OPTIMAL ELEVATOR HEDGING USING
HISTORICAL BASIS LEVELS

By

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CHAPTER I

INTRODUCTION

Risk is an inescapable part of daily life, almost as common as breathing. From driving, walking, eating and sleeping, to skydiving, rodeoing, snakecharming, and thesis writing, everyone incessantly faces some type of risk. One appeasing thought is we homosapiens have the ability to recognize and vary the amount of risk to which we are exposed. This is evidenced by the immense volume of business experienced by insurance companies and gambling casinoes.

Bacharach (1977, p. 14) commented on the theory of rational decisionmaking: "A person has a decision problem if he must choose one action out of a number of possible ones with a view to its consequences." A person facing a decision with perfect information and knowledge of the consequences of a decision has only to choose which outcome will yield him the highest utility. Conversely, a decisionmaker lacking this level of knowledge makes the decision 'under risk.'

If the decisionmaker has some idea of the possible consequences of a decision, he may assign numerical probabilities to the even occurring, aiding him in the decision. In games of chance, the probability of a unique card being drawn or a little marble landing in a particular slot can be calculated using cardinal numbers. This task becomes increasingly difficult when a random error term is introduced, as the case of predicting the winner of a horse race. The fact a specific horse and jockey has beaten another horse and jockey does not guarantee their winning again, although this author would likely place high odds in their favor. The handicapper must use historical data and 'horse sense' to produce estimates of the actual probabilities. Economists combine economic theory and historical data in a manner not too unlike the handicapper when estimating the probability certain financial events will occur.

Few industries are more aware of risk management than those involved in agriculture. The risk of infectious diseases, insect infestation, and drought are commonly reduced by vaccination, pesticides, and irrigation, respectively. Many farmers and ag-business firms are reducing their financial risks via improved marketing and hedging strategies. This study is an attempt to identify and quantitatively measure the risk incurred by commercial and cooperative grain elevators when purchasing, warehousing, and marketing Hard-Red Winter wheat.

The Problem

The cultivation of improved marketing and financial skills is vital to the survival of large, medium, and small agricultural firms. As public farm policy pursues a goal of decreased government costs, farmers can expect less help from programs which traditionally supplied them with price supports and easy credit. Government loan rates and target prices could continue to move closer to world market prices forcing producers and ag-business firms to operate on smaller margins. Any firm striving to remain competitive should implement a progressive marketing plan which allows it to adjust to the changing economic environment.

Grain merchandisers and processors have access to timely market information and the expertise to use intricate marketing strategies in an effort to increase average returns. Large producers have sufficient volume to contract sales directly to processors or distant markets and the resources to hedge production costs using futures markets. Smaller producers located in remote areas have fewer marketing options available and often pay increased marketing margins to elevators purchasing under oligopsonistic conditions.

As marketing awareness increases among wheat producers, elevators competing for their business are offering new services, information, and purchasing agreements that provide increased marketing flexibility for the Hard-Red Winter wheat producer. A well-informed producer now recognizes and is able to profit from favorable price and basis movements elevators once depended upon for additional revenues. The elevator is exposed to increased basis risk upon purchasing cash grain requiring more precise forecasting and hedging techniques.

Hypothesis

The working hypothesis for this study is that basis levels tend to gravitate toward a historical average and the difference between basis levels in time period t and the average may be used to estimate probabilities of increases or decreases in basis levels in time period t + j. These probabilities can be used to identify optimal hedging alternatives.

Specific Objectives

The objective of this study is to identify and measure the level of risk associated with individual purchasing agreements for grain elevators under different pricing conditions and to establish basic guidelines to minimize such risk. Specific objectives of this study are:

1. To discuss the mechanics and inherent risk associated with individual marketing agreements commonly made between small and medium sized Hard-Red Winter wheat (HRW) wheat producers and local elevators,

2. To review past work pertaining to hedging strategies and basis risk,

3. To assemble a data set of historical HRW wheat cash and futures prices, and

4. To statistically examine historical basis trend using regression analysis theory to determine if past basis levels may be used as predictors of forthcoming basis movements.

Definition of Terms

For the purpose of this paper, the following terms will be defined as follows:

BASIS: the difference between two prices. It may be between two cash prices, two futures quotes, or a cash price and a futures quote. For the purpose of this paper, it will most often be referring to the latter.

EXPORT ELEVATOR: a large grain handling facility located at an ocean port for the purpose of collecting large quantities of grain from regional, local or large producers to be loaded on large ships for shipment to foreign purchasers.

GULF BASIS: the difference between a futures quote and the gulf bid.

GULF BID: the average posted bid made by export elevators toward the purchase of grain of a specific quality, delivered F.O.B. to the elevator.

LOCAL BASIS: the difference between the local bid price for cash grain and a futures price.

LOCAL ELEVATOR: a grain purchasing station located in a rural area, having a large amount of storage capacity, for the purpose of collecting large quantities of grain from primary producers to be sold to processors, regional elevators or directly to export elevators.

LONG POSITION: the holding of a futures position which obligates the holder to take delivery of a specified quantity and quality of grain at a specific location unless canceled by the holder prior to the delivery date.

PRODUCER: a person who grows agricultural crops for the purpose of selling his production for income.

REGIONAL ELEVATOR: an elevator facility, usually located in urban areas near rail or water transportation, with large storage facilities for the purpose of collecting grain from local elevators or large producers for resale to export elevators or processors.

SHORT POSITION: the holding of a futures position which obligates the holder to deliver a specified quantity and quality of grain to a specific location unless canceled by the holder prior to the delivery date.

NEARBY FUTURES CONTRACT: the futures contract closest to delivery that is not in the delivery month.

CHAPTER II

CONCEPTUAL ISSUES

This chapter is divided into separate discussions. The first section concerns itself with the production characteristics and marketing environment common to Hard-Red Winter (HRW) wheat. Next is a discussion of marketing and hedging alternatives available to producers and elevators. The latter is a review of relevant work pertaining to hedging and marketing raw agricultural products.

Hard-Red Winter Wheat Marketing Systems

Hard-Red Winter wheat is the dominant crop produced in the Great Plains Region and accounts for more than 40 percent of total U.S. wheat production. It is a dual purpose crop providing both forage for cattle grazing and grain for milling. Cattle are placed in fields during fall, while the wheat is in the early vegetative stage, and removed in the spring prior to the last frost allowing the wheat to mature and be harvested in late spring. The grain kernal is also dual purpose being milled into both flour and livestock and poultry rations.

Most farmers market their grain through rural elevators. The elevators may be small independent companies, cooperatives or subsidiaries of larger marketing firms. These 'locals' serve as collection points for wheat which is later sold to larger regional elevators, millers, and feedmillers located in or near the Great Plains area. Almost all the HRW wheat used to fill export orders is shipped to export elevators located along the Texas and Louisiana Gulf coasts vie rail, truck or river barge.

The marketing decision process begins prior to the planting season. The producer determines production goals based upon his estimate of the income level his volume of grain will generate at harvest time. Higher or lower income possibilities relative to alternative crops will influence the amount of resources a producer dedicates toward wheat grain production. For example, if the expected income from HRW wheat is low in relation to feeder cattle, the producer may opt to allow cattle grazing to continue into summer, foregoing the production of grain on portions of his total acreage. Should long term expectations be higher, additional land may be diverted from other crops and placed into wheat production. the level of variable inputs (fertilizer, pesticides, and labor) used during the production cycle will vary depending on the producer's production functions, expected prices received, and total costs.

The grain producer markets his product under near perfect competition and subsequently has only the options of where and when to sell once the production decisions have been implemented. The elevator, often purchasing under oligopsonistic conditions, has no input upon the volume of wheat produced in its trade area except via the purchasing price offered to the producer. This price is not directly determined by the elevator, but is a reflection of a cash or futures price plus or minus transportation costs, handling costs, and a marketing margin. This local price is often referred to as the 'spot price.'

The marketing margin is a function of the elevator manager's forecast of average cost, competition from other purchasers, seasonality (caused by short-run supply and demand for commercial storage and services at a particular time), and the potential risk of unfavorable price movements (Brorsen, et al., 1985). In essence, the marketing margin may be considered as a fee charged by the elevator for assuming financial responsibility and short term price risk of the producer's grain.

Elevator Marketing and Hedging Options

As mentioned, the producer has the ultimate decision of where and when he will sell the crop. To receive the best possible return on the investment, producers will evaluate the potential for price increases against the risk of a potential decrease. Often the farmer can maximize returns not by increasing revenues through higher prices received but by decreasing costs. Under these circumstances, a simple cash sale may be the most feasible alternative to him. Before any further discussion of producer marketing and elevator hedging alternatives is made, one should identify the elevator's sources of income:

1. The firm sells marketing services. It provides the producers a marketing outlet where they may dispose of production and receive payment. The producer is relieved of the responsibility of locating and transacting sales with distant purchasers. For this service, the local elevator receives a fee which is reflected in the marketing margin.

2. The elevator provides the physical facilities and labor required to load, store, and clean grain to be shipped. This service is also usually available to producers who choose not to sell to the elevator, but still require the services. The elevator will charge the producers a per bushel in-out fee in exchange for the services.

3. The elevator profits from favorable basis movements while participating in a storage hedge. If the management is of the opinion favorable basis movements will occur after harvest, the elevator may purchase and store new crop grain and enter into short futures positions. Should the market experience stronger basis levels, the elevator would lose money.

The elevator may offer several purchasing alternatives to the producers. These contracts may be grouped into three separate categories: cash sale, forward contracting, and delayed pricing.

Cash Sale

The cash sale is the simplest form of purchasing arrangement. The agreement requires the simultaneous transfer of title and payment between the producer and the elevator, respectively, at the current spot price offered by the elevator. The producer is required to deliver grain to the elevator's receiving point where he will receive full payment unless he agrees to extend credit.

Upon the completion of the sale, both parties assume new financial positions and risks. The producer is relieved of possible losses due to price declines while forfeiting the opportunity to profit from increases. The elevator now stands to lose money should the market price decline.

Assuming the firm's management to be risk adverse, some type of risk transferring strategy will be enacted by the elevator. The strategy taken will depend upon the management's opinion of expected changes in basis levels. If unfavorable levels are anticipated, cash sales will be made for immediate or deferred delivery, else the elevator will store new grain and assume a short futures position for a similar quantity of grain. The elevator thus prefers basis risk over price risk.

Forward Contract

The forward contract is an accord for the future sale of grain between the producers and elevator at price levels existing at the time the agreement is made. The contract commits the producer to deliver the stipulated quantity and quality of grain to the elevator, for a price set at the time the agreement was made, regardless of current price levels. This agreement may be made anytime prior to or after harvest.

Both parties face additional risks to those incurred in the cash sale. The producer faces 'production risk' or the risk of being unable to deliver the specified quantity of grain due to crop failure or other unforeseen disasters. For example, should drought conditions prevail during the growing season causing yields to be low and prices to rise, the producer would be forced to pay the difference between the contracted or 'booking' price and the spot price on the undeliverable portion at delivery time. The elevator faces similar risks of not being able to market the quantity of grain due to phenomenons such as rail strikes and natural disasters.

Once the elevator has entered into such an agreement, it immediately assumes the price risk associated with the contracted volume of grain. Again, the elevator has the option of entering a short futures position or contracting a forward sale for a similar amount with other purchasers.

Delayed Pricing

Delayed pricing is a special type of contract used to increase the flexibility of both seller and buyer. The producer delivers his grain and transfers title to the elevator without receiving payment or agreeing upon a firm price to be paid later. The agreement permits the elevator to replace the grain with futures contracts allowing it to sell and ship the grain while the producer speculates on a favorable price move. At a later date when the producer is ready to receive payment, the futures positions are closed, and the producer receives the subsequent cash price less a specified fee.

With the introduction of option trading for agricultural commodities, a 'call' option may be used rather than a long futures position. The use of an option relieves the elevator of a cash flow problem should prices decline and permits it to offer the producer a guaranteed minimum price. This assured price is lower than the cash price on transaction day, reflecting the price of the option premium.

The producer should understand when transferring title of his grain, he faces the financial risk of the elevator becoming financially insolvent which could hinder his ability to retrieve unsold grain as possible recourse. The seller should be confident such an event is unlikely to occur.

Literature Review

Most instructors of agricultural marketing define hedging as the assumption of a position in the futures market equal and opposite to a current for future cash position. Hieronymus (1971) expanded the definition by adding:

> to hedge is to insulate one's business activities from price level speculation while retaining the opportunity to speculate in basis variation (p. 149).

He felt this definition took "hedging out of the academic context of risk shifting and put it in the business of making a profit," (p. 150). He emphasized hedgers hedge to retain a profit making opportunity, that is, they often hedge not necessarily avoiding risk, but rather to make a profit.

Holbrook Working (1953b) wrote extensively on why hedgers use futures markets to hedge rather than other alternatives. He stated hedging in futures consisted of:

> making a contract to buy or sell on standard terms established and supervised by a commodity exchange as a temporary substitute for and intended contract to buy or sell on other terms (p. 560).

He listed four reasons why hedgers use the futures markets in their business:

1. It facilitates buying and selling decisions; that is, there is need only to consider whether the price at

which a particular purchase or sale can be made is favorable in relation to other current prices.

2. It gives greater freedom for business action; that is, one may buy or sell on the futures when the actual physical commodity is not available, such as the case prior to harvest.

3. It gives a reliable basis for conducting storage of commodity surpluses; that is, a warehouseman may use the relative basis to determine when the price is favorable for commodity storage thereby enabling the stockpiling of surplus commodities.

4. Hedging reduces business risk; while stressing that a reduction of risk may be only an incidental enticement for hedging, the reduction of risk does allow reduced marketing margins between the farm and retail prices.

Working (1953a) more clearly distinguished between cash and futures markets. He stressed futures markets existed primarily to facilitate the holding of financial positions rather than transferring ownership. He preferred using the term 'non-futures' market to refer to the cash market since it consists of many types of payment and delivery arrangements. He later described the following types of hedges:

1. Carrying Charge Hedge: a hedge placed in connection with the holding of commodity stocks for direct profit from storage. It is most commonly used by elevators

holding large stocks of grain, seeking to profit from a favorable change in the basis.

2. Operational Hedge: used by millers and merchandisers whose operation requires holding positions for such short time periods that basis movements are ignored.

3. Selective Hedging: (often referred to as 'portfolio hedging', Peck, et al., 1975) only a portion of the total stocks held are hedged. The hedger is speculating that a favorable price move will occur during the time period of the hedge. The quantity to be hedged is a function of how much confidence the hedger has in available forecast of future price movements and on the firm's ability to withstand risk.

4. Anticipatory Hedging: (often referred to as 'pre-hedging') is used to take advantage of current price levels prior to obtaining or transferring actual physical and/or financial responsibility of the commodity stocks. An example is a producer entering into a short futures position or an elevator going long during the growing season prior to harvest to take advantage of current price levels when an unfavorable price movement is anticipated.

To summarize the preceding authors, the carrying-charge hedger uses futures markets not necessarily to transfer price risk, but to take advantage of favorable basis movements to increase overall storage revenues. During marketing periods when an unfavorable relationship between cash and futures prices exist, losses may be avoided by using markets other than futures, such as cash sales and forward contracting.

Nelson (1984) distinguished the dissimilarities between forward and futures contracts, identifying lumpiness, revenue, and basis differences. Lumpiness occurs when the quantity of grain a hedger desires to hedge differs from the quantity specified for standard contracts traded on the exchange floor. A forward contract may stipulate any quantity convenient to both buyer and seller. A second difference is the financial settlement methods unique to the individual agreement such as margin requirements to maintain open futures agreements. Typically, no cash payment is made with a forward contract until the stipulated quantity of grain is delivered. The third major difference is the basis existing between the futures and the forward price. This difference is important since its variability dictates the profitability of the hedge. Due to these differences, economists should not freely interchange forward and futures prices in their research models.

Heifner (1966) hypothesized carrying charge hedgers could use basis level forecast to determine the potential profitability of storing Michigan corn. He concluded basis fluctuations can be predicted more accurately than cash price level variations, allowing the hedger to identify lucrative storage periods. He identified three storage intervals. The period immediately following harvest was the most profitable when storage gains from a narrowing basis exceeded the variable cost of storage. Storage returns approximated variable cost during the second interval, sometimes being profitable and sometimes not profitable. Storage was discouraged during the last interval prior to the new harvest, since returns from favorable basis movements rarely exceeded the cost of storage.

Garcia, Leuthold, and Sarhan (1984, p. 500) defined basis risk as "the variance of the random, unsystematic component of the basis over time." They investigated the nature of basis movements using midwest livestock data, and premised basis risk could be divided into two classes. 'Short-term' (or daily) risk is caused by the introduction of new information into the marketplace and its impact upon cash and futures prices. 'Long-term' risk is a function of time, causing the cash and futures prices to approach each other as the contract delivery date nears. Their results concluded the level of basis risk did not significantly vary across markets or decrease as contract maturity approaches.

Tomek and Gray (1970) supported Working's (1942) opinion that the futures prices were not simply predictions of future cash prices since certain events caused similar variations in the cash, nearby and distant contract prices. They concluded the cash price of a commodity is determined by yearly supply and demand conditions with monthly prices fluctuating about the mean price due to seasonality (or short-run supply and demand conditions). The futures price for a particular delivery month simply reflects that average price for the year plus or minus an adjustment based on conditions peculiar to the month.

Berk (1981) studied factors influencing producer hedging. He recognized that few farmers understood how futures markets operate and many of those choose not to participate since futures holdings often tied up credit. He stated their level of hedging activity depended largely on their ability to predict the direction of price movements. Without predictive ability, the Keynes-Hicks-Cootner (1960) theory of speculative markets would hold and farmers would pay speculators a premium to take responsibility of price risk. However, with good predictability, farmers would use the futures markets similar to speculators and attempt to make a profit on their futures positions. He continued to comment that farmer's using the futures markets were able to adjust the total quantity hedged as the growing season progressed and yield levels became more certain, however, the cost of hedging with futures was high enough to discourage producers from hedging when experiencing production risk.

Speculative (or Portfolio) hedging has been the topic of study by several economists. Johnson (1960) and Stein (1961) developed a theoretical model to determine the feasibility to portfolio hedging using a ratio of spot and futures prices. Brown (1985) re-examined their approach and altered it by substituting returns from spot and futures positions rather than prices. He calculated hedging ratios for wheat, corn, and soybeans and determined an argument for portfolio hedging of these commodities could not be supported by his results.

Peck (1975) used historical egg prices to simulate producer hedging environments after production decisions are made. She deduced producers using a reliable price forecast could increase income stability by implementing a hedging strategy on part of anticipated production, and hedgers lacking such a forecast could reduce instability by hedging all production. Brandt (1984) followed by illustrating how hog producers and processors can combine alternative price forecasts with selective hedging strategies to reduce price variability and increase the average price received.

Kolb, Gray, and Hunter (1984) examined the problem of a negative cash flow exhausting operating resources when the price of a hedger's short futures contract decreases. The hedger must re-settle his position daily by adding margin money to his account when a loss is incurred due to the decreased value of his futures position. Bankers and loan companies are often reluctant to extend further credit on the increased value of unharvested crops due to production risk. The authors developed a statistical model to estimate the standard deviation of daily price changes of different market positions in the futures markets and calculated the probability of additional liquidity needs within a given time period.

Wilson (1984) evaluated the effectiveness of hedging wheat at the major U.S. cash markets against the three major commodity exchanges dealing in wheat futures. Using portfolio analysis, he calculated optimal hedging ratios and measures of hedging effectiveness for different types of cash wheat. He concluded the nearby contract and the inherent contract offered the most protection in reducing price risk, and crosshedging among different wheat types was more viable in long term hedges. Miles (1984) commented crosshedging opportunities existed when one class of wheat was experiencing abnormal supply or demand conditions resulting in potential profits from favorable basis movements.

Brorsen, et al. (1985) studied the influence of price risk upon the variability of the farm-retail price spread by developing a theoretical model of price determination. The results indicated wheat marketing firms operating under competitive conditions are increasingly risk adverse and a high level of correlation exits between the level of price risk experienced by these firms and the marketing margins placed on the retail product.

CHAPTER III

PROCEDURES

This chapter discusses the procedures used to satisfy objectives three and four: the collection of data and the statistical calculations necessary to test the hypothesis. The hypothesis is that the gulf basis levels will fluctuate around a mean and the magnitude of gravitation toward the mean is influenced by the percent deviation from the mean. Fluctuations outside the range of the standard deviation will eventually reverse and return to the range.

The 1984-1985 HRW wheat marketing year is an excellent illustration of the regression theory principle (Figure 1). The observed gulf basis for the July 1985 contract (represented by the solid line) exceeded the one standard deviation boundary of the 1980-1984 mean during the period occurring August through early October 1984. The basis later migrated toward the mean, intercepting the upper standard deviation boundary in November. This process was repeated on three more occasions with the basis meeting the mean in late May. An elevator entering into long term storage hedges under these conditions would have often lost money.

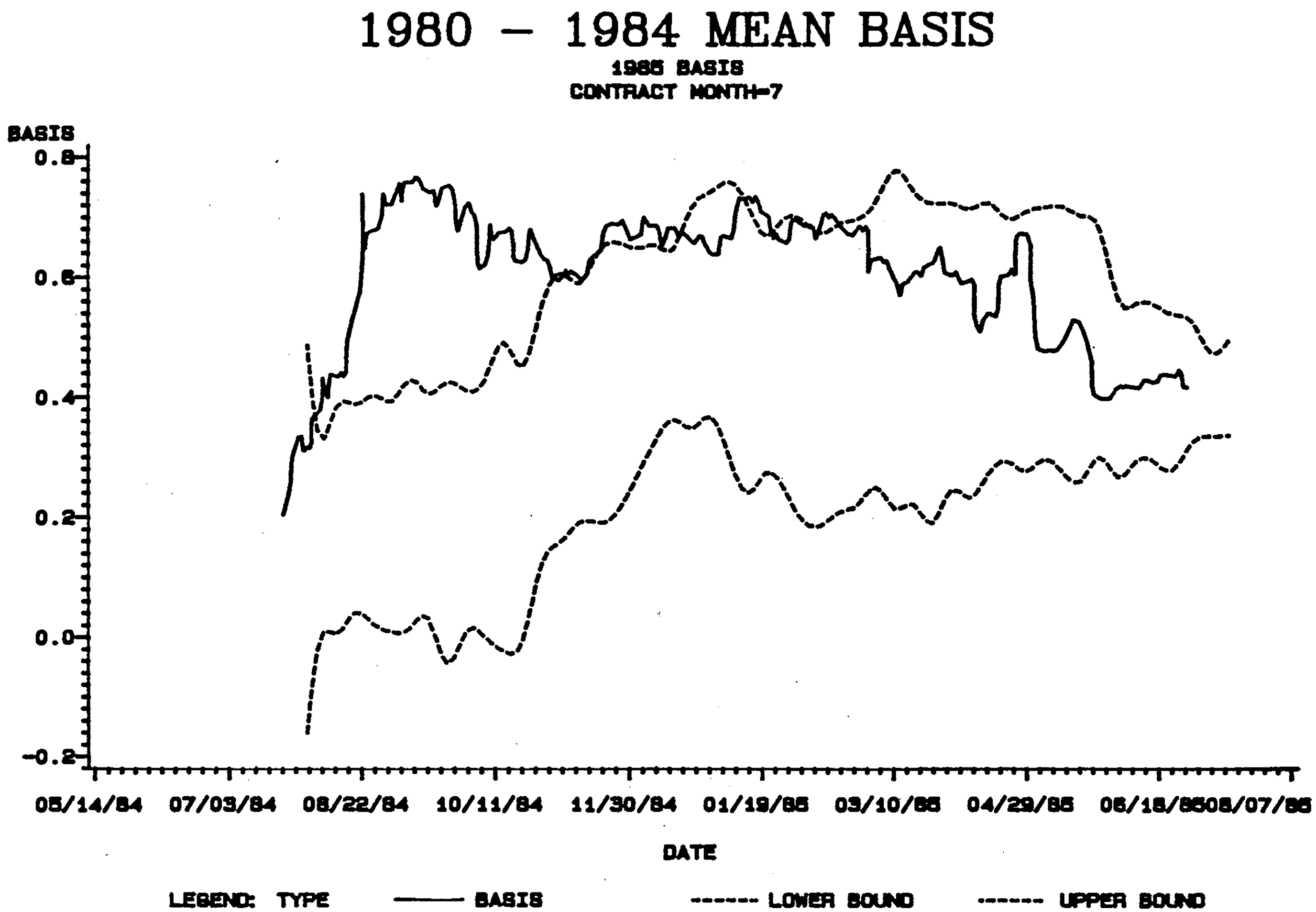

Figure 1. 1985 Basis Levels for July Contract Compared to the Upper and Lower Standard Deviation Bounds of 1980-1984 Mean

Statistical Procedures

Basis levels are reflections of seasonality or changes in short-run supply and demand conditions as well as transportation and/or storage differentials between locations, time periods or both. The basis data requires some type of alteration to remove the undesirable statistical properties of seasonality while retaining the variability factor in order to be used in a time series analysis. One method is to transform the values into standardized deviations. Standardized deviations measure the percent variation around the mean.

The first step is the calculation of the gulf basis which is accomplished by taking the differences between the gulf cash wheat bid and the corresponding futures price using the following formula:

$$BS_t^{m,f} = GC_t - FP_t \qquad (1)$$

where

$BS_t^{m,f}$ = the gulf basis at time t in month m in relation to futures contract f,

GC_t = the average gulf bid at time t,

FP_t = the price at time t of futures contract f.

Two mathematical steps are required to calculate the standardized deviation. The first step is the estimation of the expected basis mean. Assuming the following to be true:

$$E[BS_t^{m,f}] = \mu^{m,f} \qquad (2)$$

where

$E[BS_t^{m,f}]$ = expected gulf basis on trading day t of month m in relation to futures contract f,

$\mu^{m,f}$ = true basis mean for month m in relation to futures contract f,

and

$$E[\mu^{m,f}] = \quad ^{m,f} \qquad (3)$$

where

$E[\mu^{m,f}]$ = expected value of μ for month m in relation to futures contract f.

After the above assumptions are postulated, a moving average of monthly averages can be used to estimate $\mu^{m,y}$ using the following equation:

$$\mu^{m,f*} = \sum_{z=1}^{Z} \left(\sum_{t=1}^{T} BS_t^{m,f}, y-z \right) \qquad (4)$$

where

$\mu^{m,f*}$ = the estimate of the expected monthly mean gulf basis for month m in relation to futures contract f, and is assumed to be the median value of a normal distribution having variance σ^2.

$\sum_{z=1}^{Z} \left(\sum_{t=1}^{T} BS_t{m,f}, \; y-z \right)$ = the sum of the sum of basis values occurring in month m of year y-z in relation to futures contract f. Futures contract f refers to the nearest futures contract requiring delivery in a specific month m. For example, during June, 1984, the July contract will refer to the July, 1984 contract rather than July, 1985.

Tables I and II show the 4-year monthly average and corresponding standard deviations for the gulf basis for the periods June 1980 through May 1984 and for June 1981 through May 1985, respectively. The values were derived using Equation (4) and are used in the determination of the standardized deviations for the corresponding time periods June 1984 through May 1985 and for June 1985 through May 1986.

$$SD_t^{m,f} = (BS_t^{m,f} - \mu^{m,f})/\sigma\mu^{m,f} \qquad (5)$$

where

$SD_t^{m,f}$ = the standardized deviation of the gulf basis on trading day t in month m in relation to futures contract f,

$\sigma\mu^{m,f}$ = the standard deviation of $\mu^{m,f}$*.

Assuming the standardized deviations are distributed normally and the percent variation in one time period is a function of the same elements as for a later time period, ordinary least squares may be used to estimate the variation in time period t+j using the variation in time t as the independent variable using the following:

$$\tilde{SD}^{m}_{t+j,y} = \Theta\ \tilde{SD}^{m}_{t,y} + \varepsilon_y \qquad (6)$$

where

$\tilde{SD}^{m}_{t+j}$ = Θ a Y x 1 column vector of lagged observations (j = 21, 42, 63, 126),

Θ = the regression parameter estimate for $SD^{m}_{t,y}$,

$\tilde{SD}_t^{m,y}$ = a Y x 1 column vector, and

ε_y = a Y x 1 column vector of disturbance terms.

TABLE I

FOUR YEAR AVERAGE AND STANDARD DEVIATION FOR GULF BASIS,[1]
6-1-80 THROUGH 5-31-84

MONTH	MARCH		MAY		JULY		SEPTEMBER		DECEMBER	
	μ	σμ	μ	σμ	μ	σμ	μ	σμ	μ	σμ
JAN	.4892	.0658	.5194	.1265	.5671	.1514	.4838	.1638	.3150	.1837
FEB	.4966	.0403	.5123	.1103	.5454	.1568	.4587	.1793	.3972	.2069
MAR	.4868	.0420	.5306	.1030	.5839	.1796	.5064	.1892	.3637	.2129
APR	.3619	.1256	.5151	.0790	.5776	.1441	.4961	.1725	.3508	.2090
MAY	.2195	.2451	.4818	.1059	.5669	.1639	.4850	.1949	.3342	.2181
JUN	.0525	.2574	.0973	.3022	.4224	.1401	.3403	.2018	.1868	.2234
JUL	.0315	.1527	-.0021	.1921	.3101	.1845	.3031	.1731	.1510	.1359
AUG	.0347	.1454	.0092	.1541	.1396	.1452	.2640	.2717	.1434	.1479
SEP	.1555	.1312	.1165	.1585	.1556	.1884	.2502	.2605	.2896	.0939
OCT	.2069	.1747	.1765	.2168	.2117	.2493	.1221	.2618	.3398	.0970
NOV	.3504	.1739	.3359	.2283	.3999	.2359	.2618	.2420	.4247	.1147
DEC	.4379	.1090	.4501	.1618	.5171	.1877	.4412	.2017	.3605	.1780

[1] μ values calculated using Equation 3.

TABLE II

FOUR YEAR AVERAGE AND STANDARD DEVIATION FOR GULF BASIS,[1]
6-1-81 THROUGH 5-31-85

MONTH	MARCH		MAY		JULY		SEPTEMBER		DECEMBER	
	μ	σμ	μ	σμ	μ	σμ	μ	σμ	μ	σμ
JAN	.5193	.0459	.5949	.0490	.6624	.0427	.5961	.0580	.4670	.0916
FEB	.5025	.0388	.5724	.0431	.6430	.0423	.5806	.0669	.4547	.0920
MAR	.4569	.0559	.5592	.0686	.6646	.0481	.6063	.0416	.4853	.0550
APR	.3821	.1124	.5316	.0697	.6348	.0703	.5826	.0714	.5648	.0856
MAY	.3354	.0694	.4879	.1125	.6028	.1161	.5518	.0998	.4280	.0819
JUN	.1481	.2038	.2731	.0946	.4731	.1040	.4058	.1473	.2662	.1682
JUL	.0965	.1632	.0727	.1972	.4184	.0490	.3644	.0837	.2036	.1336
AUG	.1374	.2049	.1239	.2225	.2786	.1774	.4203	.0983	.2171	.1834
SEP	.3022	.1438	.3005	.1899	.3690	.2179	.4823	.0558	.3799	.0807
OCT	.3155	.1362	.3371	.1783	.4117	.2227	.3351	.2493	.3881	.0746
NOV	.4189	.1207	.4434	.1483	.5388	.1452	.4752	.1638	.4573	.0615
DEC	.4835	.0720	.5352	.0831	.6626	.0918	.5575	.1055	.4599	.0365

[1] μ values calculated using Equation 3.

The data are sorted by trading days of the year, resulting in 252 trading days and eight years of data. Therefore, 252 models were estimated with each model having eight observations. The data set is discussed further in the following section.

The intercept term is removed assuming a percent variation in time t equal to zero (the basis equal to the average basis), will indicate an expected value of the lagged deviation for time t+j also equal zero if the hypothesis is true. The correlation between the dependent and the independent variable is expected to be negative indicating an increase in percent deviation in time t would be followed by decreased deviation values for the lagged variable.

Data

The data set is constructed by collecting historical prices for HRW wheat futures contracts and cash bids. The data spans a 12-year period beginning with the first business day of June, 1974 and ending on the delivery date of the December, 1985 contract. Observations occurring prior to this period are not included to avoid the abnormal price shocks caused by the large Russian and Chinese purchases during the early seventies.

Future prices are closing quotes for all contracts of HRW wheat traded on the Kansas City Board of Trade. Cash prices are averages of closing gulf bids for HRW wheat, grade two, F.O.B. Texas gulf coast. The elevator faces the problem of predicting market direction and strategy on a daily basis, therefore the data collected is for each trading day.

Constructing and using daily models is difficult due to the inconsistence of the solar calendar. To simplify the process, time is partitioned into marketing years. Each year begins on the first trading day of June and ends on the last trading day of May.

Since the exact number of trading days observed in each solar year varies due to holidays and weekends, each year is reduced to 252 trading days. Each month contains 21 days regardless of the actual number. Additional days in each year causing the total to exceed 252 are deleted from the final days of December, when short-run supply and demand conditions are often distorted during the long holiday season.

Simultaneous cash and futures quotes occasionally are unprocurable due to trading in one market while the other observes holidays or experiences extraordinary circumstances. These instances are rare and overcome by the interpolating prices.

Model

It is postulated an elevator participates in storage hedges ranging between one day and several months determined by the anticipated returns from storage. To measure the potential risk of storage hedging, the standardized deviations of the basis variations are lagged 21, 42, 63, and 126 trade days (representing 1, 2, 3, and 6 months) and used as the dependent variables in the estimation of the model, Equation (6).

The data is sorted into 252 trading days for each year of an eight year period. The eight year period is the result of the first 4 of the 12 years being consumed in the calculation of the estimated mean values used in Equation (3). Since the elevator firm faces daily basis risk, the model is regressed for each trading day on all futures contracts. Therefore, each model had eight observations and the number of models for each length of hedge varied since it was not desired to lag data passed the delivery date.

$\bar{\Theta}_j^{m,f}$ represents the monthly average of the daily parameter estimates for each month and are shown in Tables III through VIII. Each table is representative of one of the five futures delivery months or the nearby contract. Each table is futher divided showing the $\bar{\Theta}_j^m$ values for the different lag periods used in the model. The blank spaces are the result of deleating the months nearest the end of the contract's life during the lagging process.

The $\bar{\Theta}_j^m$ values are multiplied by the corresponding standardized deviation to calculate the estimated standardized deviation for time period t+j (Equation 7) as shown in Table VII.

TABLE III

AVERAGE PARAMETER ESTIMATES FOR NEARBY CONTRACTS[1]

MONTH	ONE MONTH		TWO MONTH		THREE MONTH		SIX MONTH	
	Θ	σ	Θ	σ	Θ	σ	Θ	σ
JAN	.8929	.5926	.3565	1.4273	.7077	1.0386	.5097	1.1025
FEB	.5122	1.2079	.8902	1.1302	.4652	1.1366	.4251	1.4414
MAR	1.1544	.8296	.8148	1.2274	.5772	1.3243	.6429	1.1543
APR	.5110	1.1744	.1611	1.1407	.3874	1.2550	.3758	.8926
MAY	.7400	.5644	.2367	1.0595	.0852	1.4067	.3498	.9923
JUN	.4343	.9557	.2233	1.5113	.4273	1.7340	.8841	1.1825
JUL	1.0423	1.5564	1.0810	1.6967	1.1825	1.3990	.4820	1.5385
AUG	.9253	1.0626	1.3168	1.3569	.5370	1.1076	.3654	1.6273
SEP	.9000	.8015	.7073	1.1762	.3472	1.5137	.0722	1.3047
OCT	.8139	.9021	.4461	1.4031	.3790	1.8494	.1433	1.1462
NOV	.5577	1.3121	.2120	1.9423	.2852	1.7856	.1129	1.1638
DEC	.7795	1.2564	.5192	1.2716	.1932	1.4958	.4244	1.3821

[1]Calculated

TABLE IV

AVERAGE PARAMETER ESTIMATES FOR MARCH CONTRACTS[1]

MONTH	ONE MONTH		TWO MONTH		THREE MONTH		SIX MONTH	
	Θ	σ	Θ	σ	Θ	σ	Θ	σ
JAN	.8910	.5889	-	-	-	-	-	-
FEB	-	-	-	-	-	-	-	-
MAR	-	-	-	-	-	-	-	-
APR	-	-	-	-	-	-	-	-
MAY	.8327	.4296	.7719	.9641	.6737	1.1627	.7917	.6593
JUN	1.0959	.8599	.9990	1.2339	1.0897	1.4414	.6631	1.2763
JUL	.9270	.8594	.9777	1.1748	.9432	.9730	.2508	1.6490
AUG	.9907	1.0334	.9079	1.0219	.6865	1.1578	.2950	1.3854
SEP	.9489	.7794	.6376	1.0466	.4466	1.2890	-	-
OCT	.8109	.6534	.5919	1.0959	.4899	1.4366	-	-
NOV	.8092	.7915	.5754	1.4457	.4415	1.2686	-	-
DEC	.7830	1.2211	.5171	1.2720	-	-	-	-

[1]Omitted values are due to the lagging process.

TABLE V

AVERAGE PARAMETER ESTIMATES FOR MAY CONTRACTS[1]

MONTH	ONE MONTH		TWO MONTH		THREE MONTH		SIX MONTH	
	Θ	σ	Θ	σ	Θ	σ	Θ	σ
JAN	.8628	.3665	.5973	.5664	.7524	.9218	-	-
FEB	.7029	.5170	.8856	.9180	-	-	-	-
MAR	1.1544	.8296	-	-	-	-	-	-
APR	-	-	-	-	-	-	-	-
MAY	-	-	-	-	-	-	-	-
JUN	-	-	-	-	-	-	-	-
JUL	1.0277	.9116	1.0653	1.3613	1.1643	1.4421	.3523	1.4740
AUG	1.0103	.9291	1.0462	1.2338	.7796	1.1502	.3207	1.2655
SEP	.9941	.9214	.7238	1.0234	.4768	1.0052	.1610	1.0526
OCT	.7510	.6316	.4924	.8551	.4574	1.0893	.3317	1.2573
NOV	.6784	.6883	.5248	1.2018	.4430	1.0974	-	-
DEC	.7898	1.0685	.6207	1.0574	.4154	.9150	-	-

[1]Omitted values are due to the lagging process.

TABLE VI

AVERAGE PARAMETER ESTIMATES FOR JULY CONTRACTS[1]

MONTH	ONE MONTH		TWO MONTH		THREE MONTH		SIX MONTH	
	Θ	σ	Θ	σ	Θ	σ	Θ	σ
JAN	.9992	.4503	.8684	.5258	1.0668	.6330	-	-
FEB	.8493	.4544	1.0259	.6125	.8926	1.8482	-	-
MAR	1.1366	.5500	1.1854	1.6285	.8863	1.2870	-	-
APR	.8701	1.7077	.6846	1.3276	-	-	-	-
MAY	.7574	.5572	-	-	-	-	-	-
JUN	-	-	-	-	-	-	-	-
JUL	-	-	1.0955	1.3878	-	-	-	-
AUG	.8538	.7782	.8181	.9800	.8802	1.1857	.3780	.1434
SEP	.9042	.8370	.9210	1.1922	.5220	1.1676	.2256	.0911
OCT	1.0566	.6330	.5461	1.1068	.5406	1.6510	.5166	.0172
NOV	.5388	1.0172	.5280	1.5832	.4737	1.0175	.2202	.5681
DEC	.9759	1.3679	.6097	1.1690	.5491	1.0677	.5710	.2356

[1]Omitted values are due to the lagging process.

TABLE VII

AVERAGE PARAMETER ESTIMATES FOR SEPTEMBER CONTRACTS[1]

MONTH	ONE MONTH		TWO MONTH		THREE MONTH		SIX MONTH	
	Θ	σ	Θ	σ	Θ	σ	Θ	σ
JAN	-	-	-	-	-	-	-	-
FEB	.7671	.4955	.7113	.4071	.7843	.7645	.4598	1.2610
MAR	1.0336	.4806	.9180	.6433	.7613	.5767	.6600	1.1076
APR	.7322	.7608	.5721	.6983	.6513	.7408	.5678	.6631
MAY	.7769	.3929	.5944	.9182	.5438	1.2261	.5986	1.3029
JUN	1.0058	.9163	.9235	1.2958	.9282	1.4237	-	-
JUL	.9461	.8640	.9294	1.1075	.9828	.9026	-	-
AUG	.8460	1.1800	.8874	1.0697	.6326	1.4120	-	-
SEP	.9023	.7834	.7144	1.1514	-	-	-	-
OCT	.9023	.7834	.7144	1.1514	-	-	-	-
NOV	-	-	-	-	-	-	-	-
DEC	-	-	-	-	-	-	-	-

[1]Omitted values are due to the lagging process.

TABLE VIII

AVERAGE PARAMETER ESTIMATES FOR DECEMBER CONTRACTS[1]

MONTH	ONE MONTH		TWO MONTH		THREE MONTH		SIX MONTH	
	Θ	σ	Θ	σ	Θ	σ	Θ	σ
JAN	1.0087	.4376	.8708	.5322	1.0227	.5355	.6349	.6981
FEB	.8581	.4436	.9869	.5170	.7431	1.1954	.7039	1.9388
MAR	1.0835	.4797	.9352	1.0170	.7142	.9202	-	-
APR	.7445	1.0868	.5773	.9684	.5858	.6895	-	-
MAY	.7773	.3781	.4544	.7982	.4523	1.9667	-	-
JUN	.8212	.9350	.7769	2.0273	-	-	-	-
JUL	1.0629	1.5772	-	-	-	-	-	-
AUG	-	-	-	-	-	-	-	-
SEP	-	-	-	-	-	-	-	-
OCT	-	-	-	-	-	-	-	-
NOV	.4510	1.1022	.4915	1.4963	.3517	.9881	.1589	1.5442
DEC	1.0077	1.0077	.7136	1.1462	.6051	1.0857	.5347	1.1104

[1]Omitted values are due to the lagging process.

$$ESD^{m}_{t+j} = \bar{\Theta}_{j}^{m,f} * SD_{t}^{m,f} \quad (7)$$

where

ESD^{m}_{t+j} = estimated standardized deviation for time t+j.

These expected values for SD_{t+j} are multiplied by the standard deviation of the average basis value for the month concurring with time period t+j. The product is added to the average basis value for the month resulting in the estimated basis value for time t+j as shown in the following equation derived from Equation (4):

$$EBS^{m,f}_{t+j} = (ESD^{m,f}_{t+j} * \sigma\mu^{m,f}_{t+j}) + \mu^{m,f}_{t+j} \quad (8)$$

where

$EBS^{m,f}_{t+j}$ = estimated basis for time t+j of month m in relation to futures contract f.

One will notice the average parameter estimate for the shorter term estimates listed in Tables III through VIII have Θ^{m} values closer to 1 while the more distant parameter estimates tend to be smaller. This would be expected since the change in percent variation will be greater as new information becomes available in the marketplace. This indicates the regression theory would be used by a hedger as a technical rather than a fundamental tool when forecasting basis movements.

To evaluate the efficiency of the basis level estimation process, the values derived from Equation (8) are subtracted from the observed basis levels. The differences are referred to as the forecast errors. The equation is:

$$FE^{m,f}_{t+j} = BS^{m,f}_{t+j} - EBS^{m,f}_{t+j} \quad (9)$$

where

$FE^{m,f}_{t+j}$ = forecast error of the estimated basis level for time t+j of month m in relation to futures contract f.

The forecast errors for each length hedge and futures contract are summed and the mean and standard deviation determined those hedges having sums and means equal to zero indicate the estimation process produces estimates that are consistant and unbiased. Theory would lead one to expect the shorter term hedges to yield the highest quality estimates since longer term hedges are affected by additional news introduced to the market.

Simulation and Results

The estimation process was evaluated using the procedures and data set previously mentioned. A moving average of monthly average basis levels was calculated using Equation (4) resulting in an eight year data set, each year containing 12 monthly averages and standard deviations. The monthly means for the marketing years beginning June, 1980 through May, 1984 and June, 1981 through May, 1985 are shown in Tables I and II, respectively.

The monthly means and standard deviations were input into Equation (5) along with the daily basis values for each futures contract month to calculate the 252 daily standardized deviations for each of the eight years. The standardized deviations were sorted by trading day to create 252 separate column vectors, each containing 8 observations. As previously mentioned in the data section, the first 4 years of the 12 year data set are consumed in the calculation of the initial averages.

Four additional column vectors were created by lagging the standardized deviations ($SD_t^{m,f}$) 21, 42, 63, and 126 days and were each regressed onthe originals using Equation (6). The resulting parameter estimates were averaged by month ($\Theta_j^{m,f}$) and substituted into Equation (7) along with $SD_t^{m,f}$ to produce the expected standardized deviations for time t+j ($ESD^{m,f}_{t+j}$). The estimated base for time t+j were derived by inserting the values for $ESD^{m,f}_{t+j}$ into Equation (8) along with the corresponding monthly mean and standardized deviation occurring in the same month as time t+j.

The estimated base values for the period beginning June 1, 1984 and ending December 31, 1984 were subtracted from the observed basis values to create 24 separate columns of forecast errors (Equation 9). To further simplify the process, all forecast errors were deleted except those for every 5th trade day beginning with the values for the 5th trade day.

Tables IX through XIV contain the results of the forecasting error summations. It was surprising to discover the mean values for all hedges not significantly different from zero at the five percent level (a two-tailed test was

TABLE IX

STATISTICAL SUMMARY OF FORECASTING ERROR
FOR THE NEARBY CONTRACT

Length of Hedge	Sum	Mean	t	Standard Deviation	(DF)
1 Month	-2.1440	-.02783	-.2976	.0935	76
2 Month	-4.1287	-.05360	-.3569	.1502	72
3 Month	-4.9075	-.06370	-.3896	.1635	68
6 Month	-9.7200	-.12620	-.6041	.2089	56

TABLE X

STATISTICAL SUMMARY OF FORECASTING ERROR
FOR MARCH CONTRACT

Length of Hedge	Sum	Mean	t	Standard Deviation	(DF)
1 Month	1.7204	.0269	.3074	.0875	63
2 Month	3.9679	.0709	.6165	.1150	59
3 Month	4.9750	.1036	.9088	.1140	53
6 Month	5.3985	.2454	1.3904	.1765	27

TABLE XI

STATISTICAL SUMMARY OF FORECASTING ERROR
FOR MAY CONTRACT

Length of Hedge	Sum	Mean	t	Standard Deviation	(DF)
1 Month	1.8606	.0321	.2113	.1519	55
2 Month	5.3970	.1018	.7011	.1452	52
3 Month	5.9940	.1394	1.0036	.1389	42
6 Month	5.8852	.3270	1.8000	.1817	17

TABLE XII

STATISTICAL SUMMARY OF FORECASTING ERROR
FOR JULY CONTRACT

Length of Hedge	Sum	Mean	t	Standard Deviation	(DF)
1 Month	7.3863	.1211	.6004	.2017	60
2 Month	6.6019	.1223	.8142	.1502	53
4 Month	8.5678	.1714	1.0773	.1591	49
6 Month	16.3361	.3890	1.6603	.2343	41

TABLE XIII

STATISTICAL SUMMARY OF FORECASTING ERROR FOR SEPTEMBER CONTRACT

Length of Hedge	Sum	Mean	t	Standard Deviation	(DF)
1 Month	1.1378	.0215	.4370	.0491	52
2 Month	.0137	.0003	.0009	.3448	42
3 Month	.3068	.0099	.0606	.1634	30
6 Month	.6708	.0419	.2550	.1643	15

TABLE XIV

STATISTICAL SUMMARY OF FORECASTING ERROR FOR DECEMBER CONTRACT

Length of Hedge	Sum	Mean	t	Standard Deviation	(DF)
1 Month	.8756	.0148	.7550	.0196	58
2 Month	.4067	.0083	.0842	.0986	48
4 Month	.8330	.0083	.0623	.1333	41
6 Month	-1.2308	-.0724	-1.0112	.0716	16

performed). The summations for the Nearby, March, May, and June contracts appeared (although not statistically tested) to be somewhat biased.

It was assumed the Nearby basis would yield the most impressive results, however, the September and December had summations closer to zero and lower standard deviations. These results would indicate storage hedgers would prefer using the September and December contracts as hedging variations since the basis appears to be less volatile and more predictable. The September and December contracts are used for hedging new crop wheat and are not affected by the fundamental disturbances caused by weather and new crop yield expectations.

Illustration

The applicability of using historical basis deviations about a mean to measure the risk of adverse basis movements during a hedging period may be demonstrated with actual price data occurring in 1985. In the following illustration, a rural Oklahoma elevator considers taking a long position in the cash Hard Red Winter wheat market on March 15, 1985, with an offsetting short position in the July, 1985 Kansas City Board of Trade wheat contract. The elevator's marketing specialist has previously accessed cash and futures price data for the prior four years and references a table of average parameter coefficients ($\bar{\Theta}\ j^m$).

On March 14, the July futures contract closed 60 cents per bushel under the average gulf bid. The elevator has a goal of realizing a 35 cent basis for delivery to the gulf on June 15. This will allow for a 25 cent (.60 - .35) decrease in the basis over the life of the hedge.

The specialist has calculated the expected average basis for the month of March to be 58 cents per bushel[1] with a standard error of 18 cents. Using equation (7), the expected standardized deviation for June 15 is calculated to be .979. Substituting this value into Equation (8) the expected basis on June 15 for the July contract is 43 cents, 8 cents higher than the goal of 35 cents per bushel.

Based upon this information, the market specialist considers his options. One option is based on a higher expected basis, increase the offering price to the seller. The hedger may analyze the probability that the contracted basis will be equal to or greater than the expected basis. Assuming a normal distribution facilities determining this probability, the expected mean is 43 cents and the standard deviation is 14 cents (Table I). The calculations show that there is a 63 percent chance that the actual basis is equal to or greater than the expected basis. A standard normal distribution function may also be used to estimate the probability.

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[1]Wilson's (1984) conclusion that crosshedging between different types of wheat often offers improved price protection has been acknowledged. For the purposes of this study, only the Kansas City Board of Trade futures quotes will be considered.

Based on these figures, the market specialist can make the decision to enter into a storage hedge, buy and sell immediately on cash market earning only a market margin, or may delay entering into short futures position, speculating for a favorable basis change. The last alternative is, of course, dependent on the level of risk adverseness of the elevator management.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The marketing of agricultural commodities is subject to many risks, the most dangerous being price risk incurred while holding long cash positions. Many grain merchandisers attempt to minimize their exposure to price risk using hedging strategies incorporating futures markets. The success or failure of hedging is dependent upon the timing of the hedge and the hedgers ability to anticipate changes in the cash-futures price relationship, commonly referred to basis risk.

The objective of this study was to identify and to measure the level of risk associated with grain elevator purchasing agreements under various market conditions. The mechanics of different purchasing contracts were discussed and the underlying risk identified along with possible hedging strategies.

Periods of increased and decreased basis risk were identified using a regression theory. The theory assumes basis levels will gravitate toward a mean and the probability of moving toward the mean increases the greater the distance between them. This theory may be used by a hedger to identify profitable storage periods and to be alerted to the possibility of incurring losses.

The first step in the process was the estimation of an expected mean value for the basis. A data set consistency of historical Hard Red Winter wheat basis levels between gulf export bids for cash delivery and closing settlement prices for all contracts traded on the Kansas City Board of Trade was collected.

A four year monthly moving average of basis levels was used as an estimator of the expected mean basis level for time period t (Equation 4). Deviations from the mean were measured using standardized deviations (Equation 5) having two favorable characteristics. The standardized deviations allowed cardinal measurements of the percent deviation and removal of the undesirable characteristics of seasonality allowing the use of ordinary least squares to estimate parameter coefficients.

A hedger examining the feasibility of entering into a storage hedge must have some estimate of future basis deviations from the mean in relation to prevailing basis deviations. Lagged values of the standardized deviations were used as dependent variables with the values for time t as the independent (Equation 6). The intercept term was deleted since a variation of zero in time period t would indicate a zero deviation in the lagged. The predicted values for the dependent variable were substituted into the original standardized deviation equation along with the four year monthly moving average estimate and the associated standard error and solved for the estimated basis value for the lagged period (Equation 8).

The accuracy of the estimates were examined by taking the differences between the actual and the predicted (Equation 9). Those error terms summing to a value not significantly different from zero indicate a high degree of confidence in the accuracy of the model.

It was concluded the process should be used as a technical aid in predicting basis fluctuations and not as a fundamental tool. The process seems to be best suited for shorter term hedges and more desirable for the September and December contracts.

It is recommended the hedger use this process as an aid to the decision process and not as the sole forecasting method. This method used in collaboration with a proven fundamental forecasting method could improve the profitability of placing storage hedges by allowing the hedger to improve the timing and the method of heding.

A SELECTED BIBLIOGRAPHY

Bacharach, Michael. "Economics and the Theory of Games." Boulder, Colorado: Westview Press (1977) p. 14.

Bailey, Fred. Understanding Basis and the Economics of Where and When. Chicago, Illinois: Chicago Board of Trade Clearing Corporation, 1983.

Berk, Peter. "Portfolio Theory and the Demand for Futures: The Case of California Cotton." American Journal of Agricultural Economics. 63(1981): 466-474.

Brandt, Jon A. "Forecasting and Hedging: An Illustration on Risk Reduction in the Hog Industry." American Journal of Agricultural Economics. 67(1985): 24-31.

Brennan, Michael J. "The Supply of Storage." American Economic Review. 48(1958): 50-72.

Brorsen, B. Wade. "Marketing Margins and Price Uncertainty: The Case of the U.S. Wheat Market." American Journal of Agricultural Economics. 67(1985): 521-528.

Brown, Stewart L. "A Reformulation of the Portfolio Model of Hedging." American Journal of Agricultural Economics. 67(1985): 508-512.

Cootner, Paul H. "Returns to Speculators: Telser Versus Keynes." Journal of Political Economy. 68(1960): 396-404.

Garcia, P. "Basis Risk: Measurement and Analysis of Basis Fluctuations for Selected Livestock Markets." American Journal of Agricultural Economics. 66(1984): 499-504.

Heifner, Richard G. "The Gains from Basing Grain Storage Decisions on Cash-Future Spreads." Journal of Farm Economics. 48(1966): 1490-1495.

Helmberger, Peter G. and Vincent Akinyosoye. "Competitive Pricing and Storage Under Uncertainty With an Application to the U.S. Soybean Market." American Journal of Agricultural Economics. 66(1984): 119-130.

Hieronymus, Thomas A. Economics of Futures Trading, for Commercial and Personal Profit. New York, New York: Commodity Research Bureau, 1971.

Johnson, Leland L. "The Theory of Hedging and Speculation." Review of Economic Studies. 27(1960): 139-151.

Keynes, John M. Treatise on Money, Vol. II. London: Macmillan and Co., 1930.

Kolb, Gray, and Hunter. "Cash Flow Requirements for Elevator Hedging." Review of Research and Futures Markets. Vol. 34, No. 2, 1984.

Nelson, Ray D. "Forward and Futures Contracts as Preharvest Commodity Marketing Instruments." American Journal of Agricultural Economics. 67(1985): 16-23.

Peck, Anne E. "Hedging and Income Stability: Concepts, Implications, and an Example." American Journal of Agricultural Economics. 57(1975): 410-419.

Stein, Jerome L. "The Simultaneous Determination of Spot and Futures Prices." American Economics Review. 51(1961): 1012-1025.

Tomek, William G. and Roger Gray. "Temporal Relationships Among Prices on Commodity Futures Markets: Their Allocative and Stabilizing Roles." American Journal of Agricultural Economics. 52(1970): 372-380.

Wilson, William W. "Heding Effectiveness of U.S. Wheat Futures Markets." Review of Research in Futures Markets. 3(1984): 64-79.

Working, Holbrook. "Theory of the Inverse Carrying Charge in Futures Markets." Journal of Farm Economics. 30(1948): 1-28.

Working, Holbrook. "The Theory of the Price of Storage." American Economic Review. 39(1949): 1254-1262.

Working, Holbrook. "Futures Trading and Hedging." American Economic Review. 43(1953a): 314-343.

Working, Holbrook. "Heading Reconsidered." Journal of Farm Economics. 35(1953b): 544-561.

Working, Holbrook. "A Theory of Anticipatory Prices." American Economic Review. 48(1958): 188-199.

Working, Holbrook. "New Concepts Concerning Futures Markets and Prices." American Economic Review. 52(1962): 431-459.

Working, Holbrook. "Quotations on Commodity Futures as Price Forecasts." Econometrica. 25(1984): 214-218.

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VITA

Donald Dale Stemple

Candidate for the Degree of

Master of Science

Thesis: OPTIMAL ELEVATOR HEDGING USING HISTORICAL BASIS LEVELS

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Duncan, Oklahoma, July 22, 1956, the son of Donald and Patsy Stemple.

Education: Graduated from DeQueen High School, DeQueen, Arkansas, in May, 1974; received Bachelor of Science Degree in Agriculture from the University of Arkansas in December, 1978; completed requirements for the Master of Science degree at Oklahoma State University in December, 1986.

Professional Experience: Graduate Research Assistant, Department of Agricultural Economics, Oklahoma State University, January, 1984, to March, 1986.

Professional Organizations: Member of the American Agricultural Economics Association; member of the Oklahoma Agricultural Economics Association.