(C) 2.0 TOL.	2.798	-14.769	-15.629	153.930	107.036	28.953	129.753	-28.858	45.402	73.327
(D) 2.5 TOL.	2.148	-12.479	-19.379	121.930	122.806	50.103	122.503	-38.608	43.628	69.964
(E) 3.0 TOL.	-6.102	-12.479	-9.929	116.680	122.836	28.353	121.503	-55.358	38.188	71.673
(F) 3.5 TOL.	*	-13.229	-6.979	156.480	114.586	28.353	130.903	-59.358	43.844	79.214
(G) 4.0 TOL.	*	-13.229	-9.979	156.480	106.636	16.603	127.153	-58.358	40.663	78.151
5-AND-15 DAY										
(A) 1.0 TOL.	1.448	-5.829	-29.729	78.480	85.186	34.303	123.203	-10.608	34.557	55.098
(B) 1.5 TOL.	-0.302	-7.379	-21.029	87.080	62.236	37.353	126.703	-7.108	34.694	53.215
(C) 2.0 TOL.	-0.302	-12.479	-13.329	76.280	60.736	31.703	138.103	-10.358	33.794	54.628
(D) 2.5 TOL.	2.398	-12.479	-13.379	77.530	66.836	21.203	140.253	-13.108	33.657	56.123
(E) 3.0 TOL.	*	*	-9.429	64.280	92.286	14.453	143.403	-28.358	34.579	59.461
(F) 3.5 TOL.	*	*	-30.179	76.280	90.536	22.703	134.153	-30.608	32.861	60.636
(G) 4.0 TOL.	*	*	-22.229	66.780	91.036	21.703	134.153	-41.358	31.261	60.477
3-AND-10 DAY										
(A) 1.0 TOL.	1.748	-4.079	-53.979	-16.470	89.036	-8.847	92.250	9.642	13.663	51.158
(B) 2.0 TOL.	4.398	-18.929	-40.079	-26.720	106.086	-31.097	90.653	8.142	11.557	56.233
(C) 3.0 TOL.	*	*	-51.379	-38.220	75.586	34.903	103.103	-23.608	12.548	54.720
(D) 4.0 TOL.	*	*	-47.879	-16.720	80.686	17.303	93.853	-52.108	9.392	53.718
(E) 5.0 TOL.	*	*	-44.379	2.080	109.536	31.453	129.003	-55.608	21.511	66.541
(F) 6.0 TOL.	*	*	-41.929	5.580	108.786	36.703	140.403	-24.108	28.179	64.268
(G) 7.0 TOL.	*	*	-36.329	-29.920	143.636	-7.047	146.803	-18.608	24.817	75.466
4-AND-9-AND-18 DAY										
(A) 0.0 TOL.	-6.602	-11.929	-29.327	82.330	122.586	18.153	126.003	-26.608	34.326	65.835
(B) 1.0 TOL.	1.198	-11.929	-20.129	84.130	123.536	53.103	119.753	-26.608	40.382	62.918
(C) 2.0 TOL.	-1.102	*	-8.429	85.430	104.336	44.103	117.253	-30.358	38.904	57.025
(D) 3.0 TOL.	*	*	-11.729	129.230	93.586	37.353	132.153	-45.608	41.873	68.148
(E) 4.0 TOL.	*	*	-23.229	129.230	97.386	8.603	126.903	-67.858	33.879	73.993
(F) 5.0 TOL.	*	*	-45.979	102.730	113.936	65.653	128.903	-31.108	41.761	69.269
(G) 6.0 TOL.	*	*	-81.329	102.730	130.236	5.253	138.803	-11.358	35.542	78.782

*No hedges placed.

Table A.2. Futures market returns earned annually during the study period by managing post-harvest storage hedges for the duration of each marketing period.

MOVING AVG. ALTERNATIVE	FUTURES MARKET RETURNS IN MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
5-AND-20 DAY										
(A) 1.0 TOL.	4.399	-22.244	126.797	124.450	51.330	137.161	3.235	-25.583	49.943	69.936
(B) 1.5 TOL.	1.239	-18.494	119.797	121.450	53.330	147.311	5.735	-21.833	51.067	69.320
(C) 2.0 TOL.	4.809	-22.744	114.797	121.450	55.980	146.561	3.235	-9.583	51.813	67.303
(D) 2.5 TOL.	-0.941	-18.744	109.597	124.950	55.480	146.311	-6.515	-2.583	50.944	67.345
(E) 3.0 TOL.	0.809	-1.344	109.597	107.450	58.480	145.561	-2.265	-2.083	52.026	61.555
(F) 3.5 TOL.	1.179	-0.844	99.597	118.950	62.730	148.961	-2.515	-2.333	53.216	62.737
(G) 4.0 TOL.	0.809	4.406	99.597	100.450	60.980	147.961	-9.015	-3.333	50.232	60.412
5-AND-15 DAY										
(A) 1.0 TOL.	5.109	-23.994	178.697	99.100	1.930	106.361	-3.765	-26.139	42.162	75.732
(B) 1.5 TOL.	1.729	-23.744	170.497	136.900	1.930	124.861	-5.515	-32.139	46.815	82.377
(C) 2.0 TOL.	2.309	-17.294	170.997	144.150	2.430	135.111	-5.015	-31.639	50.131	84.097
(D) 2.5 TOL.	0.309	-22.044	168.497	129.150	-1.320	132.411	8.235	-2.639	51.575	77.355
(E) 3.0 TOL.	0.309	-14.294	127.997	110.650	-3.820	152.961	-8.015	-4.639	45.144	71.739
(F) 3.5 TOL.	-6.811	-4.344	110.997	119.200	-8.320	148.961	-4.515	-3.389	43.972	69.092
(G) 4.0 TOL.	-0.741	-5.844	121.797	120.200	-8.320	148.961	-12.765	-4.389	44.862	71.371
3-AND-10 DAY										
(A) 1.0 TOL.	0.769	-7.194	-42.303	24.600	-8.570	95.161	18.485	-37.389	5.445	43.225
(B) 2.0 TOL.	6.179	-18.194	7.497	43.350	1.230	103.311	7.985	-50.889	12.559	45.310
(C) 3.0 TOL.	-0.941	-7.044	8.297	93.800	-6.620	82.961	-2.515	-42.889	15.631	47.412
(D) 4.0 TOL.	-0.741	-16.794	6.097	121.850	8.530	96.011	-22.015	-46.389	18.319	59.052
(E) 5.0 TOL.	-0.741	-11.594	26.397	98.150	23.680	104.661	-35.765	-17.139	23.456	52.306
(F) 6.0 TOL.	-0.741	-0.894	31.397	103.650	19.930	124.211	3.735	-11.139	33.769	51.508
(G) 7.0 TOL.	-0.741	0.356	40.897	124.950	29.830	156.611	10.485	-0.889	45.187	61.503
4-AND-9-AND-18 DAY										
(A) 0.0 TOL.	0.679	-13.744	146.597	103.200	10.330	126.911	5.235	-7.639	46.446	66.945
(B) 1.0 TOL.	0.359	-11.544	152.597	103.200	10.330	125.661	12.735	-9.139	48.025	67.360
(C) 2.0 TOL.	-0.741	-4.094	145.597	123.200	10.330	135.311	8.985	-0.639	52.244	68.719
(D) 3.0 TOL.	-0.741	-4.094	135.597	118.700	60.230	138.961	-20.015	-21.389	50.906	71.272
(E) 4.0 TOL.	-0.741	11.356	135.597	103.450	53.480	147.611	12.485	-26.889	54.544	66.489
(F) 5.0 TOL.	-0.741	11.356	116.597	143.050	51.380	148.111	10.485	-45.389	54.356	72.995
(G) 6.0 TOL.	-0.741	1.856	106.597	139.300	35.880	148.111	5.485	-43.139	49.169	72.256

Table A.3. Futures market returns earned annually during the study period by two-way speculation (w/o storage) for the duration of each marketing period.

MOVING AVG. ALTERNATIVE	FUTURES MARKET RETURNS IN MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
5-AND-20 DAY										
(A) 1.0 TOL.	10.539	20.806	380.096	128.450	110.080	108.811	21.235	-41.583	92.304	130.654
(B) 1.5 TOL.	5.839	28.306	366.096	122.450	114.080	129.111	26.235	-33.083	94.879	124.960
(C) 2.0 TOL.	14.229	19.806	361.096	122.450	119.380	127.611	21.235	-11.583	96.778	120.814
(D) 2.5 TOL.	2.729	28.206	355.196	129.450	118.380	127.111	5.235	-4.083	95.278	120.307
(E) 3.0 TOL.	4.479	62.606	355.196	107.450	128.380	125.611	16.235	-4.083	99.484	116.504
(F) 3.5 TOL.	6.099	63.606	335.196	117.450	132.880	132.411	22.735	-3.583	100.849	109.928
(G) 4.0 TOL.	6.359	74.106	335.196	80.450	129.380	108.411	8.235	6.417	93.569	108.838
5-AND-15 DAY										
(A) 1.0 TOL.	8.509	15.556	473.096	75.250	32.180	58.111	15.235	-49.639	78.537	163.690
(B) 1.5 TOL.	1.729	16.056	456.696	150.850	32.180	95.111	3.735	-61.639	86.840	162.636
(C) 2.0 TOL.	7.979	28.956	457.696	165.350	33.180	115.611	4.735	-62.139	93.921	162.792
(D) 2.5 TOL.	3.979	19.456	452.696	135.350	25.680	99.211	31.235	-4.139	95.433	152.260
(E) 3.0 TOL.	5.229	34.956	371.696	98.350	20.680	128.411	2.235	-4.889	82.083	126.561
(F) 3.5 TOL.	-6.811	54.856	337.696	115.450	11.680	120.411	18.735	-5.639	80.797	115.397
(G) 4.0 TOL.	-0.741	51.856	369.296	117.450	11.680	120.411	2.235	6.361	84.818	125.351
3-AND-10 DAY										
(A) 1.0 TOL.	-2.051	51.856	51.897	-75.750	13.180	24.811	61.735	-60.639	8.130	51.925
(B) 2.0 TOL.	8.769	29.856	151.497	-38.250	32.780	41.111	40.735	-87.639	22.357	69.167
(C) 3.0 TOL.	-5.471	51.456	153.097	62.650	17.080	0.411	19.735	-71.639	28.415	64.803
(D) 4.0 TOL.	-5.071	31.956	148.697	118.750	47.380	26.511	-29.265	-72.139	33.352	73.064
(E) 5.0 TOL.	-0.741	42.356	189.297	71.350	77.680	43.811	-40.265	-22.389	45.137	72.206
(F) 6.0 TOL.	-0.741	63.756	193.297	82.350	70.180	82.911	38.735	-9.139	65.169	62.813
(G) 7.0 TOL.	-0.741	39.006	212.297	124.950	60.080	147.711	46.485	10.111	79.987	74.366
4-AND-9-AND-18 DAY										
(A) 0.0 TOL.	4.719	35.306	409.646	72.450	32.080	90.311	33.985	-13.139	83.170	136.016
(B) 1.0 TOL.	4.079	37.206	442.696	72.450	32.080	87.811	40.735	-16.139	87.615	147.299
(C) 2.0 TOL.	2.929	45.356	428.696	112.450	32.080	93.111	32.735	13.861	95.152	139.909
(D) 3.0 TOL.	-0.741	38.356	408.696	103.450	131.880	90.411	-21.765	-29.139	90.143	141.970
(E) 4.0 TOL.	-0.741	49.256	408.696	89.750	118.380	107.711	52.735	-39.639	98.268	136.397
(F) 5.0 TOL.	-0.741	61.006	370.696	168.950	114.180	126.711	46.485	-58.139	103.643	130.044
(G) 6.0 TOL.	-0.741	42.706	350.696	161.450	83.180	118.671	36.485	-53.639	92.351	124.130

Table A.4. Annual marketing returns earned by routine storage hedging from harvest until the indicated marketing week, Concordia.

MKT. WEEK	POST-HARVEST MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	-0.700	-0.700	-0.800	-0.800	-0.900	-0.900	-1.000	-1.000	-0.850	0.120
2	-3.077	-2.628	1.085	1.955	18.188	0.607	7.991	-3.015	2.638	7.268
3	-1.704	-2.807	7.472	3.710	9.276	2.615	9.231	0.971	3.555	4.721
4	-1.332	-2.860	14.857	-1.035	13.364	-3.879	11.472	-3.044	3.443	8.207
5	-0.084	-6.164	18.244	-1.779	19.452	-8.872	13.212	7.942	5.244	11.011
6	2.914	-15.093	56.129	-6.024	6.540	-7.614	9.953	10.677	7.185	21.791
7	1.412	-11.021	12.014	-2.269	0.628	-2.857	11.943	7.913	2.220	7.994
8	2.159	-12.200	45.401	-1.513	-4.284	-3.851	13.434	10.398	6.193	17.857
9	0.032	-11.378	24.786	-6.758	-17.196	1.406	16.174	7.884	1.869	14.056
10	0.280	-10.931	-5.829	-6.603	-8.108	-0.836	14.165	4.369	-1.612	8.062
11	1.278	-9.735	-9.442	-1.747	1.480	-4.829	9.155	2.354	-1.436	6.403
12	2.401	-4.663	6.943	-3.492	0.068	-5.073	8.646	0.840	0.709	5.142
13	2.648	-4.342	10.330	-6.237	-5.844	-2.315	5.386	7.325	0.869	6.410
14	2.521	-5.770	9.215	-11.982	-0.256	-5.558	4.377	9.561	0.264	7.645
15	4.769	-6.449	5.100	-13.227	0.332	-9.301	4.117	11.045	-0.452	8.360
16	3.892	-7.878	7.487	-22.472	-5.580	-6.043	5.357	10.531	-1.838	10.813
17	0.014	-8.806	10.872	-15.717	-3.492	2.213	6.848	9.766	0.212	9.272
18	0.887	-7.735	29.259	-19.961	1.596	3.220	8.588	4.752	2.576	13.997
19	1.685	-3.663	34.644	-19.206	-0.316	1.978	10.079	6.487	3.986	15.150
20	0.383	-5.091	38.029	-20.451	2.272	7.735	12.569	5.222	5.083	16.622
21	0.131	-2.020	18.416	-21.945	-2.140	5.241	14.560	2.958	1.900	12.240
22	0.378	1.052	19.801	-18.440	0.448	5.498	14.800	2.443	3.247	11.367
23	-0.749	-1.127	16.186	-16.185	1.036	6.756	18.041	0.429	3.048	10.848
24	-2.501	-3.306	13.573	-6.929	6.624	3.763	19.281	-2.836	3.459	9.193
25	-4.753	0.266	-1.042	8.326	5.212	2.769	15.272	-5.100	2.619	6.890
26	-4.381	7.337	8.345	7.081	0.800	2.527	12.012		4.817	5.503
27	-4.383	11.909	2.730	5.836	-9.112	1.534	10.753		2.752	7.643
28	-4.635	9.481	-3.884	-0.409	-6.024	-0.709	11.994		0.831	7.100
29	-3.387	10.052	5.502	3.846	-3.186	-1.201	11.734		3.337	6.177
30	-4.139	8.624	3.887	4.601	-3.348	0.305	14.725		3.522	6.697
31	-5.267	10.945	1.273	3.357	0.740	0.812	16.465		4.046	7.281
32	-5.894	7.766	-2.341	-3.868	-1.172	-1.680	17.456		1.464	8.262
33	-5.896	-12.662	-2.955	5.367	-4.334	-1.673	20.946		-0.172	10.745
34	-6.773	-27.641	-14.570	0.623	-6.996	-2.667	21.687		-5.220	15.107
35	-6.526	-20.019	-42.683	-7.622	-9.408	-3.910	24.427		-9.392	20.026
36	-9.528	-9.572	-49.298	-28.117	-7.320	-4.902	21.668		-12.438	21.861
37	-10.530	-13.126	-46.412	-5.861	-10.982	-5.145	20.158		-10.271	19.521
38	-11.157	-9.679	-39.027	-4.106	-7.144	-5.139	17.149		-8.443	16.486
39	-12.409	-11.608	-40.640	-2.351	-8.306	-7.381	12.139		-10.079	15.840
40	-11.287	-10.911	-46.755	-4.346	-7.468	-6.874	6.380		-11.609	16.592
41	-12.039	-5.590	-44.870	-10.841	-6.380	-6.117	3.870		-11.710	15.494
42	-13.041	-4.269	-40.983	-12.086	-3.542	-6.609	-1.390		-11.703	13.622
43	-13.168	-12.947	-43.098	-19.081	-4.204	-6.103	-0.399		-14.143	14.245
44	-15.296	-15.001	-44.711	-16.825	-13.116	-6.346	1.091		-15.743	14.257

Table A.5. Annual marketing returns earned by routine storage hedging from harvest until the indicated marketing week, Garden City.

MKT. WEEK	POST-HARVEST MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	-0.700	-0.700	-0.800	-0.800	-0.900	-0.900	-1.000	-1.000	-0.850	0.120
2	-4.075	-3.622	-13.916	0.971	2.199	8.618	5.997	-5.012	-1.105	7.119
3	-1.699	-5.794	8.469	0.741	1.297	4.636	9.243	-0.022	2.109	5.096
4	-1.325	-2.842	12.853	-5.988	2.397	0.154	8.490	-5.034	1.088	6.597
5	-0.075	-4.139	18.237	-4.716	-8.505	-5.829	11.237	5.956	1.520	9.423
6	1.926	-13.062	57.121	-6.947	-13.406	-5.560	6.983	8.694	4.469	22.868
7	0.426	-11.984	35.005	-3.177	-22.308	-1.793	10.980	5.934	1.635	16.964
8	2.175	-18.157	28.390	-3.405	-19.208	-0.775	14.477	8.422	1.490	15.966
9	-1.950	-15.329	14.774	-4.635	-29.110	4.492	17.224	4.911	-1.203	15.378
10	-2.699	-11.876	0.158	2.136	-22.011	0.261	13.220	1.400	-2.426	10.468
11	-0.699	-7.673	30.542	6.406	-24.413	6.278	6.217	-1.612	1.881	15.499
12	-2.574	2.404	-10.074	-1.323	-20.813	6.046	7.714	-3.122	-2.718	9.224
13	-0.324	-5.268	16.311	-6.053	-19.715	5.814	3.466	3.366	-0.301	10.526
14	-0.449	-0.690	-21.805	-6.782	-19.116	3.582	3.457	5.606	-4.525	10.556
15	2.801	-10.363	8.079	-9.011	-19.517	0.850	4.203	7.094	-1.963	9.655
16	0.927	-7.765	7.464	-18.241	-23.419	5.118	6.449	5.583	-2.988	12.106
17	-4.949	-9.708	8.848	-16.470	-16.319	9.386	6.946	4.822	-2.180	11.059
18	-4.074	-12.630	3.232	-21.700	-27.221	14.403	6.693	-2.189	-5.436	14.238
19	-2.073	-4.552	31.616	-20.929	-25.122	17.172	9.189	0.550	0.731	18.781
20	-2.573	-7.974	30.000	-25.159	-10.524	16.939	12.686	-1.712	1.460	17.516
21	-4.823	-4.897	17.385	-22.637	-22.924	16.457	14.683	-6.973	-1.716	16.470
22	-2.574	3.181	-17.231	-15.117	-22.326	14.724	13.930	-4.484	-3.737	13.938
23	-4.698	3.008	17.153	-12.846	-14.727	11.993	18.176	-9.495	1.070	13.429
24	-5.448	1.836	3.537	-5.576	-14.129	9.010	20.423	-13.756	-0.513	11.721
25	-7.698	-1.587	-17.079	7.695	-12.529	7.028	16.420	-13.017	-2.596	11.977
26	-8.323	8.491	-14.694	6.465	-17.931	5.796	10.166		-1.433	11.854
27	-8.323	9.069	-5.310	6.236	-20.832	2.814	8.913		-1.062	11.046
28	-7.573	4.647	-28.925	3.007	-20.733	3.582	9.160		-5.262	14.476
29	-7.322	15.225	-4.542	7.277	-20.885	2.100	9.906		0.251	12.229
30	-6.072	8.802	7.842	6.048	-18.035	5.618	11.903		2.301	10.598
31	-9.198	10.130	-12.773	4.818	-14.937	6.135	15.650		-0.025	12.105
32	-9.822	-10.043	-19.389	4.589	-17.838	-1.346	16.646		-5.315	12.869
33	-9.822	-1.465	-15.004	5.859	-21.990	-4.329	20.143		-3.801	13.934
34	-9.697	-5.638	-24.620	1.131	-22.640	-3.311	20.890		-6.269	15.373
35	-8.448	-0.810	-43.735	-8.099	-26.042	-1.544	21.631		-9.577	20.644
36	-13.447	-3.357	-39.351	-9.578	-23.943	-1.525	18.883		-10.331	18.336
37	-12.447	-6.904	-49.468	-16.308	-23.595	-2.758	18.380		-13.300	20.735
38	-14.072	-1.452	-46.084	-3.537	-19.745	-4.740	13.377		-10.693	18.695
39	-15.321	-8.374	-45.699	-3.166	-20.897	-9.972	7.373		-13.808	16.650
40	-16.197	-17.671	-53.815	-5.746	-21.048	-10.454	3.620		-17.330	18.105
41	-17.947	-8.344	-67.931	-12.225	-18.949	-7.686	2.116		-18.709	22.833
42	-13.946	1.984	-59.046	-14.455	-21.101	-7.168	-4.138		-16.839	20.095
43	-16.071	-8.689	-62.162	-21.434	-25.751	-6.650	-1.141		-20.271	20.370
44	-17.197	-9.736	-61.778	-28.164	-30.653	-9.883	-0.644		-22.579	20.286

Table A.6. Annual marketing returns earned by holding a long futures position from harvest until the indicated marketing week.

MKT.	POST-HARVEST MARKETING YEAR									
WEEK	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	-0.700	-0.700	-0.800	-0.800	-0.900	-0.900	-1.000	-1.000	-0.850	0.120
2	0.263	8.777	-9.340	-12.871	21.050	-2.464	-8.791	-3.056	-0.801	11.088
3	-1.484	11.504	-2.379	-28.942	63.999	-20.527	-12.832	-13.111	-0.472	28.859
4	-4.252	10.106	37.581	0.487	50.949	-29.091	-17.873	-3.167	5.593	26.870
5	-4.894	13.958	57.542	8.916	56.898	-39.155	-18.414	-22.222	6.579	35.590
6	-8.286	32.434	102.002	7.845	68.848	-55.468	-17.955	-28.028	12.674	52.408
7	-7.178	36.911	147.462	-0.226	102.797	-58.282	-23.746	-18.333	22.426	69.693
8	-7.321	46.638	151.423	-9.296	122.747	-65.346	-23.037	-15.889	24.990	75.940
9	-7.588	47.365	171.383	-9.367	113.696	-70.660	-26.578	-13.444	25.601	80.467
10	-7.230	49.467	156.343	-16.438	103.646	-66.473	-19.369	-11.000	23.618	74.073
11	-8.622	55.819	191.304	-14.009	102.095	-76.537	-8.160	-7.056	29.354	84.081
12	-10.139	66.296	217.264	-11.580	115.545	-91.351	-0.451	-4.611	35.121	95.382
13	-9.782	59.523	197.225	-3.151	108.494	-107.164	-0.992	-6.167	29.748	91.621
14	-10.049	54.499	195.685	24.278	111.944	-104.978	6.217	-4.472	34.140	89.633
15	-10.691	65.726	191.145	56.207	97.394	-90.292	-3.325	-5.028	37.642	84.911
16	-9.208	69.703	125.106	60.136	92.343	-108.605	1.634	0.417	28.941	73.520
17	-5.726	64.180	172.066	66.065	89.293	-123.919	3.343	0.111	33.177	86.733
18	-6.993	63.657	128.027	68.994	83.242	-129.983	12.802	4.056	27.975	78.373
19	-7.385	63.134	124.987	68.923	77.192	-136.796	13.511	1.250	25.602	79.305
20	-7.277	67.111	141.947	49.852	45.641	-142.610	24.220	-1.556	22.166	81.302
21	-7.419	65.588	159.908	45.032	28.091	-140.174	15.429	2.639	21.137	83.721
22	-7.062	70.065	177.868	40.211	41.540	-145.488	12.388	4.083	24.201	89.912
23	-5.329	88.791	192.828	36.640	36.990	-139.801	7.347	3.028	27.562	93.607
24	-1.971	105.518	220.789	18.069	28.439	-142.865	1.306	-3.778	28.188	103.572
25	-3.113	88.495	231.749	1.498	18.889	-143.929	5.515	-2.583	24.565	105.446
26	-2.881	97.972	212.710	-19.573	16.338	-135.742	16.974		26.543	107.459
27	-3.273	94.949	248.670	-12.644	14.288	-137.806	12.433		30.945	118.088
28	-4.415	104.926	253.630	-46.715	34.238	-132.620	12.392		31.634	122.098
29	-4.057	93.903	263.591	-46.286	37.437	-136.183	6.851		30.751	125.054
30	-4.699	83.880	241.551	-85.357	35.637	-138.747	8.060		20.046	122.789
31	-6.967	77.107	258.511	-76.428	24.586	-141.311	2.519		19.717	126.834
32	-5.734	61.833	253.472	-75.499	33.536	-133.874	0.728		19.209	122.657
33	-5.126	54.810	285.432	-69.070	54.735	-132.938	0.437		26.897	132.210
34	-4.643	77.537	316.393	-87.640	59.435	-131.002	-3.104		32.425	145.581
35	-4.286	71.264	304.853	-95.711	71.884	-142.816	-5.645		28.506	145.545
36	-2.678	82.366	262.813	-108.532	56.834	-138.879	3.314		22.177	133.371
37	-2.070	63.468	258.274	-99.103	55.533	-144.693	9.023		20.062	130.284
38	-1.637	55.570	206.234	-107.174	52.733	-146.757	16.232		10.714	116.109
39	-0.979	58.047	185.195	-92.245	47.932	-153.570	17.441		8.831	109.404
40	0.503	67.898	152.655	-87.566	31.132	-160.134	40.399		6.413	102.906
41	2.861	66.125	155.115	-95.387	37.082	-156.948	44.108		7.565	104.157
42	1.469	72.352	150.576	-115.458	31.281	-157.511	46.567		4.182	107.296
43	2.202	83.579	142.036	-121.779	31.981	-172.075	22.776		-2.469	111.505
44	3.934	73.181	112.997	-126.350	17.930	-175.889	14.485		-11.387	103.814

Table A.7. Annual marketing returns earned by unhedged storage (one-time sale) from harvest until the indicated marketing week, Concordia.

MKT. WEEK	POST-HARVEST MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-1.360	7.595	-6.575	-9.174	41.138	0.071	1.282	-3.959	3.627	15.997
3	-1.720	10.189	6.851	-25.348	75.277	-15.858	-1.437	-9.918	5.004	30.512
4	-4.080	8.784	54.276	1.478	66.415	-30.788	-4.155	-3.877	11.007	32.654
5	-3.440	9.378	77.702	9.305	78.554	-45.717	-2.874	-11.836	13.864	43.245
6	-3.800	18.973	160.127	4.131	77.692	-60.646	-5.592	-14.795	22.011	67.739
7	-4.160	27.568	161.552	-0.043	105.831	-58.575	-9.311	-7.754	26.888	71.585
8	-3.520	36.162	198.978	-8.217	120.969	-66.505	-7.029	-2.713	33.516	85.445
9	-5.880	37.757	198.403	-13.391	99.108	-66.434	-7.748	-2.672	29.893	82.944
10	-5.240	40.352	152.828	-19.565	98.246	-64.363	-2.466	-3.631	24.520	70.101
11	-5.600	47.946	184.254	-12.738	106.385	-78.292	3.815	-1.590	30.522	81.463
12	-5.960	63.541	226.679	-11.912	118.523	-93.222	11.097	-0.549	38.525	97.531
13	-5.320	57.135	210.105	-6.086	105.662	-106.151	7.378	4.492	33.402	93.393
14	-5.680	50.730	207.530	15.740	114.800	-107.080	13.660	8.533	37.279	92.357
15	-4.040	61.325	198.955	46.566	100.938	-96.009	3.942	9.573	40.156	86.307
16	-3.400	63.919	135.381	41.392	90.077	-110.938	10.223	14.614	30.159	73.291
17	-3.760	57.514	185.806	54.218	89.215	-117.868	13.505	13.655	36.536	80.460
18	-4.120	58.108	160.232	53.045	88.354	-122.797	24.786	12.696	33.788	81.424
19	-3.480	61.703	162.657	53.871	80.492	-130.726	27.068	11.737	32.915	83.623
20	-4.840	64.298	183.082	33.697	51.631	-130.655	40.349	7.778	30.667	86.778
21	-5.200	65.892	181.508	27.523	29.769	-130.585	33.631	9.819	26.545	85.858
22	-4.560	73.487	200.933	26.349	45.908	-135.514	30.912	10.860	31.047	92.831
23	-3.920	90.082	212.358	25.175	42.046	-128.443	29.194	7.901	34.299	95.340
24	-2.280	104.676	237.784	16.002	39.185	-134.372	24.475	-2.058	35.426	105.501
25	-5.640	91.271	234.209	14.828	28.323	-136.302	24.757	-3.017	31.054	104.008
26	-5.000	107.865	224.635	-7.346	21.462	-128.231	33.038		35.203	109.160
27	-5.360	109.460	255.060	-1.520	9.600	-131.160	27.320		37.628	119.162
28	-6.720	117.055	253.485	-41.694	32.738	-128.089	28.602		36.482	121.600
29	-5.080	106.649	272.911	-36.868	38.877	-132.018	22.883		38.193	126.815
30	-6.440	95.244	249.336	-75.042	37.015	-132.948	27.165		27.761	123.356
31	-9.800	90.838	263.761	-67.215	30.154	-134.877	23.446		28.044	126.873
32	-9.160	72.433	255.187	-73.389	37.292	-129.806	22.728		25.041	122.613
33	-8.520	45.028	286.612	-57.563	55.431	-128.735	26.009		31.180	129.792
34	-8.880	52.622	304.037	-80.737	57.569	-127.665	23.291		31.748	139.119
35	-8.240	54.217	266.463	-96.911	67.708	-140.594	23.572		23.745	131.884
36	-9.600	75.812	217.888	-130.085	54.846	-137.523	29.854		14.456	123.549
37	-9.960	53.406	216.314	-98.258	49.985	-143.452	34.135		14.596	117.010
38	-10.320	49.001	171.739	-104.432	51.123	-145.382	38.417		7.164	106.281
39	-10.680	49.595	149.165	-87.606	45.262	-154.311	34.698		3.732	99.554
40	-8.040	60.190	110.590	-84.780	29.400	-160.240	51.980		-0.129	93.406
41	-6.400	63.785	115.015	-98.954	36.538	-156.169	53.262		1.011	96.336
42	-8.760	71.379	114.441	-120.128	33.677	-157.098	50.543		-2.278	100.856
43	-8.120	73.974	103.866	-139.302	33.815	-171.028	27.825		-11.281	104.888
44	-8.480	61.568	73.292	-135.475	10.954	-174.957	21.106		-21.713	96.145

Table A.8. Annual marketing returns earned by unhedged storage (sequential sale) from harvest until the indicated marketing week, Concordia.

MKT. WEEK	POST-HARVEST MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	-0.680	3.797	-3.287	-4.587	20.569	0.035	0.641	-1.979	1.814	7.998
3	-1.027	5.928	0.092	-10.841	38.805	-5.262	-0.052	-4.626	2.877	15.318
4	-1.790	6.642	13.638	-7.761	45.707	-11.644	-1.077	-4.438	4.910	18.308
5	-2.120	7.189	26.451	-4.348	52.277	-18.458	-1.437	-5.918	6.704	22.443
6	-2.400	9.153	48.730	-2.935	56.513	-25.490	-2.129	-7.397	9.256	28.511
7	-2.651	11.764	64.848	-2.522	63.558	-30.216	-3.155	-7.448	11.775	34.364
8	-2.760	14.831	81.614	-3.233	70.734	-34.752	-3.639	-6.856	14.492	40.514
9	-3.107	17.378	94.590	-4.362	73.887	-38.272	-4.096	-6.392	16.203	44.975
10	-3.320	19.676	100.414	-5.882	76.323	-40.881	-3.933	-6.115	17.035	47.424
11	-3.527	22.246	108.036	-6.506	79.056	-44.282	-3.229	-5.704	18.261	50.437
12	-3.730	25.687	117.923	-6.956	82.345	-48.361	-2.035	-5.274	19.950	54.242
13	-3.852	28.106	125.014	-6.889	84.138	-52.806	-1.311	-4.523	20.985	57.131
14	-3.983	29.722	130.908	-5.273	86.328	-56.683	-0.241	-3.591	22.148	59.543
15	-3.987	31.629	135.444	-1.817	87.302	-59.305	0.037	-2.713	23.349	61.135
16	-3.950	33.835	135.440	0.884	87.476	-62.532	0.674	-1.630	23.775	61.585
17	-3.939	35.227	138.403	4.021	87.578	-65.767	1.429	-0.731	24.525	62.811
18	-3.949	36.499	139.616	6.745	87.621	-68.954	2.726	0.015	25.040	63.594
19	-3.924	37.825	140.828	9.225	87.246	-72.205	4.008	0.632	25.454	64.390
20	-3.970	39.149	142.941	10.448	85.465	-75.128	5.825	0.989	25.715	65.228
21	-4.029	40.422	144.778	11.262	82.813	-77.768	7.149	1.410	25.755	65.890
22	-4.055	41.925	147.330	11.947	81.136	-80.393	8.229	1.840	25.995	66.905
23	-4.047	44.019	150.157	12.522	79.436	-82.482	9.140	2.103	26.356	67.931
24	-3.973	46.546	153.808	12.667	77.759	-84.644	9.779	1.930	26.734	69.274
25	-4.040	48.335	157.024	12.754	75.781	-86.711	10.378	1.732	26.907	70.406
26	-4.077	50.625	159.625	11.981	73.692	-88.308	11.250		30.684	76.341
27	-4.124	52.804	163.159	11.481	71.318	-89.895	11.845		30.941	77.636
28	-4.217	55.099	166.385	9.582	69.941	-91.259	12.444		31.139	78.969
29	-4.247	56.876	170.059	7.980	68.869	-92.664	12.804		31.382	80.453
30	-4.320	58.155	172.701	5.213	67.808	-94.007	13.282		31.262	81.674
31	-4.497	59.209	175.638	2.876	66.593	-95.325	13.610		31.158	82.960
32	-4.642	59.623	178.124	0.493	65.677	-96.403	13.895		30.967	84.056
33	-4.760	59.180	181.412	-1.266	65.367	-97.383	14.262		30.973	85.324
34	-4.881	58.988	185.077	-3.604	65.137	-98.273	14.528		30.996	86.753
35	-4.977	58.851	187.402	-6.270	65.211	-99.483	14.786		30.789	87.920
36	-5.106	59.322	188.249	-9.709	64.923	-100.539	15.205		30.335	88.685
37	-5.237	59.162	189.008	-12.102	64.519	-101.699	15.716		29.910	89.339
38	-5.371	58.895	188.553	-14.532	64.167	-102.849	16.314		29.311	89.637
39	-5.507	58.657	187.543	-16.406	63.682	-104.168	16.785		28.655	89.771
40	-5.570	58.695	185.619	-18.115	62.825	-105.570	17.665		27.936	89.629
41	-5.590	58.819	183.897	-20.087	62.184	-106.804	18.533		27.279	89.555
42	-5.666	59.118	182.243	-22.469	61.505	-108.001	19.295		26.575	89.555
43	-5.723	59.464	180.421	-25.186	60.861	-109.467	19.494		25.695	89.629
44	-5.785	59.511	177.986	-27.692	59.727	-110.955	19.530		24.617	89.479

Table A.9. Annual marketing returns earned by managing storage hedges from harvest until the indicated marketing week, Concordia.[A]

MKT. WEEK	POST-HARVEST MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	3.550	0.0	-14.800	0.0	0.0	0.0	0.0	0.0	-1.406	5.553
2	0.173	7.572	-12.415	-9.245	41.088	0.007	1.241	-4.015	3.051	16.597
3	1.546	10.143	-6.528	-23.490	75.176	-8.385	1.481	-12.029	4.739	30.210
4	1.916	8.715	40.857	-29.035	66.264	-14.879	3.722	-16.044	7.690	31.628
5	3.171	9.286	64.244	-18.779	78.352	-19.872	5.462	-5.058	14.601	36.762
6	6.164	18.857	146.629	-24.024	77.440	-18.614	-1.297	-2.323	25.354	58.161
7	4.667	27.429	148.014	-28.269	105.528	-13.857	4.193	-5.087	30.327	62.673
8	5.409	36.000	185.401	-42.313	120.616	-14.851	5.684	-4.602	36.418	77.184
9	3.532	37.572	184.786	-47.558	98.704	-9.594	8.424	-4.616	33.906	74.221
10	3.535	40.144	139.171	-46.803	97.792	-11.836	6.415	-5.631	27.848	61.824
11	4.528	47.715	170.558	-42.547	111.480	-15.829	5.405	-3.646	34.708	71.993
12	5.651	63.287	212.943	-44.292	110.068	-16.073	12.646	-2.660	42.656	83.922
13	5.903	56.858	196.330	-42.537	91.156	-13.315	8.886	2.325	38.201	76.082
14	5.776	50.429	167.915	-20.782	100.244	-16.558	15.127	6.311	38.558	65.358
15	8.019	50.551	163.800	9.973	85.432	-20.301	5.367	7.295	38.767	60.142
16	7.142	49.622	166.187	4.728	79.520	-17.043	11.607	12.281	39.255	59.432
17	3.264	43.194	169.572	17.483	81.608	-9.037	14.848	11.266	41.525	58.835
18	4.137	43.765	187.959	16.239	86.696	-7.780	26.088	10.252	45.919	64.385
19	5.140	47.337	193.344	16.994	84.784	-9.022	26.329	9.237	47.018	65.911
20	3.633	49.909	196.729	-3.251	87.372	-3.265	41.569	5.222	47.240	68.415
21	3.386	51.480	182.116	-6.345	82.960	-5.759	34.810	2.958	43.201	64.447
22	3.628	59.052	201.501	-3.040	85.548	-5.502	32.050	2.443	46.960	70.561
23	2.501	75.623	212.886	-0.785	86.136	-4.244	27.291	0.429	49.980	74.876
24	-1.126	90.194	238.273	1.471	91.474	-7.237	28.531	-2.836	55.593	84.078
25	-4.503	76.766	234.658	23.726	90.312	-8.231	24.522	-5.100	54.019	81.982
26	-3.881	93.337	225.045	22.481	85.900	-8.473	21.262		62.239	82.325
27	-4.258	94.909	255.430	21.236	75.988	-8.716	15.503		64.259	92.980
28	-5.635	87.281	253.815	14.991	79.076	-5.709	16.744		62.938	92.317
29	-4.012	87.852	273.201	19.246	85.164	-9.701	10.984		66.105	99.665
30	-5.389	86.424	249.587	20.001	83.252	-10.695	12.725		62.272	91.519
31	-8.767	88.745	263.972	18.757	76.340	-11.588	14.465		63.132	96.831
32	-8.144	85.566	252.559	11.512	73.528	-15.080	15.456		59.342	93.567
33	-7.521	85.138	251.944	20.767	77.116	-15.073	18.946		58.760	91.807
34	-7.898	49.959	271.329	-2.477	79.204	-13.067	17.937		56.427	100.550
35	-7.276	54.031	231.716	-10.022	89.292	-26.060	22.427		50.587	89.449
36	-8.653	75.603	183.101	-30.517	76.380	-27.952	19.418		41.054	76.857
37	-9.030	53.174	185.188	-8.261	71.818	-28.195	24.908		41.372	72.874
38	-9.407	56.046	194.573	-6.506	75.656	-28.189	29.149		44.474	75.997
39	-9.784	54.117	190.960	2.499	74.494	-30.181	25.389		43.927	74.267
40	-7.162	54.688	184.845	5.254	74.832	-29.674	42.629		46.488	71.189
41	-5.539	62.510	186.630	-8.991	75.920	-29.167	43.870		46.462	73.346
42	-7.916	70.081	190.617	-23.286	78.758	-29.409	41.110		45.708	77.443
43	-7.293	72.653	188.502	-30.281	78.096	-28.903	18.351		41.589	78.470
44	-7.671	60.224	182.889	-28.025	69.434	-29.396	18.841		38.042	75.088

[A] Using 5-and-20 day moving averages with 3.0 cent tolerance.

Table A.10. Annual marketing returns earned by two-way speculation (with storage) from harvest until the indicated marketing week, Concordia.*

MKT. WEEK	POST-HARVEST MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	7.100	0.0	-29.600	0.0	0.0	0.0	0.0	0.0	-2.812	11.105
2	1.706	7.549	-18.254	-9.316	41.037	-0.056	1.200	-4.070	2.474	17.456
3	4.811	10.097	-19.907	-23.632	75.075	-0.913	4.399	-14.140	4.474	31.113
4	7.917	8.645	27.438	-59.548	66.112	1.030	11.599	-28.210	4.373	37.005
5	9.782	9.193	50.785	-46.862	78.150	5.973	13.798	1.720	15.317	36.674
6	16.128	18.742	133.131	-52.178	77.187	23.417	2.998	10.149	28.697	54.887
7	13.493	27.291	134.477	-56.494	105.225	30.861	17.697	-2.421	33.766	60.267
8	14.339	35.838	171.823	-76.410	120.263	36.803	18.396	-6.491	39.320	76.234
9	12.944	37.387	171.169	-81.726	98.301	47.247	24.595	-6.561	37.920	74.242
10	12.310	39.936	125.515	-74.042	97.338	40.691	15.295	-7.631	31.176	61.678
11	14.696	47.484	156.862	-72.356	116.576	46.634	6.994	-5.701	38.893	71.768
12	17.261	63.032	199.207	-76.672	101.613	61.077	14.194	-4.771	46.868	81.539
13	17.127	56.580	182.554	-78.988	76.651	79.520	10.393	0.159	42.999	76.134
14	17.232	50.129	128.300	-57.304	85.688	73.964	16.593	4.089	39.836	57.277
15	20.078	39.778	128.646	-26.620	69.925	55.408	6.793	5.017	37.378	47.955
16	17.683	35.326	196.993	-31.936	68.963	76.851	12.992	9.947	48.352	69.295
17	10.289	28.874	153.338	-19.252	74.000	99.794	16.192	8.877	46.514	57.682
18	12.394	29.422	215.685	-20.566	85.038	107.237	27.391	7.807	58.051	76.106
19	13.760	32.971	224.031	-19.882	89.075	112.681	29.591	6.737	61.120	78.856
20	12.106	35.520	210.377	-40.198	123.113	124.125	42.790	2.667	63.812	82.035
21	11.971	37.067	182.723	-40.214	136.151	119.067	35.989	-3.903	59.856	77.353
22	11.817	44.616	202.069	-32.430	125.189	124.511	33.188	-5.973	62.873	79.912
23	8.922	61.165	213.415	-26.746	130.226	119.955	25.388	-7.044	65.660	82.492
24	0.028	75.713	238.762	-1.060	143.764	119.898	32.587	-3.614	75.760	86.967
25	-3.367	62.261	235.107	32.624	152.301	119.841	24.287	-7.184	76.984	85.368
26	-2.761	78.809	225.454	52.308	150.339	111.284	9.486		89.274	80.696
27	-3.156	80.358	255.800	43.992	142.376	113.728	3.686		90.969	90.487
28	-4.550	57.507	254.146	71.676	125.413	116.672	4.886		89.393	88.017
29	-2.944	69.055	273.492	75.360	131.451	112.615	-0.915		94.016	94.290
30	-4.339	77.603	249.838	115.044	129.488	111.558	-1.715		96.782	86.932
31	-7.733	86.651	264.184	104.730	122.526	111.701	5.484		98.220	89.739
32	-7.128	98.700	249.931	96.414	109.763	99.645	8.184		93.644	83.878
33	-6.522	85.249	217.276	99.098	98.801	98.589	11.883		86.339	72.779
34	-6.917	47.296	236.622	75.782	100.838	101.531	12.582		81.105	80.215
35	-6.311	53.845	196.969	76.866	110.877	88.475	21.281		77.429	66.146
36	-7.705	75.394	148.315	69.050	97.914	81.619	8.981		67.652	52.915
37	-8.100	52.942	154.062	81.736	93.652	87.062	15.680		68.148	53.808
38	-8.494	63.090	217.407	91.420	100.189	89.005	19.880		81.785	72.122
39	-8.889	58.638	232.754	92.604	103.727	93.948	16.079		84.123	78.075
40	-6.283	49.187	259.100	95.288	120.264	100.892	33.279		93.104	85.385
41	-4.678	61.236	258.246	80.972	115.301	97.836	34.479		91.913	83.604
42	-1.072	68.784	266.792	73.556	123.839	98.279	31.678		93.694	87.482
43	-6.467	71.332	275.138	78.740	122.376	113.222	8.878		94.460	92.511
44	-6.861	58.880	292.485	79.426	127.914	116.165	16.577		97.198	98.784

* Using 5-and-20 day moving averages with 3.0 cent tolerance.

Table A.11. Annual marketing returns earned by two-way speculation (w/o storage) from harvest until the indicated marketing week, Concordia.*

MKT. WEEK	POST-HARVEST MARKETING YEAR 1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	AVERAGE	STD.DEV.
1	3.550	0.0	-14.800	0.0	-12.900	3.100	0.750	0.0	-2.537	7.139
2	1.533	-0.023	-5.840	-0.071	9.050	1.536	-7.041	-4.056	-0.614	5.123
3	3.266	-0.046	-13.379	-16.942	51.999	-0.427	-4.082	-17.111	0.410	22.325
4	5.998	-0.069	25.761	-47.313	38.949	8.009	0.877	-27.167	0.633	27.401
5	6.611	4.208	45.742	-36.684	44.898	17.945	1.336	-8.222	9.479	27.223
6	9.964	22.684	90.202	-35.755	56.848	34.132	-2.705	-2.528	21.605	39.105
7	8.827	27.161	135.662	-43.826	90.797	36.818	6.504	-12.333	31.201	57.503
8	8.929	36.888	139.623	-63.696	110.747	43.754	5.713	-19.889	32.759	66.563
9	9.412	37.615	159.583	-63.767	88.696	48.940	9.172	-17.444	34.026	68.060
10	8.775	39.592	144.543	-56.838	91.646	44.627	1.881	-15.000	32.403	63.231
11	10.128	46.069	179.504	-59.409	102.195	54.563	-2.410	-11.056	39.948	74.410
12	11.611	56.546	205.464	-61.980	88.645	69.249	5.299	-8.611	45.778	80.516
13	11.223	49.773	185.425	-62.351	68.694	84.936	4.758	-10.167	41.536	74.766
14	11.456	44.749	133.085	-34.922	91.144	82.622	11.967	-8.472	41.454	56.904
15	12.059	35.776	137.545	-2.993	56.694	67.808	2.425	-9.028	37.536	49.253
16	10.542	32.053	203.506	0.936	61.643	85.995	7.384	-3.583	49.809	69.661
17	7.024	26.330	156.466	6.865	64.593	100.931	9.093	-3.889	45.927	57.139
18	8.257	26.007	200.427	9.794	70.542	107.117	18.552	0.056	55.094	69.203
19	8.620	25.484	203.387	9.723	76.492	113.804	19.261	-2.750	56.753	71.313
20	8.473	29.461	186.347	-9.348	107.941	119.490	29.970	-5.556	58.347	71.089
21	8.586	27.938	177.508	-7.268	125.391	116.926	21.179	-8.861	57.675	71.441
22	8.188	32.415	195.468	-2.789	111.840	122.112	18.138	-10.417	59.369	74.635
23	6.421	51.141	210.428	0.640	116.290	116.299	8.097	-9.472	62.480	78.295
24	-1.426	67.868	238.389	18.069	124.489	119.235	14.056	-2.778	72.238	84.462
25	-2.563	50.845	249.349	35.498	134.189	120.171	9.765	-4.083	74.146	88.322
26	-2.211	60.072	230.310	56.427	136.638	111.858	-1.776		84.474	82.739
27	-2.728	57.299	266.270	49.356	138.588	117.644	-7.317		88.444	95.716
28	-3.865	37.576	271.230	83.285	118.538	119.330	-7.358		88.391	96.249
29	-3.382	48.553	281.190	82.714	120.837	115.767	-12.899		90.397	99.370
30	-4.149	58.530	259.151	121.643	119.037	113.453	-15.690		93.139	93.061
31	-6.417	65.257	276.111	112.572	107.986	112.989	-10.231		94.038	96.471
32	-5.184	80.483	266.272	111.501	98.036	104.426	-8.522		92.430	91.854
33	-4.561	87.460	234.232	104.930	89.335	103.362	-8.313		86.632	81.387
34	-4.098	64.687	264.392	85.560	94.035	106.398	-6.604		86.338	90.785
35	-3.736	62.714	252.853	95.689	106.484	94.584	-2.395		86.599	86.442
36	-2.003	73.691	210.813	108.368	91.434	89.621	-11.686		80.034	74.510
37	-1.520	54.918	214.474	98.797	91.733	95.307	-4.727		78.426	74.436
38	-1.287	62.195	268.434	106.726	94.433	97.243	2.482		90.032	90.329
39	-0.434	59.672	287.395	105.855	99.132	104.180	3.691		94.213	96.543
40	0.928	49.648	319.855	110.034	115.332	110.616	26.649		104.723	105.166
41	3.531	55.675	317.215	102.213	109.282	107.052	30.108		103.582	102.786
42	2.014	61.902	321.776	96.842	114.981	107.739	32.817		105.439	103.953
43	2.747	73.229	330.236	109.021	114.181	122.175	9.026		108.659	109.323
44	4.479	62.606	355.196	107.450	128.380	125.611	16.235		114.280	117.440

*Using 5-and-20 day moving averages with 3.0 cent tolerance.

THE EFFECTS OF USING WHEAT FUTURES IN FORWARD-PRICING AND POST-HARVEST MARKETING ALTERNATIVES

by

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The objective of this study was to determine the potential for using the futures market as a tool to improve the risk-return relationships for total returns to wheat production and marketing. Forward-pricing and post-harvest marketing alternatives were evaluated in terms of their ability to (1) reduce the variation of total annual returns per bushel without causing a corresponding reduction in the level of returns, and/or (2) increase the level of total returns without a corresponding increase in variability; relative to total returns earned from selling unhedged production at harvest cash prices.

Eight production and marketing years, including wheat harvested 1971 through 1978, were selected. Cash prices came from two local Kansas markets, while respective futures prices used in forward-pricing and post-harvest marketing were daily settlement prices of July and May Kansas City Board of Trade contracts. Returns to each alternative reflect gross returns per bushel less applicable interest, hedging and commercial storage costs.

Alternatives considered for forward-pricing wheat during production included (1) routine hedging at specified times prior to harvest, (2) selective hedging using criteria based on the relationship between government price support levels and futures prices, and (3) managed hedging, where moving averages were used to indicate opportune times for placing and lifting hedges during the period.

None of the forward-pricing alternatives effectively reduced the variability of annual returns relative to the variability of returns from unhedged production. Neither routine or selective forward-pricing significantly increased average annual returns (α=.05). Managed forward-pricing alternatives were most effective at increasing annual returns, although the increase was significant (α=.05) for only one variation.

It was assumed that post-harvest marketing offered producers the option of performing one, both, or neither of two marketing functions; storage and risk-bearing. Each alternative was evaluated relative to the results from selling in the cash market at harvest. Alternatives included (1) routine storage hedging, (2) replacing inventories with long futures positions, (3) unhedged storage for a specified period of time, (4) unhedged storage with weekly sequential selling for a specified period of time, (5) managed storage hedging with various moving averages, and (6) "two-way speculation" where moving averages are used to initiate either net long or net short positions in the market.

Again, none of the alternatives effectively reduced the variability of total annual returns without reducing average returns.

Returns to routine storage hedging were approximately zero, indicating that, on the average, interest on the inventory, hedging costs and commercial storage rates could be recovered. However, unless convenience yields or lower storage costs are applicable, little would be earned by routine storage hedging.

Returns to routine risk bearing by holding a long futures position were greater than zero, but not significantly (α=.05).

The results of unhedged storage were similar to results of holding a long futures position, except that sequential selling did reduce the variability of marketing returns relative to nonsequential selling.

Managed storage hedging and "two-way speculation" produced the second greatest and greatest average returns, respectively, with most returns from "two-way speculation" being significantly greater than zero (α=.05). Although variability of annual returns also increased, the increases were generally not significant (α=.05.