AN ANALYSIS OF EXPECTED RETURNS TO OKLAHOMA GRAIN ELEVATORS FROM ALTERNATIVE HEDGED WHEAT STORAGE PRACTICES

By

JAMES LAWRENCE DRISCOLL

Bachelor of Science
Montana State College
Bozeman, Montana
1964

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1966

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
May, 1969

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Thesis Approved:

Leo V. Oakley
Thesis Adviser

William Lewis Grant

John R. Brazzmann

Carl E Marshall

D. D. Durham
Dean of the Graduate College

724810

PREFACE

This dissertation is concerned with an investigation of the feasibility of hedged storage of wheat as a business activity of grain elevators in Oklahoma. This activity is analyzed to determine whether or not the net income of these firms could be increased by holding wheat in storage rather than selling the wheat immediately after its purchase from the producer. The returns which would have been realized during specified periods of the year during the 1962 and 1964 to 1967 crop years are analyzed to determine the feasibility of the activity. Returns are analyzed for several hedging practices for the Kansas City and Chicago wheat futures markets.

I would like to take this opportunity to express my appreciation to Dr. Leo V. Blakley for his assistance as chairman of my graduate advisory committee. Appreciation is also expressed to Dr. John R. Franzmann and Dr. William L. Brant for their helpful suggestions and encouragement. All of the members of my advisory committee rendered assistance which was invaluable in the preparation of the final manuscript.

I would also like to thank Dr. Carl E. Marshall, Director of the Statistical Laboratory, for serving on my graduate committee. Appreciation is expressed to Dr. James E. Martin and Dr. James S. Plaxico, both of whom previously served as chairman of my advisory committee and to Dr. John W. Goodwin, Dr. Charles H. Little, and Dr. Luther G. Tweeten

for their previous service on my advisory committee. The advice and encouragement of these men aided substantially to my education.

A note of thanks is given to Mrs. Suzanne Moon and Mrs. Judy Eley for their assistance in typing earlier drafts of the manuscript. Thanks also are given to Miss Pat Cundiff, Mrs. Sandy Workman, and other members of the statistical section who have keypunched innumerable data cards and computer programs for me. In addition, I wish to recognize Mrs. Frank Roberts for the excellence of the final copy and for her many helpful suggestions concerning the form of the final copy.

Finally, I wish to express appreciation to my wife, Marina, for her understanding, encouragement, and sacrifice.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Grain elevators assist the grain marketing industry in the assembly, storage, and the distribution of the market supply of wheat. These functions are performed within a price system upon which is superimposed various Government rules and regulations arising from programs designed to implement public policies. The emphasis given to a particular Government program can have dramatic effects upon the revenues of grain elevators.

Grain elevators in Oklahoma derive much of their income from the storage and handling of grain. In some areas, grain production is limited primarily to wheat, and elevators in these areas necessarily rely upon wheat to provide their handling and storage income. Some elevators also engage in sideline activities such as fertilizer and gasoline, which are not directly concerned with the grain business. These activities are of varying importance among elevators, ranging from cases in which the elevator is the principal supplier of such items in a particular locality to cases in which the income from these products or services is very small.

Income of grain elevators from handling is derived primarily from the margin, or the difference between the price paid to the seller by the elevator and the price which the elevator receives when the wheat is sold. An elevator seeks to maintain a margin which is sufficient to

repay the variable costs associated with elevating the wheat, the fixed costs of maintaining the grain handling facilities and a normal rate of return on the investment. Handling income may also be derived from blending and conditioning wheat. Competition among grain elevators would be expected to force the margin for handling grains to be equal to the costs of providing this service (including a normal return on investment).

Many grain elevators, especially those in the Southern Great Plains, are larger than the size which is required solely for grain handling. This excess capacity is partially utilized by local producers in areas of deficit on-farm storage. Producers utilize the facilities of grain elevators in lieu of constructing storage of their own, and elevators receive payments for rental of the excess capacity. Other inventory owners, the Commodity Credit Corporation (CCC) in particular, also utilize this excess capacity. Again, competition would be expected to equate the rental fee for the storage space to the costs of providing the space.

Grain elevators also may utilize their facilities to store wheat which they own. Some wheat may be stored to facilitate the operations of the business. Additional volumes may be stored in anticipation of an increase in price sufficient to repay the costs of storage. Storage on the elevator's account differs from storage for other inventory owners since the returns per bushel are not known in advance. In a purely competitive equilibrium, the return for this storage should also equal the cost of storage. Given the normal price variability which occurs during the course of a crop year, the return per bushel to individual elevator operators from the storage of owned stocks is more

nearly a random variable.

The opportunity to earn income from handling wheat during a crop year is dependent upon the size of the crop. Opportunities to earn income from the storage of wheat owned by other individuals or firms depends upon the volume of wheat available for this purpose and the length of time these inventory owners wish to store the wheat. The individual firm has little or no control over the volume of wheat which it will handle or which it will store for other inventory owners. The firm can exercise a degree of control over the quantity of wheat which it will store on its own account.

CCC owned inventories may be used to illustrate the lack of control which grain elevators have upon the income derived from storage for other inventory owners. At the beginning of the 1961 crop year, CCC owned stocks of wheat amounted to approximately 1.2 billion bushels.[1] Nearly 100 million bushels of this inventory were stored in Oklahoma.[2] At the beginning of the 1968 crop year, CCC owned stocks had declined to slightly more than 100 million bushels, of which approximately six million bushels were stored in Oklahoma.[3] This decline in CCC stocks thus has resulted in reduced opportunities for Oklahoma grain elevators to utilize excess storage capacity.

Since an important source of income for Oklahoma grain elevators does not currently exist, some firms may need to develop alternate sources of income. Storage of owned inventories of wheat may provide such an alternative. However, this may expose the firm to considerably more risk than it would face if it engaged solely in a handling operation since storage entails longer periods of inventory ownership and greater cost.

The use of futures markets to protect the firm against the risks of adverse price changes has long been advocated. Futures markets are specialized commodity markets which facilitate contract holding. Futures markets may be used for hedging, or the holding of futures contracts to balance a position in the cash market. The use of futures markets for hedging has been viewed as arising from a desire on the part of the hedger to shift the risks of adverse price movements to persons who are willing to assume these risks. Continuing research on business use of futures markets has resulted in a broader definition of hedging. This broader definition does not repudiate the risk-lessening aspects of hedging. Instead, attention is focused upon the role of hedging as an integral component of the business decisions of grain elevators. In this context, hedging transactions are not solely motivated by a desire to avoid risk, but instead are a logical alternative which the firm may utilize. The applicability of hedging transactions to the business operations of individual grain elevators thus requires that futures prices provide a foundation upon which an elevator operator can base hedging decisions.

Several persons in the grain trade in Oklahoma have indicated a belief that futures prices do not provide a foundation upon which hedging decisions may be based. According to this belief, futures prices are strongly influenced by the domestic demand for wheat, whereas the price of wheat in Oklahoma is strongly influenced by the price of wheat in the Gulf export market. As a consequence of these diverse characteristics of the two markets, these persons believe that there is an extremely poor relationship between the two prices. If this belief

is true, then hedging may be of limited usefulness for the average elevator operator in Oklahoma.

Objectives and Procedures

The belief that hedging is of limited usefulness for Oklahoma grain elevators seems to be widely accepted by members of the grain trade in Oklahoma. Consequently, the first objective of this study is to investigate the contention that there is an extremely poor relationship between export prices at Gulf ports and futures contract prices. Specifically, this objective is to determine if the carrying charge, or the change in the spread between cash and futures prices during a specified period, can be predicted from the spread existing at the beginning of that period. Simple linear regression is used to establish this relationship. This accomplishes a two-fold purpose of establishing whether or not basis changes are correlated with an initial basis and of developing predictive equations which may be utilized to fulfill the second objective.

The second objective is to estimate the average earnings from an annual practice of carrying hedged storage during specified intervals of the crop year. Allied with this objective is an attempt to estimate the average earnings from a practice of carrying hedged storage only when the predicted gross storage earnings are greater than the cost of storage. The expected frequency, or the proportion of years that profits can be expected, is also estimated.

The third objective of this study is to provide an understanding of the role of futures markets in grain marketing. To fulfill this objective, the relationship of various grain elevator operations and

hedging decisions is discussed.

Organization of the Study

Chapter II of this study contains a brief development of the role of grain elevators in wheat marketing. The various operations utilized by grain elevators to fulfill this role are outlined. The need for hedging in conjunction with various sales and storage practices is established. The determination of wheat prices in Oklahoma is also outlined.

Chapter III contains a description of the role of futures markets in wheat marketing and the significance of futures contract prices is discussed. Several of the purposes for which hedging may be used in grain elevator operations are described. The costs of hedging and the significance of futures contract prices are used to indicate the appropriate futures market for Oklahoma grain elevators which use the practice of hedging. The limits of hedging are outlined also.

Chapter IV contains an evaluation of the spread between cash and futures prices at the beginning of a storage interval as a predictor of the change that may be expected in the spread during the interval. Linear predictive equations are developed using the Kansas City Board of Trade and the Chicago Board of Trade futures contract prices and the price of export wheat at Gulf ports. These predictive equations are developed for ten overlapping periods during a crop year. Three hedging practices are analyzed for the Kansas City futures market and one hedging practice is analyzed for the Chicago futures market.

Chapter V contains an analysis of the expected net returns from carrying hedged storage of wheat. The linear predictive equations

developed in Chapter V are subjected to random shocks to simulate several thousand observations which might occur with the conditions which existed during the historical period to which the equations were fitted. The expected returns and frequency of profitable storage are estimated for hedges placed in the Kansas City futures market.

Chapter VI presents a summary and the conclusions derived from this analysis. Recommendations for additional research are given also.

FOOTNOTES

[1]U. S. Department of Agriculture, Agricultural Statistics 1967, (Washington: Economic Research Service, 1967), p. 12.

[2]U. S. Department of Agriculture, Grain Market News, (Washington: Consumer and Marketing Service), selected issues.

[3]Ibid.

CHAPTER II

ECONOMIC FRAMEWORK OF GRAIN ELEVATOR OPERATIONS

The grain marketing system of the United States performs its functions within a free enterprise system which has been modified by domestic public policy goals and international commitments. National policies for wheat producers have a goal of income parity relative to the non-farm sector. The means of achieving this goal have varied and have involved both high price supports and direct payments to eligible producers. International programs are designed to achieve goals such as providing assistance for developing nations and of improving the balance of payments position of the United States. All of these programs ultimately influence both the price of wheat and the quantity of wheat handled by grain elevators.

Influence of Government Policies on Wheat Prices and Storage

Government policies which affect wheat prices and storage generally fall into three classes: 1) domestic price support activities; 2) foreign aid and export assistance programs; and, 3) international pricing activities. The programs associated with each of these classes will be discussed briefly, with emphasis on objectives and methods of operation. The impact of these programs on wheat prices and storage will be discussed also.

National Programs for Wheat Producers

Government programs for wheat producers are designed to support the price by means of a non-recourse loan program. Producers who qualify may acquire a loan from private lending agencies (primarily local banks) at the announced loan rate in that area for the particular type of wheat they produce. Producers then have the option of selling the wheat at the market price and repaying the loan principal plus accumulated interest anytime during the crop year, or of delivering the wheat to the CCC at the end of the crop year in fulfillment of their obligations.

Prior to the 1964 wheat crop, Government programs attempted to achieve income parity for the producers of wheat by maintaining a high loan rate. The volume of wheat marketed by producers in a given year was regulated by a system of acreage allotments. Producers of 15 acres or less of wheat were exempted from the marketing controls. Penalties were levied on producers who exceeded their acreage allotments if they wished to market the wheat from the excess acreage during the year in which it was produced.

Wheat producers have been given several opportunities to accept or reject proposed national programs for wheat. A major change in these programs was proposed for the 1964 crop year. This program would have continued high price support levels for wheat, but acreage restrictions would have become mandatory for all producers (including the formerly exempt 15 acres or less). This program was rejected by wheat producers in May, 1963.

A new program for wheat producers was established after the 1963 referendum. The basic features of this program (currently in effect) are: 1) a relatively low national average loan rate[1]; 2) domestic

processors of wheat for food uses are required to purchase certificates for each bushel of wheat utilized; and, 3) participation by producers is on two levels and is entirely voluntary. Producers who voluntarily agree to comply with acreage restrictions are eligible for loans and payments for certificates issued on a percentage of their normal production. Producers who also agree to participate in an acreage diversion program are eligible for subsidy payments.[2] Producers who do not participate are not eligible for program benefits, but they may sell their entire output on the open market without payment of a penalty.

Foreign Aid Programs

The U. S. Government assists exports of wheat and wheat products to needy nations of the world primarily through Public Law 83-480, as revised and extended. Originally enacted in 1954 as a temporary measure to remove surplus commodities from the United States, this program has evolved into a policy tool which may be used to stimulate economic development of other nations and to support U. S. trade and foreign policy goals. Increasing emphasis is also being given to this program as a means of improving the international payments position of the United States.

Public Law 480 allows Government sponsored shipments of wheat and wheat products under its various titles. These shipments may be sold for local currencies, for long term dollar credits, or may be donated to countries suffering from disaster. Exports under Public Law 480 programs are primarily made from private stocks. The importing nation negotiates the transaction with the U. S. Government, and after

approval of the transaction, contracts are negotiated with private exporters to procure the commodity. Under certain conditions, exports from CCC stocks are possible.

Government sponsored exports also are authorized through the Agency for International Development (AID) of the U. S. Department of State. Exports of wheat and wheat products under this program have become relatively insignificant during the past few years, and increasing reliance has been placed upon Public Law 480 for Government sponsored shipments.

Export Assistance Programs

Several policies have been implemented to provide financial assistance to private United States exporters of wheat. CCC export credits are offered to private exporters to enable them to meet credit terms offered by competitors in Free World Countries. These credits, initiated in 1956, were restricted to surplus commodities held in CCC inventory until 1965. In 1965, the program was extended so that deferred payment terms could be offered by U. S. exporters on commodities such as wheat flour and bulgar, which are not held by the CCC. The CCC accomplishes this financing by purchasing an exporter's accounts receivable. Credit periods are limited to a maximum of 36 months.

The Export-Import Bank initiated a system of guarantees against political or financial risk in 1963. These guarantees are offered by the Bank to commercial financial institutions of the United States which undertake non-recourse financing of commodity exports. Exporters thus are not limited to the CCC as a source of financing, but may also utilize the commercial financial system.

Finally, a system of export subsidies and certificates has been in effect for several years. This system is designed to remove differentials between domestic market prices and export or world market prices. If domestic prices are higher than export prices, then exporters receive a subsidy. If the reverse situation holds, then exporters must pay a tax on their shipments. The tax (inverse subsidy) is levied by requiring exporters to purchase certificates when the wheat is registered for export. Normally, only one of these programs is in effect at any given time, but both have been administered concurrently in past years. In 1964 and 1965, export certificates were required and a subsidy was paid.

Basic export subsidy rates or certificate costs are announced in advance for specific periods. However, these are subject to change daily to reflect current market conditions. The subsidy or certificate cost applicable to a given transaction is the rate announced for the day that the transaction is registered for export. This registration normally is done when the principals sign the contract. However, under a change in procedure initiated in 1966, an exporter may register wheat for export during a specified period prior to sale of the wheat. The subsidy or certificate cost applicable to the transaction is the one announced for the day that the wheat is registered. A penalty must be paid by the exporter if he fails to export the wheat during the period he specified when the wheat was registered for export.

International Pricing Arrangements

International agreements designed to stabilize the price of wheat

in international trade began with the International Wheat Agreement (IWA) of 1949. This Agreement was revised and extended several times, and on July 1, 1968, the IWA was superseded by the International Grains Arrangement (IGA). The IGA combines a Memorandum of Agreement negotiated during the Kennedy Round tariff discussions with the administrative and institutional structures of the IWA. The IGA consists of a Wheat Trade Convention and a Food Aid Convention.

The objectives of the Wheat Trade Convention are:[3]

(a) To assure supplies of wheat and wheat flour to importing countries and markets for wheat and wheat flour to exporting countries at equitable and stable prices;

(b) To promote the expansion of international trade in wheat and wheat flour and to secure the freest possible flow of this trade in the interests of both exporting and importing countries, and thus contribute to the development of countries, the economies of which depend on commercial sales of wheat;

(c) In general to further international co-operation in connection with world wheat problems, recognizing the relationship of the trade in wheat to the economic stability of markets for other agricultural products.

The IGA sets minimum and maximum prices for 14 different types and grades of wheat. This contrasts with the IWA, which sets a price range for only one type of wheat. The minimum price set by the IGA for No. 2 ordinary Hard Red Winter wheat at U. S. Gulf ports is $1.73 per bushel, free on board (f.o.b.) vessel. The maximum price defined for all grades and types of wheat is 40 cents over the minimum for each grade and type. All prices are quoted f.o.b. vessel at U. S. Gulf ports, with appropriate premiums or discounts for other points of origin. For example, the entire schedule is discounted 6 cents per bushel for U. S. Pacific ports. Provisions are also made to determine prices for other

grades and types of wheat not specified in the Convention, with the restriction that the minimum and maximum prices of any wheat cannot be higher than those of No. 1 Manitoba ($1.95½-2.35½, f.o.b. vessel, U. S. Gulf ports).

The role of the minimum prices is to contribute to market stability. These minimum prices specified in the IGA are not rigid floor prices, but are used to define conditions which would indicate that revisions in the minimum schedule are necessary. The maximum prices indicate when a critical stage has been approached. When this condition prevails, the obligations of the signatory exporting nations come into effect. The prices may be adjusted by the Prices Review Committee (a body which did not exist under the IWA).

Each exporting nation of the Wheat Trade Convention agrees to make available annually a specified minimum quantity of wheat and wheat flour at prices which may not exceed the maximum. Importing nations are guaranteed the right to purchase a minimum quantity of wheat and wheat flour from the exporting countries each year at prices which may not exceed the maximum. Importing nations are required to purchase a minimum percentage of their annual commercial requirements from members of the Wheat Trade Convention. Concessional transactions must be made in such a way as to avoid harmful interference with normal production patterns and commercial trade channels.[4] Concessional transactions are not allowed if there is a possibility that such a transaction would displace a commercial sale of another member of the Wheat Trade Convention.

The Food Aid Convention is a program of the member nations of the IGA to annually provide 4.5 million metric tons of food aid to needy nations. Ratification of both Conventions is mandatory for the nations

which ratified the Memorandum of Agreement of the General Agreement on Tariffs and Trade. Other nations may ratify either or both Conventions. Aid may be granted in the form of wheat, coarse grains suitable for human consumption, or cash. This aid is to be supplied on soft terms, i.e., as gifts or for local currency, of which not more than ten percent is available to the grantor. The United States has subscribed to furnish 1.89 million metric tons of food aid annually, or approximately 69.5 million bushels.

The IGA does not encompass any concept of market sharing. Importing countries are not obligated to purchase wheat from a particular country. Annual obligations of the importing countries may be satisfied by purchases of wheat from any member of the Wheat Trade Convention. United States exporters do have the right of access to the markets of some importing countries under this Convention.

Impact of Government Policies on Wheat Prices and Storage

Price support programs, in addition to the objective of setting a minimum market price, are designed to control supply. The extent to which producers elect to participate in these programs partially determines the amount of wheat which will be produced in a crop year since acreage may be restricted. The degree of participation also has an influence on the market price by restricting the amount of wheat which would be available at prices below the loan rate. The market price must be at least equal to the loan rate before sales on the open market are a profitable alternative for eligible producers. These price support activities also may influence the rate at which producers are willing to place wheat on the market. For example, low prices at

harvest time may encourage producers to enter wheat in the loan program. Once wheat has been placed under loan, the market price must be greater than the loan rate plus accumulated interest and storage charges before sales are a profitable alternative for producers.

The export programs are supply management programs. An objective of these programs is to insure the maximum possible disappearance of current production. Transactions negotiated under Public Law 480 and AID are exports over the amounts which could be exported through commercial channels. In recent years, exports under Government-financed programs have been greater than commercial exports (Table I). The timing of these shipments during a crop year may have a noticeable impact upon price changes and the amount available for storage at any time.

The impact of international pricing activities such as the International Grains Arrangement upon domestic marketing conditions is less direct than the domestic activities of the Government. However, the provisions of these agreements, especially the minimum prices, can influence disappearance and thereby affect the domestic price of wheat.

International agreements to regulate the price of a commodity are generally undertaken in order to prevent "dumping" of surpluses. "Dumping" involves the offering of the surplus at whatever price the market is willing to pay for that quantity. This activity reduces the sales alternatives of other nations which export the commodity, and these nations may be forced to meet the lower prices to protect their markets. The situation could result in a price war and possibly in higher tariffs, lower import quotas, or a prohibition of imports on other goods which are also exported from the country which is engaged

TABLE I

COMMERCIAL EXPORTS OF WHEAT AND WHEAT PRODUCTS FROM THE UNITED STATES AND EXPORTS UNDER U. S. GOVERNMENT-FINANCED PROGRAMS, 1954-1960 AVERAGE AND ANNUALLY, 1961-1967[a]

Crop Year	Exports Under Government-Financed Programs	Commercial Exports	Total Exports
		--Million Bushels--	
1954-1960 (average)	313	142	455
1961	506	215	721
1962	501	142	643
1963	509	347	856
1964	574	151	725
1965	577	292	869
1966	Not available	Not available	742
1967	Not available	Not available	762[b]

[a]Quantity of wheat products is expressed in wheat equivalents.

[b]Preliminary

Sources: Eleanor DeBlois, Twelve Years of Achievement Under Public Law 480, U. S. Department of Agriculture, Economic Research Service Pub. No. Foreign-202 (Washington, 1967), p. 6; and U. S. Department of Agriculture, Wheat Situation, Economic Research Service Pub. No. WS-205 (Washington, 1968), p. 2.

in the "dumping" activity. Thus, an aim of international pricing arrangements is to assure more stable conditions for international trade in all commodities.

The exporting countries which agree to an international pricing arrangement must be the major sources of supply for the commodity for such an arrangement to be feasible. Similarly, the major importing nations must be induced to join the arrangement, and they must be encouraged to purchase the commodity from the exporting members of the arrangement. The inducement to the importing nations usually takes the form of the right to purchase a guaranteed minimum quantity of the commodity at a guaranteed maximum price in times of shortage. The importing countries agree to purchase a minimum amount each year in order to protect their rights during the periods of shortages.

Problems may arise under an international pricing arrangement when the minimum prices are set above the price which would prevail in the absence of the arrangement. In this case, the importing nations will probably purchase only the amount necessary to protect their rights, and will then seek the commodity from nations outside the arrangement. When the other sources of the commodity have been exhausted, or when the price in the other market approaches the minimum price of the arrangement, any unsatisfied requirements would again be purchased under the arrangement. The exporting members of the arrangement are thus cast in the role of residual suppliers, and will be residual suppliers as long as commercially significant quantities of the commodity are available outside the arrangement at prices lower than the minimum prices.

The above discussion indicates that the minimum prices specified in an international pricing arrangement should be compatible with current market conditions. Minimum prices that are higher than current market conditions warrant will encourage the development of alternative sources of supply. A second effect would be the substitution of greater amounts of other types of food. However, the total revenue may increase with the high minimum prices in the short run. This would be true only if demand were relatively inelastic for this period of time. In the longer run, as alternative supply sources are developed and substitution takes place, both total revenue and the quantity exported could decline significantly. Given that all other conditions are constant (domestic price supports, production, etc.), the net result could be an increase in domestic stocks and accompanying downward pressure on domestic prices.

The Role of Grain Elevators in Price Determination

The price of any commodity is determined when the quantity supplied per unit of time is equal to the quantity demanded per unit of time. When production and consumption are continuous and unchanging, an equilibrium price which holds in all periods may be attained. If production and consumption are subject to variation over time, as in the case of wheat, then an equilibrium price is more difficult to achieve. Grain elevators can assist the wheat marketing system to achieve an equilibrium price by their storage and handling operations.

The Demand for Wheat

Domestic demand for wheat consists of four principal elements: food, feed, seed, and industrial uses. The demand for wheat for food

uses has been relatively constant at slightly more than 500 million bushels annually since 1959.[5] Food uses require relatively high quality wheat. Flour millers, for example, require wheat which can be milled into flour which will meet the specifications of bakers regarding dough strength and consistency, baking quality, etc. The wheat which individual producers place on the market will rarely meet these specific requirements. Grain elevators provide an economic service by blending the wheat received from individual producers so that it will meet the requirements of these specialized users.

The demand for wheat for use as seed is a function of acreage planted. The demand for seed has two annual peaks, one in the late summer and early autumn for winter wheat, and one in the early spring for spring wheat.

The demand for wheat for use as feed depends upon the price of wheat relative to the price of feed grains. Some wheat is used for feed on farms where it is grown, and this amount is not handled by the wheat marketing system. The remaining wheat used for feed must be handled by the marketing system. The remaining component of the domestic demand for wheat, or industrial uses, is relatively insignificant and accounts for only 0.1 million bushels annually.[6]

Export sales of wheat and wheat products arise from two sources. First, exporting firms in the United States may enter into sales agreements with private firms in foreign countries or with the governments of these countries. These private sales are made in competition with exporters in other exporting countries. Public Law 480 and AID sales are usually on a government-to-government basis. The CCC does not (since 1956) export wheat under Public Law 480 authorizations from its

own stocks.

Finally, some exports of wheat occur for barter purposes. These transactions are arranged by the CCC on behalf of government agencies which would otherwise spend dollars overseas in order to procure various items. The volume of wheat exported for this purpose depends upon the willingness of foreign governments to accept wheat in lieu of dollars.

The Supply of Wheat

The supply of wheat in a crop year is the production that year plus the carryover from the previous crop year. However, all of this supply is available to the marketing system only on certain conditions. Under normal conditions, the available supply of wheat is less than the total supply.

The availability of current production for use in a crop year is, as noted earlier, influenced by the loan program. In years of low market prices, the loan program may be an attractive alternative for producers. This situation will prevail in those years that production is large relative to the expected disappearance of wheat. The optimal strategy of the marketing system in these years would be to encourage deliveries of current production above expected needs (including private carryover) to the CCC.

The carryover of wheat from one crop year to the next consists of privately held or "free" carryover and carryover owned or controlled by the CCC. The free carryover is the quantity of wheat held by private firms in the marketing system, and includes wheat owned by producers which has not been placed under price support or resealed. CCC owned or controlled inventory includes wheat which has been delivered to the

CCC in past years, outstanding price support loans, purchase agreements, and the wheat which has been resealed by producers. CCC owned wheat is removed from inventory only under certain conditions. In past years, export subsidies were paid in-kind, i.e., exporters were given certificates which could be redeemed for wheat from the CCC inventory in lieu of cash payments. This practice was discontinued in 1966 when the CCC inventories reached their current relatively low levels. Some barter transactions are filled from CCC inventory, but the volumes removed from CCC inventory for this practice have also been reduced as CCC inventories declined. Relatively minor amounts are also removed from inventory for domestic donations and other purposes. Finally, the CCC has the authority to sell wheat on the open market whenever the market price exceeds 115 percent of the loan rate plus accumulated carrying charges.

The Role of Grain Elevators

The role of grain elevators in wheat marketing is to assist in the achievement of an equilibrium among all the factors which may affect the price of wheat. The above cursory examination of the sources of supply and demand and of forces outside the marketing system which can have an effect upon wheat production and disappearance indicates that this task is a complex one.

The role of grain elevators in the marketing of wheat may be broken down into three phases. The first phase is assembly or receipt. Grain elevators assemble wheat from the producers and accumulate sufficient volumes so that the orders of the largest buyers may be quickly and efficiently filled. Associated with this assembly phase is conditioning

and blending of wheat. Conditioning operations involve cleaning, drying, or other operations which improve the quality of the wheat received from producers. Blending operations involve mixing of various types and grades of wheat so that the entire lot meets standards that differ from the separate lots.

The second phase of the role of grain elevators in wheat marketing is storage. The rate at which producers wish to sell wheat rarely coincides with the rate that users wish to buy wheat. Grain elevators assist in equating buying and selling rates by purchasing wheat from producers when they wish to sell and storing it until needed by users. Price fluctuations during a crop year may be moderated by this action.

The third phase in the role of grain elevators is distribution. Wheat is shipped by grain elevators in response to price signals from the various markets. In this way, the needs of all the markets can be satisfied and an equilibrium can be established among them.

Determination of the Price of Wheat in Oklahoma

Approximately 70 percent of the wheat produced in Oklahoma has been exported in recent years. The export market thus constitutes an important outlet for Oklahoma wheat, and the price of wheat in Oklahoma will be strongly influenced by conditions in this market. The principal outlet for this export movement is the Texas Gulf ports.

The price which is paid for wheat at the Gulf export market depends on the anticipated sales of exporters during a given period and the amount inventory holders are willing to place on the market during that period. The major commercial export transactions are conducted by issuing world-wide tenders for specified quantities and qualities of

wheat to be delivered during a specified time period. The low bidder among the exporters of the world is awarded the contract. Public Law 480 authorizations are also bid upon by U. S. exporters. The major difference between commercial tenders and tenders issued on Public Law 480 authorizations is that the Public Law 480 authorizations usually specify the coastal region from which shipments are to be made. Thus, the quantities of wheat which will be shipped from specified coastal regions during specified periods generally are known.

The amount of wheat which inventory holders are willing to place on the market during a given period depends on a number of factors. Among these are the price expectations of inventory holders, the availability of government programs, and the volume of wheat remaining in private holdings. The interaction of exporters' demand and inventory holders' willingness to sell determines the price which will be paid for wheat delivered at Gulf ports during any period.

Wheat shipped by rail from Oklahoma points to Gulf destinations may be shipped at either of two rates. The primary difference between the two rates is the amount of service offered by the railroads. The domestic rate usually allows several transit stops for storage or milling, and any of the Texas ports may be used as the destination point for shipments originating from a particular point in Oklahoma. Export rates generally allow fewer transit stops, a limited number of destination points, and heavier minimum loads. The specific requirements may vary among railroads.

The rate for transporting wheat by truck is subject to seasonal variation, but the rail rate is not. Seasonal demand for transportation equipment causes a relative scarcity at harvest time in particular,

and truckers' rates for hauling wheat accordingly increase. Rail rates may be adjusted only upon approval from the Interstate Commerce Commission. In order to effect a change in rates (or in service), railroads must be prepared to show cause at a public hearing. All burden of proof is upon the railroad. Consequently, rail rates change infrequently.

The price which will be paid for Oklahoma wheat moving into export channels is derived from the Gulf price. The effective price at any country point in Oklahoma for this wheat is the Gulf price minus the cost of transporting the wheat to the Gulf from that point. The elevator operator in Oklahoma will receive this price whether the wheat is shipped f.o.b. origin or f.o.b. destination. The effective price to grain elevators will vary according to the method of transportation employed.[7]

The price which will be paid to producers for their wheat depends in part upon the margin between the buying price and the selling price anticipated by the elevator operator and upon transportation costs. As noted in Chapter I, this margin should be equal to the costs of handling the wheat. However, the price which a producer receives for his wheat depends upon the method which elevator operators uses to account for seasonally variable transportation rates since the effective price to grain elevators is affected by variability in these rates.

Elevator operators have two principal courses of action which they could follow in their pricing policies. First, the operator could seek to achieve some average margin for the year. Under this procedure, a constant amount would be deducted from the Gulf price each day in order to determine the price the operator is willing to pay to producers. As

much wheat as possible would then be shipped at the lowest transportation rate, with the remainder shipped at the higher rate. The differential deducted from the Gulf price could be computed as a weighted average of the proportion of the expected shipments at each transportation rate plus a profit margin. The realized margin would depend upon the proportion which was actually shipped at each rate.

A second pricing procedure which could be used by elevator operators would involve deducting a fixed amount from the effective selling price of wheat at the elevator. The price which is paid to producers then would be directly affected by seasonal changes in transportation rates. This pricing procedure would cause greater variability in prices received by producers during the course of a crop year than would the first pricing method.

The first pricing method of elevators seems to be the more feasible of the two. The constant differential procedure is much easier to apply, and does not encourage producers to sell at any particular time. In this respect, the constant differential procedure is better since changes in the market price caused by demand and supply forces will be better transmitted to the producer.

The second pricing procedure can give rise to another source of income for elevator operators. Storage of wheat purchased during periods of higher transportation rates until a period of lower rates existed could result in a higher selling price than would be received if the wheat were sold immediately after purchase. Storage also may assist the operator who prices with a constant differential. Storage would increase returns if the operator had underestimated the proportion to be shipped at the higher rate.

Price Risks Involved in Grain Elevator Operations

Terminal elevators, by the nature of their functions, generally must expose themselves to price risks. Country elevators generally are able to choose whether or not they wish to place themselves in a situation in which the firm is exposed to price risks. It is theoretically possible for all grain elevators to avoid all price risk by the use of forward sales. However, this may not be an optimal strategy, especially for terminal elevators.

The grain marketing operations of grain elevators may be generally classified into two categories: 1) handling and 2) handling and storage. A firm engaged in the handling of a commodity is concerned with the physical act of assembling the commodity for sale to other firms in the marketing chain. Most grain elevators are necessarily engaged in this activity. A firm engages in storage activities when it accumulates stocks on its own account for sale at a later date. This storage activity must be differentiated from storage which is provided for other inventory owners such as producers or the CCC. In the latter case, the elevator operator is renting available storage space to someone who does not wish to construct adequate storage space of his own. The elevator operator is not assuming any of the price risks incident to inventory ownership.

Price risks are inherent to inventory ownership. There are three ways in which an elevator operator may react to this risk. The operator may: 1) sell the wheat (either immediate or forward delivery), 2) sell a futures contract, or 3) maintain ownership of the inventory. The first two alternatives pass ownership of the inventory from the elevator. The first alternative removes all risk since the operator no

longer has a market position. The second alternative does not eliminate the risk if the inventory holder is not in a deliverable position, or if the wheat held is not deliverable on the futures market commitment. The operator assumes the entire risk under the third alternative.

The alternative of selling the wheat may appear as the most favorable alternative to certain elevator operators, especially the operators of country elevators. Country elevators tend to exhibit the characteristics of any small business. Traditionally, these characteristics have included a relatively limited access to market information (especially the "up to the minute" type of information) and a restricted capital structure. These characteristics may tend to make the firm hesitant to accept any appreciable degree of risk which can be effectively avoided. However, some degree of price risk may still be present even if the firm seeks to market wheat immediately upon its purchase.

The most common methods utilized by country elevators to merchandise wheat are to ship it "on consignment," "to arrive," or to sell it "track country point." Wheat shipped on consignment is sent to a terminal market where a commission firm designated by the shipper locates a buyer. The shipper maintains title to the wheat until the commission firm sells it, and is subject to any loss (both physical and price) incurred while the grain is in transit. The cost of shipping also is paid by the shipper.

The "to arrive" method of sale is also known as a "track destination" or "f.o.b. destination" sale. The selling price is determined prior to shipment. The price received by the country elevator may be less than the prevailing spot or immediate delivery price in the market since the buyer assumes the price risks while the wheat is in transit.

The seller assumes the physical risks. Shipping costs are paid by the country elevator. This type of contract also specifies a specific date by which the grain must be delivered to the buyer's place of business.

Wheat sold "track country point" is also sold at a known price prior to shipment. This method of sale differs from the "to arrive" method in that the buyer must arrange and pay for transportation. All risk of loss is shifted to the buyer.

In addition to the three principal methods of selling wheat purchased from producers, there are other methods which are considerably less important. Among these are sales to itinerant truckers and local sales of wheat as feed. Itinerant truckers purchase wheat from farmers and country elevators and transport it to market. This method of sale is relatively unimportant in Oklahoma (Driscoll and Martin, 1967). Feed sales of wheat have been limited by the high price of wheat relative to feed grains, but if the price of wheat were low enough, these sales could become an important outlet for country elevators in some areas.

Terminal elevators also have the option of selling wheat as soon as it is purchased from a supplier. The methods of sale utilized by country elevators, either for immediate or deferred delivery, are also available to terminal elevators. However, terminal elevators may find that their optimum strategy is to maintain control of inventory for relatively extended periods of time since control of inventory may provide a convenience yield to the firm.

The convenience yield of stocks is the benefit which the firm derives from holding stocks. This yield is derived in two ways. First, the availability of stocks may allow a firm to maintain a given level of output at a lower cost per unit than would be possible if stocks were

not held. These stocks are sometimes called pipeline or working stocks. Second, maintaining stocks may allow a firm to vary the level of output at a lower per unit cost than could be achieved if the stocks were purchased as required. The second source of the convenience yield arises since fewer transactions may be required, thereby lowering purchasing costs. Also, holding stocks in excess of immediate needs allows the firm to seek the best price, possibly achieving a better deal than it could if the need to purchase stocks was urgent.[8]

Among grain elevators, convenience yields may be earned primarily by terminal elevators. Terminal elevators are located in central markets, and are in a position to accumulate stocks of varying types and qualities of wheat. Country elevators, on the other hand, assemble wheat from a relatively small producing area. There is less likelihood that country elevators can assemble sufficient quantities of wheat possessing different characteristics so that the demands of a wide variety of commercial users can be satisfied. In many cases, country elevators do not handle sufficient volumes of wheat to fill even one contract of a large buyer. For example, many country elevators handle less wheat during a crop year than is required to fill one ship. Country elevators thus are primarily limited to sales to other grain merchants, and terminal elevators are a major outlet for country elevators.

Under some conditions, a firm thus may find that its optimal policy would be to maintain unobligated stocks. Such a firm cannot avoid price risks by immediate or deferred sale of wheat since this would conflict with its optimal policy. The firm is thus left with the alternatives of assuming the risks or attempting to alleviate the risks by hedging.

Of the three principal methods of sale, only "on consignment" sales require an elevator operator to maintain inventory ownership for a relatively long period of time. "To arrive" and "track county point" sales can often be made the same day that the wheat is purchased. If "on consignment" sales are uncommon, then a systematic policy of hedging is not likely to provide any benefits to the firm. Frequent market contacts may not be economically feasible for firms which do not buy and sell large quantities of wheat each day. These firms may utilize only market information which they can obtain at low cost, such as from newspapers and radio. Thus, the price paid for wheat by smaller elevators may lag behind conditions currently prevailing in the market. Since the price may not be closely related to current market conditions, the returns from hedging may be a random variable, which may or may not be less random than the returns which could be expected in the absence of hedging.

Firms which must store stocks of wheat for relatively extended periods of time as a normal procedure of the business may derive benefits from hedging. A firm would derive benefits from hedging if the returns from hedging are, on the average, greater than or equal to the price change minus the net cost of storage. The net cost of storage is not necessarily greater than zero since the convenience yield reduces gross storage costs. From small levels of stocks, the convenience yield of maintaining the stocks may be greater than the costs of storage.

Convenience yields may be derived only from some minimum level of stocks.[9] After this minimum level is attained, the convenience yield would be unaffected by additional stocks. These additional stocks will be stored only if a return greater than the cost of providing the storage is anticipated. The expected price change must therefore be greater

than the per unit costs of storage before storage of additional stocks is a profitable enterprise.

Hedging is a feasible alternative for firms which store wheat regardless of whether or not a convenience yield can be derived from the inventory. If elevator operators act rationally, the amount of wheat carried in inventory would be determined by the condition that the marginal net cost of storage is equal to the expected price change.[10] The use of hedging may not only lead to greater profits (or smaller losses) than could be realized in the absence of hedging, but may also enable firms to carry greater volumes of stocks than could otherwise be justified.

To this point, hedging has been discussed only to the extent that these transactions may be appropriate for various business operations. No attempts have been made to describe hedging practices. Although it is impossible to state rigid rules or requirements for hedging situations, general recommendations for Oklahoma elevator operators are appropriate. These recommendations involve the appropriate futures markets for hedging transactions and appropriate futures months. These recommendations will be developed later in the study.

FOOTNOTES

[1]The level of the loan rate, within certain limits, is determined by the U. S. Secretary of Agriculture. The national average loan rate was $1.30 per bushel for the 1964 crop, and $1.25 per bushel from the 1965 crop until the present time.

[2]Acreage diversion payments were not in effect for the 1966 and 1967 crop years.

[3]U. S. Department of Agriculture, International Grains Arrangement 1967, Foreign Agricultural Service Pub. No. M-195 (Washington, 1967), p. 7.

[4]Concessional transactions involve virtually any transaction other than cash sales or short-term credit sales.

[5]U. S. Department of Agriculture, Wheat Situation, Economic Research Service Pub. No. WS-205 (Washington, 1968), p. 2.

[6]Ibid.

[7]Cf. Yates (1963) for a discussion of the effects of differing transportation rates upon the effective price of wheat at country elevators in Oklahoma.

[8]Lester Telser, "Futures Trading and the Storage of Cotton and Wheat," Journal of Political Economy, LXVI (1958), pp. 235-236.

[9]Rollo Ehrich, "The Impact of Government Programs on Wheat-Futures Markets," Food Research Institute Studies, VI (1966), p. 320.

[10]Michael Brennan, "The Supply of Storage," American Economic Review, XLVIII (1958), p. 53.

CHAPTER III

THE ROLE OF FUTURES MARKETS IN GRAIN MARKETING

Much controversy has surrounded futures markets since their origin. Futures markets have been praised as a cause of more orderly marketing of commodities, and condemned as a cause of excessive variations in price. The contributions of futures markets probably lie between these extreme viewpoints. Much of this controversy possibly has been caused by a lack of understanding of the role of futures markets in the marketing of commodities.

Speculation was long advanced as the sole reason for the existence of futures markets. Hedging, defined as the transference of the risk of price fluctuations from inventory owners to speculators, was viewed as an incidental benefit of futures markets. However, hedging was not viewed as necessary for the survival of these markets. Associated with this belief was the concept that futures contract prices were biased estimates of expected spot prices, and that changes in these prices were largely unwarranted. Recent research has cast doubt upon these beliefs and has assisted in delineating the role of futures markets in the marketing of wheat. This research has assisted in the understanding of the significance of futures contract prices, the concept of hedging, and the relationship of business operations and hedging decisions.

Futures Contract Prices

Theoretical Meaning of Futures Contract Prices

Keynes (1930) and Hicks (1946) viewed futures contract prices as biased estimates of expected spot prices. This belief was based on the premises that: 1) no forward market can exist without speculation; 2) speculators will be willing to buy futures contracts only if the futures price is below the expected cash price; and, 3) hedgers use futures markets solely for the purpose of transferring risk. The futures price thus must be sufficiently below the expected cash price so that speculators are assured a satisfactory return. The difference between the current cash price and the current price of a futures contract therefore "...measures the amount which hedgers have to hand over to speculators in order to persuade the speculators to take over the risks of the price fluctuations in question."[1]

If the belief of Keynes and Hicks is true, then hedgers must expect to pay a risk premium for the protection they seek. The principle embodied in this concept is the same as the principle of any insurable risk - the insured pays a small premium to the insuror for protection against the possibility of a large loss. Also, as in the case of insurance, the premium will vary with the amount of risk involved.

The risk premium concept implies that upward secular trends are a normal characteristic of all futures markets. Specifically, since the futures contract price must be less than the expected cash price, futures prices in all markets for all commodities must display an upward trend as the delivery date approaches. The existence of such a trend would imply that the level of futures contract prices is not a reliable

estimate of the expected cash price. But if futures prices do not display a consistent upward trend, then the risk premium hypothesis is of doubtful validity. The evidence accumulated to date refutes this hypothesis.[2]

Early tests of the validity of the risk premium hypothesis primarily utilized a statistical method which was known to be useful in detecting trends in a price series. These tests were designed to detect the presence of auto-correlation, and were sometimes refined to include cyclical variation as well as secular variation. These tests were appropriate tests given the nature of the assumed characteristic elements of futures contract prices. The validity of the risk premium hypothesis could be verified by these methods if a statistically significant positive trend was detected in all futures markets for all commodities. The trend also must exist for the entire life of the contract. The failure to detect systematic trends meeting these conditions allows a researcher to draw the inference that futures prices are not biased in favor of speculators. Occasional trends consistent with these conditions cannot be cited as proof of the hypothesis. Similarly, rejection of this hypothesis does not rule out the existence of trends which do not meet the above conditions. Such trends were sometimes detected in futures contract prices, and no reason for these trends could be found in conventional price theory.

Analysis of futures contract prices also failed to explain the frequent changes which these prices exhibit. In particular, futures prices seem to exhibit a different response at different points in time when economic conditions appear to be similar at these points in time. This characteristic of futures contract prices, combined with the

failure of the risk premium hypothesis to explain changes in futures prices, lead to an inference that changes in futures prices were largely the result of pure random variation. If this is true, then changes in these prices are unwarranted and cannot be justified by price theory.[3]

The inference that changes in futures prices were largely the result of pure random variation was questioned by some researchers. The statistical tests utilized in prior research had determined that secular and cyclical variation were not essential characteristics of futures prices. However, no one had demonstrated that futures prices exhibited a complete lack of systematic characteristics. Apparent erratic behavior does not constitute such proof, since the reason for such behavior may be extremely complex. Additional research indicated that futures prices and other prices which are determined largely on the basis of expectations exhibit close approximations to pure random walk.[4] This behavior, in contrast to pure random variation, does have economic significance (Working, 1949).

Changes in a price series may be due to known causes, but if changes in the price are unpredictable from past prices and changes, then the price series exhibits random walk. A series of futures prices would exhibit this characteristic since the prices are the result of a composite evaluation of changes in information by the traders. This composite judgement represents an evaluation made by a changing group of traders, and by traders who may be changing their techniques of information evaluation. This characteristic would also be exhibited by a price series in the cash market for a commodity if current demand and supply conditions are partially unknown. Each new bit of information entering a cash market of this sort may cause a response which is

unpredictable from past experience, but the price generated in such a market represents the best and most reliable estimate of the equilibrium price.

The economic significance of the discovery that futures prices exhibit random walk is that:[5]

> Pure random walk in a futures price is the price behavior that would result from perfect functioning of a futures market, the perfect futures market being defined as one in which the market price would constitute at all times the best estimate that could be made, from currently available information, of what the price would be at the delivery date of the futures contracts.

Random walk provides an explanation for apparently erratic price changes, but fails to provide an explanation of trends in futures prices. However, random walk does not preclude the existence of trends in a price series since this term merely denotes the absence of a systematic characteristic.[6] Trends which were observed only occasionally thus would not be inconsistent with a concept describing futures prices as the best available estimate of the price at the delivery date.

The trends which have been observed in futures prices have not been consistent with respect to direction, timing, magnitude or duration. Trends have been observed in some futures prices in some years but sometimes the trend begins at one point in time and sometimes at another. Both positive and negative trends have been observed at different time periods. In short, no systematic trend among commodities or among futures contract exchanges has been found.

The differences in observed trends appear to be explained by differences in the amount of speculation relative to the amount of potential hedging. Gray (1960) has advanced the hypothesis that these trends are due to a lack of balance in the market. "The significant

requirement for balance is enough participation by speculators to balance the hedging."[7] This concept of market balance has not been proven, and it will be difficult to do so. The Commodity Exchange Authority (CEA) classifies only the contract holdings of large traders with respect to their position (speculation or hedging). Some method is needed to separate the volume of hedging and the volume of speculation by the small traders before this hypothesis can be tested. Some attempts have been made in this direction (Working, 1960; Larson, 1961). Also, much of the volume of trading classified as speculation by the CEA actually may be anticipatory hedging.[8] If this is the case, then adequate treatment of the market balance hypothesis will depend on a separation of this type of hedging from the published statistics of the CEA.

Research thus indicates that the prices of a futures contract may provide a reliable estimate of the expected cash price at the delivery date of the futures contracts. There is no evidence which suggests that these prices are biased in favor of either speculators or hedgers. The fact that futures prices may be reliable estimates of prospective demand and supply conditions does not imply that they are perfectly accurate estimates. These prices are determined by traders, whose evaluation cannot be wholly accurate, and on the basis of information which may not be complete. The main imperfection which futures prices exhibit is a retardation of price response to new information which warrants a fairly large change in price. The initial reaction to new information is less than that required; consequently, several days may elapse before the impact of the new information is completely reflected in futures prices.[9]

The Meaning of Particular Futures Contract Prices

There are several commodity exchanges which conduct trading in wheat futures contracts. The prices of futures contracts on the various exchanges are rarely, if ever, equal. At times, there is a substantial variance in price among the exchanges. A reason for these variations of price may be found in the differences of the types and grades of wheat deliverable at the contract price on the various exchanges.

A commodity which is traded on a futures exchange should have commercially significant quantities available for delivery. If adequate supplies of a commodity are available, then arbitrage between the cash and futures markets is possible. Such arbitrage, or the threat of it, can prevent imperfections such as "squeezes," which may develop when physical supplies in deliverable positions are small in relation to the open interest.

Futures contract exchanges have attempted to insure that adequate physical supplies of wheat are available at delivery points by designating one or more types and grades of wheat as deliverable at the contract price. The types of wheat chosen by the exchanges for delivery on the contract are those which are marketed in relatively large quantities at the delivery point. The grade designated as acceptable for delivery also should constitute a substantial amount of the trading in that type of wheat. Other types and grades of wheat are also designated as acceptable for delivery, with appropriate premiums or discounts over or under the delivery grade price.

Wheat quality is continuous rather than discrete. Grading standards constitute a discrete scale which cannot completely describe the characteristics of a particular lot of wheat. Relatively substantial

variations can exist among lots of wheat given the same rating on a grading scale. These variations are reflected in the price of each separate lot of wheat. A futures contract, however, has only one price at any point in time. If futures markets are to serve as a reliable means of price discovery, then the one price of a futures contract must be related to one set of quality characteristics. Otherwise, the price of a futures contract would be difficult to interpret.

It would be difficult to insure that the price of a futures contract always refers to the same set of quality characteristics of one type of wheat. However, the choice of the deliverable types and grades and the appropriate premiums or discounts can assist in causing futures contract prices to primarily reflect only one set of quality characteristics. The magnitude of the premiums for delivery of better quality wheat than the contract grade should be less than the premium which this wheat would normally command in the cash market. Similarly, discounts for poorer quality wheat should be greater than those normally prevailing in the cash market. Setting premiums and discounts at amounts differing from those normally prevailing in cash markets discourages delivery of types and grades other than those specified by the contract when adequate supplies of wheat specified by the contract are available. This tends to encourage traders to evaluate price prospects in terms of the wheat specified as deliverable at the contract price.

The price of any futures contract thus should tend to be an evaluation of price prospects during the delivery month for types and grades of wheat deliverable at the contract price. Because of variability within grades, the price should reflect price prospects for the lowest quality of wheat which may be delivered with no penalty since this is

the quality of wheat which is likely to be delivered.

If the above criteria are applied to the various futures markets, then the Kansas City futures contract price should reflect expectations concerning No. 2 hard wheat since this contract designates only hard wheats (Dark Hard, Hard Red, and Hard Yellow) as acceptable for delivery, with No. 2 as the grade deliverable at the contract price. Only hard winter wheats may be delivered. The Minneapolis wheat futures contract allows deliveries of spring wheats, with No. 1 Northern Spring designated as the contract grade. The Chicago wheat futures contract allows delivery of both hard and soft wheats. Deliverable types include winter and spring wheats, with No. 2 Hard Winter, No. 2 Red Winter, No. 2 Yellow Hard Winter and No. 1 Northern Spring designated as deliverable at the contract price.

A futures contract price thus should provide an estimate of the price of the type and quality of wheat most likely to be delivered on the contract. Actual delivery is not necessary for this to be true. Adequate physical supplies available to commercial interests will provide a threat that such deliveries may occur. If futures contract prices are higher than the price prevailing in the cash market during the delivery month, then the short contract holders will deliver on the contracts. Alternatively, the long contract holders will sell at a loss if they do not wish to accept delivery. The opposite actions would occur if futures prices were lower than cash prices during the delivery month.

The Concept of Hedging

A prevailing belief for many years was that hedging was done solely

to transfer the risk of price fluctuations. This belief was an extension of the hypothesis that futures markets depend solely on speculation for their existence. The fact the business interests could use futures markets to hedge inventories was regarded as a fortunate by-product of the operation of these markets. Based upon these beliefs, hedging effectiveness could be determined by measuring the extent to which the effects of price changes would have been reduced by hedging. A study by Graf (1953) may be used to illustrate the methodology involved in testing the "risk-aversion-only" concept of hedging.

Graf defined hedging effectiveness in terms of departures from a no-gain, no-loss situation. The method of analysis employed was to initiate a hedge based on Friday prices. The hedge was maintained for eight weeks. At the end of this time, any change was determined and recorded as a gain or a loss to the hedger. The effectiveness of hedging in reducing the risks associated with price variability was determined by computing the extent to which gains or losses on unhedged grain could have been reduced by hedging. To be 100 percent effective to both long- and short-basis hedgers, there must have been neither a gain nor a loss on the hedge.[10]

Graf thus treated long term prospects solely in terms of current prices. Two months is a substantial period of time in the case of a seasonally produced commodity, but this definition of hedging effectiveness implied that persons engaged in the trading of a commodity would be willing to sell (or buy) the commodity in two months at the same price as the one currently prevailing in the cash market.[11] Grain merchandisers, for example, must have been willing to absorb the costs of two months' storage for the protection afforded by a perfect hedge.

Graf's article was followed immediately with an article by Holbrook Working (1953). Working's article was an inquiry into the failure of the conclusions of Graf and others to be reconciled with observable facts. The conclusions were that hedging was relatively ineffective as a means of reducing risk. But it is an observable fact that business interests do hedge, and sometimes in substantial volumes. Working concluded that "...the attempted tests of the effectiveness of hedging have gone astray because the prevalent concept of hedging, on which they have been based, is inadequate, and misleading."[12]

The multipurpose concept of hedging has been advanced as a replacement for the risk-aversion concept. This concept is that hedging "is done for a variety of different purposes and must be defined as the use of futures contracts as a temporary substitute for a merchandising contract, without specifying the purpose."[13] The purpose of hedging will differ according to the circumstances involved. Some of these purposes are listed below.

Carrying-charge hedging is utilized by firms seeking a profit from storage. The storage operations of a firm utilizing carrying-charge hedging are transformed from that of seeking a profit through changes in price levels to that of seeking a profit through changes in price relationships. The users of carrying-charge hedging are chiefly merchants "...whose merchandising business requires close attention to price differences according to grade, quality, and location, who choose to seek storage profits by anticipating changes in price relations..."[14] The decision made by carrying-charge hedgers is not whether to hedge or not, but whether to store or not.

Hedging done chiefly to facilitate the operations of the merchandising or processing operation is known as operational hedging. Operational hedging involves rapid turnover of futures and cash transactions so that basis changes may be ignored. A grain broker, for example, may judge that a particular lot of wheat is worth two cents over the price of the near futures. If he is able to purchase the wheat for less than this premium, he will do so and immediately hedge the purchase. A few minutes later the broker may find a buyer willing to pay two cents over the near futures. The broker will sell the wheat and buy in his hedge. The absolute price level in the cash market is not a factor in the transaction. The transaction deals only in premiums with respect to the price of the near future. This practice requires a high degree of short-term correlation between cash premiums (or discounts) and futures prices.

Selective hedging involves price expectations. The decision is whether or not to hedge in order to avoid a loss. Stocks are hedged only if a price decline is expected during the period that the inventory is held.

Anticipatory hedging is also guided by price expectations. However, the futures market commitment is not immediately offset by an equivalent inventory of raw materials, of finished products, or of commitments to deliver (or to accept delivery of) commodities. A businessman who anticipates concluding a deal during the hours the futures exchanges are closed may sell futures contracts at the market close. If the transaction in the cash market materializes, the businessman will then be hedged. This practice is not limited to short-term transactions such as this. Several weeks or months may elapse before the anticipated

cash market transaction is concluded.

The last specific purpose of hedging to be listed is pure risk-aversion hedging. This form of hedging is probably unimportant or virtually nonexistent in current business use of futures markets.[15]

The broader definition of hedging permits practices such as selective and anticipatory hedging to be classified as hedging transactions even though they are closely related to speculation. Any futures transactions which are incident to the normal conduct of a business may be so classified. Speculation may then be distinguished from hedging by defining speculation as the holding of a net long or a net short position (in either market) in hope of a gain from this position, and not as a normal procedure of the business.

The Relationship of Business Operations and Hedging Decisions

The purposes of hedging given in the previous section indicate that hedging decisions must be closely related to the operations of a business. The listed purposes include many different aspects of business operations, ranging from storage to a grain broker's type of activity. Several factors must be considered by a firm contemplating the practice of hedging. Among these are the costs of hedging and the needs of the business.

Costs of Hedging

An obvious cost involved in hedging transactions is the commission charge. However, this cost is relatively low, even for non-members of the exchange. The current commission charge for wheat futures

transactions for non-members is less than one-half cent per bushel for a 5,000 bushel contract. This commission charge is for a "round-turn", i.e., a sale and a purchase of one contract. This cost has been held low in order that trading not be seriously discouraged. Margin requirements are also relatively small, so that the opportunity cost of the capital invested in the margin requirement is also small.

Besides the commission charges, there is another cost of hedging which is not directly charged to hedgers. This cost is the difference between the bid and asked prices, or the "margin," of speculators. The margin of the traders on the futures exchange is synonymous with the margin in the cash market. A cash grain merchant, a typical long-basis hedger, normally buys in the cash market at the bid price and sells at higher asked prices. In the futures market, this situation is reversed. Purchases are made by hedgers at asked prices, and sales are made at bid prices. The merchant is paid for his services in the cash market by receiving the asked price, and he pays for the services of the futures market by buying at asked prices.

The amount of this cost will depend on the activity of the exchange. In a very active exchange, scalpers (who provide much fluidity in the market) can afford to take a smaller margin between their bid and asked prices. They can afford to do so since the greater activity provides an opportunity to make more trades in a given time period, thereby increasing the opportunity to earn a satisfactory return. Also, the greater activity allows the scalper to easily reverse his position if he has judged the market incorrectly. The risk of a large loss is thus smaller. Evidence suggests that on the most active exchanges, the

scalper's margins average between 1/10 and 1/5 of one percent of the price.[16]

Needs of the Business

The execution of a successful policy of hedging by a firm engaged in grain marketing requires that the firm pursue a policy consistent with its needs. The needs of the business can influence decisions such as the timing of hedging decisions and the choice of the appropriate futures market for its hedging transactions.

The needs of the business may dictate that hedging operations be performed quickly and at a low cost (e.g., operational hedging), or that current price differentials provide a good basis for evaluation of the prospects of gain from hedging transactions (e.g., carrying charge hedging). The former need of the business requires only a high degree of short term correlation of changes in the futures and cash prices. The latter need requires that the futures price provide a reliable estimate of the expected price of a particular type of wheat at a later date.

The businessman should recognize that his needs must govern the conduct of his hedging transactions. For example, if he is not well versed in knowledge of stocks of the various types of wheat and the market differentials which exist between the various types and grades, then the Chicago futures price may not provide him with a reliable estimate of the future price of Hard Red Winter wheat at Gulf locations.[17] The businessman contemplating storage of Hard Red Winter wheat in the Southern Great Plains may choose the Kansas City market as the logical and most reliable estimate of the price for this

particular type of wheat. In contrast, the Chicago futures market may provide the greatest protection at the lowest cost for a firm engaged in operational hedging. Failure to analyze hedging policies in terms of needs may result in a low degree of success (measured in terms of increased costs relative to returns).

It should be noted that business decisions involving hedging cannot be made by analyzing conditions in only one market. Hedging cannot protect against a bad decision made in the cash market. If the firm misjudges the market and pays too much for a particular lot of grain, no amount of hedging can prevent a loss. Many criticisms of hedging perhaps arise from a misunderstanding of this aspect of the hedging transaction.

Implications for Business Users of Futures Markets

The accumulated evidence suggests that futures markets provide a useful service in grain marketing whether a particular firm engages in hedging transactions or not. Since futures prices appear to provide unbiased evaluations of market expectations, the firm can reach business decisions that involve price expectations with a degree of confidence. Also, for hedgers or non-hedgers, cash-futures price relationships can provide signals for processes such as inventory accumulation or production scheduling. There are also implications unique to individuals using futures markets to hedge their operations.

First, hedging may be a sort of arbitrage between the cash market and the futures market. Hedging may be done with the expectation of a change in the cash-futures price relationship, and the change which may be expected is often indicated by the current price relationship.

Secondly, hedging does not eliminate the price risk incident to inventory ownership. Risk is still present, but may be less than when hedging is not used. The change in the risk will depend on factors such as the quality of the grain being hedged and the location of the hedger. When the grain held is of substantially different quality than that to which the futures price relates, or the location is remote from the futures market, these risks will probably increase.[18]

The Use of Futures Markets for Carrying Charge Hedging

The previous sections of this chapter have attempted to define the significance of futures contract prices and to delineate the role of hedging decisions as an integral part of business operations. The remainder of the chapter will be devoted to a fuller development of the process of carrying charge hedging and to the presentation of the model which will be utilized to evaluate this practice.

Carrying charge hedging is a name which has been used to define the practice of hedging an inventory of grain held for sale at a later date. This hedging is done in anticipation of an improvement in price relationships, and the firm seeks a profit through these changes rather than through an increase in the price of the commodity during the storage period. An understanding of the relationship between the price of the commodity in the cash market and its price in the futures market is necessary to successfully utilize this practice.

A futures price should, at all times, constitute the best available estimate of the price of the commodity at the delivery date of the futures contracts. The cash price of a seasonally produced commodity at any point in time primarily reflects supply and demand conditions in

the cash market at that time.[18] In an equilibrium situation, in which the supply quantity is adequate to meet demand and the commodity is flowing into consumption at the rate necessary to satisfy consumer wants, the cash price will be discounted relative to the futures price by an amount sufficient to cover the costs of storage. This discount is necessary to induce inventory owners to hold the commodity for sale at a later date rather than offer it for immediate sale. During the delivery month of the futures contract, the cash price and the futures contract price refer to the same point in time. Hence, the cash price and the futures price should be approximately equal to each other for the same quality of the commodity only in the delivery month, and only at the delivery point.[19]

It would be an oversimplification to say that spreads between cash and futures prices at a point in time arise solely from storage costs. Other factors also may influence this spread. Among these are the need for specific grades at designated locations on specific dates, new crop prospects, the general economic outlook, world crop prospects, changes in Government loan and sales programs, and slightly different conditions of supply and demand at the cash market. These are only a few of the factors which may influence spreads between cash and futures prices. The many forces which may interact to give rise to spreads between cash and futures prices makes it virtually impossible to determine a "normal" spread for any point in time.

Although there are many factors which can influence cash-futures price spreads at any point in time, these spreads still may provide some indication of prospects during a specific period. Permanent changes in any of the variables which influences cash and futures prices at

different markets also should result in a permanent change in the spread between the prices. For example, a permanent reduction in freight rates between two markets will probably change the spread. However, a change such as this, once reflected in the market, should not influence the change in the spread during a specified period of a crop year. Variables which are subject to annual change, such as general economic conditions or world crop prospects, will cause different spreads for the same date in different crop years. This annual change also could be expected to result in different changes in the price spread during the same period of the different crop years. However, the change in the spread of the prices during a specified period still may be indicated by the spread at the beginning of the period.

As an example of the above discussion, consider a case of two spatially separated markets (a futures market and a cash market) in which the spread of the prices has averaged 22 cents on a certain date over time. Assume that the spread has averaged 24 cents one month later. A reduction in freight rates between the markets may cause a reduction in the spread between the markets, but this should have an equal effect upon the spread at both points in time. Hence, the two cent average increase should be unaffected by this change. On the other hand, temporary changes in supply or demand conditions may cause a spread of 25 cents at the beginning of the month in question in a given year. If the cash market price is greater than the futures market price, then this would mean that buyers at the cash market are willing to pay a greater premium than the average in order to obtain wheat. If the greater than average premium existed until the maturity date of the futures contracts, shipments which would normally go to the location of

the futures market would be diverted to the other market. Adjustments would be necessary to reflect this condition, and the result quite possibly could be a smaller than average increase in the spread.

There is a characteristic of the relationship between cash and futures prices which leads to a stronger inference concerning the spread of the prices. This characteristic is the tendency of the cash price to change in the same direction and with the same magnitude as a change in the futures price in the extreme short run. This means that the spread between the prices tends to be constant over short periods of time. The difference of the prices on a given date thus tends to measure the return which could be earned from storing hedged wheat until the delivery month. Price differences have come to be regarded as measuring the competitive price of storage services, and the price of storage often is reflected in temporal price spreads. The price spread, or the basis, thus may be used to evaluate the prospective earnings from hedged storage.

Determination of Returns From Storage

Net earnings from unhedged storage are equal to the price change during a storage interval minus the costs of storage for that period of time. The criterion for the profitability of unhedged storage thus is that the price must increase by an amount which is greater than the costs of storage. Gross earnings from hedged storage are equal to the change in the cash price relative to the futures price. For profitability, the cash price must increase relative to the futures price by an amount greater than storage costs.

Many expositions of the returns from hedging show separate computations for the price change in each market and then determine the net gain (or loss) on the transaction as the sum of the changes in the separate markets. Although this practice does determine the net gain or loss, the underlying principle of the transaction is hidden. For this reason, firms engaged in the grain trade usually evaluate hedging transactions in terms of basis.

As an example of basis change computations, consider a situation in which No. 1 Hard Red Winter wheat was stored at a Gulf port from August 3 to December 7, 1967. The cash price and the closing price of the Kansas City December contract on these two dates are given in Table II. Cash wheat could have been purchased on August 3 at a price which was 16 3/8 cents per bushel over the closing price of the Kansas City December futures contract. If this transaction had been made, then the buying basis of 16 3/8 cents would have been established. A sale of the cash wheat and a purchase of the futures contract at the prices given for December 7 would have established a selling basis of 25 3/8 cents per bushel. Gross earnings on the transaction would have been nine cents per bushel, which is computed by subtracting the buying basis from the selling basis. These are gross earnings since storage costs and broker's fees have not been considered.

The above example may be used to illustrate several points with regard to hedging transactions. First, it is incorrect to speak of a decrease in the basis as a prerequisite for positive returns from hedged storage. In the example, the basis increased, and there were positive returns. Depending on the normal relationship of the prices and the definition of the basis, the algebraic signs of the basis and of basis

changes will differ. It is more correct to speak of an increase in the cash price relative to the futures price as the prerequisite for positive returns from hedged storage. This definition implies that if cash prices exceed futures prices, the spread must increase, and if the opposite is true, the spread must decrease for positive returns on the transaction.

TABLE II

PRICES AND GROSS EARNINGS FROM STORAGE OF NO. 1 HARD RED WINTER WHEAT AT A GULF LOCATION, AUGUST 3 TO DECEMBER 7, 1967

Date	Cash Price (Gulf Ports)	December Futures (Kansas City)	Basis
		--Dollars per Bushel--	
August 3, 1967	$1.79	$1.62 5/8	$.16 3/8
December 7, 1967	1.78	1.52 5/8	.25 3/8
		Gross Earnings	$.09

A second point which may be illustrated by the example is that the spread on a single date provides little information for a hedger unless the hedger has knowledge of previous price relationships and seasonal changes. Two additional bits of information can provide a foundation for the analysis of price prospects. These are the price of the September futures contract and typical spreads at a given point in a crop year. The price of the September futures contract on August 3,

1967, was $1.57 7/8 per bushel. Thus, the basis with respect to the September contract was 21 1/8 cents per bushel or 4 3/4 cents per bushel greater than the basis with respect to the December contract. Historically, the basis is weakest during the period immediately after harvest. This information then could indicate that the spread of the prices by the first week in December should exceed the 21 1/8 cents per bushel spread between the cash price and the September futures contract price which existed in the first week in August.

A third point which may be made from the above example illustrates that the earnings from hedged storage may be more predictable than the earnings from unhedged storage. Typically, an increase in the cash price could be expected from August to December. However, for this particular year, the cash price decreased. The use of hedging, or at least the evaluation of price spreads, may provide a greater degree of predictability of storage earnings.

Evaluation of Carrying Charge Hedging

Little research has been reported which attempts to evaluate the effectiveness of hedging to earn the storage return under conditions other than at a deliverable location. Analysis of carrying charge hedging at a delivery point is unnecessary since returns are assured to the hedger. If the cash-futures price relationship worsens, the hedger can simply deliver on the futures. This alternative is not open for hedgers in remote locations (relative to the location of the futures market) such as Oklahoma. In these locations, storage returns may be earned only through changes in the cash-futures price relationship.

Heifner (1966) determined the expected returns from carrying charge hedging for country elevators in Western Michigan. Heifner used linear regression with the initial basis as the independent variable. The dependent variable was the change in the basis, or the return from carrying charge hedging. Net returns for storage were estimated by use of a Monte Carlo technique for several overlapping periods during the crop year. Returns were estimated under two alternatives: 1) storage conducted for the same interval every year, and 2) storage conducted only if the basis change is expected to be greater than the variable costs of storage for the interval.

Heifner's study is subject to some limitations and fails to answer several relevant questions. His study covered a period when the CCC was very active in the market, and no attempt was made to determine if the actions of the CCC had any effect on the basis.[20] The prices which Heifner used may be considered as the prices relevant to evaluating a practice of anticipatory hedging. The hypothetical hedgers would have sold futures contracts at the market close in anticipation of overnight purchases of wheat. A question which is of importance relates to the timing of the futures contracts transactions and the effect of this timing on returns. Instead of conducting futures transactions at the market close, these transactions may have been made at the market open on the next trading day. Also, Heifner did not determine if the use of a different futures market would have significantly altered the results.

A Model for Estimating Storage Returns for Oklahoma Elevator Operators

The linear model and the Monte Carlo technique used by Heifner will

also be utilized in the present study. However, some of the limitations of Heifner's work will be investigated in the current analysis.

The linear model which is employed in the analysis utilizes the expectations that the cash price should be discounted relative to the futures price prior to the delivery month of the futures contracts. Given a constant interest rate, variable storage costs change in a linear fashion over time. Thus, the cash price should approach the futures price in a linear manner as the delivery month approaches.

Given the hypothesis of a linear relationship, the model can be stated in more formal terms. The model can be stated as

$$y_{it} = \alpha_i + \beta_i x_{it} + u_{it}; \quad i = 1,\ldots,n \text{ intervals}$$
$$t = 1,\ldots,T \text{ years}$$

where y_{it} = the change in the cash-futures price spread during storage interval i of year t;

x_{it} = the cash-futures price spread at the beginning of storage interval i during year t; and,

u_{it} = random disturbances occurring during period i of year t.

The coefficients of the equations (α_i and β_i) provide estimates of the characteristics associated with the cash-futures price relationship during a specified storage interval. The information provided by the estimates of these coefficients may be illustrated after some simplifying assumptions are made. These assumptions may then be relaxed to conform with the market conditions relevant to the present analysis.

Three simplifying assumptions will be made. These are: 1) all wheat produced is of a single homogeneous type; 2) all transactions in

this wheat occur at a single point; and 3) futures contracts mature on a single day in the delivery month. These conditions require that the cash price and the futures contract price must be equal on the date of maturity.

Given the above assumptions, there must be a one for one correspondence between the initial spread of cash and futures contract prices and the change in the spread by the maturity date of the futures contracts. Regardless of the initial spread of the prices, they must be equal on the delivery date. This can be accomplished only if the cash price changes relative to the futures price by an amount equal to the initial spread of the prices. The condition of a one for one correspondence of the prices thus requires that the slope coefficient (β) must be equal to one. The sign of this coefficient will depend upon the method used to compute the initial price spread and changes in the spread.

Under the above assumptions, the value of the intercept term (α) is zero. This indicates that no change would be expected in the spread between the cash and futures prices if a hedge were initiated when the prices were equal.

When the above assumptions are relaxed to include multiple markets for wheat, several varieties and grades of wheat, and a more extended delivery period, the slope coefficient maintains its interpretation, i.e., it indicates the expected change in earnings associated with a change in the initial price spread. The theoretical value of this coefficient would be one only for wheat of the quality priced by the futures contract held at the delivery point. For locations other than the delivery point, the characteristics of the market at these locations

may give rise to a slightly different supply and demand response than that existing at the delivery point. Such a situation could exist when a cash market is subject to relatively greater variability of demand for wheat during a crop year and among crop years than the cash market at the delivery point. If deliveries are not a feasible alternative for hedgers at markets other than the delivery point, then returns from hedging may be earned only through price changes. Hedgers at these other cash markets must depend upon a relatively constant relationship of the cash price in their market to the price in the cash market at the delivery point. Equality of the prices on the maturity date of the futures contracts is not necessarily true in this case. Hence, the value of the slope coefficient may differ from one when the cash and futures prices are formulated in geographically distinct but related markets.

Grades or qualities of wheat other than the grade and quality of wheat most likely to be delivered in fulfillment of a futures contract commitment also are likely to exhibit a response other than a one for one correspondence between an initial cash-futures price spread and the change in this spread over time. During some crop years, qualities of wheat higher than the contract grade may become scarce relative to lower qualities and command a greater premium late in the year. The amount of the premium between two grades of wheat may vary from one year to the next as the relative amount of each grade changes. The value of the slope coefficient may be influenced by this characteristic of the market when the grade or quality of wheat held differs from the contract grade or quality.

Geographic separation of the cash and futures markets may result in a price differential between the two markets caused partially by the cost of transportation. When this situation exists, cash-futures price spreads cannot be directly evaluated to estimate the carrying charge. The cash-futures price spread in this situation would be influenced by the transportation cost as well as all the other factors which may have an influence on the price spread. Price differentials caused by forces other than seasonal discounts of the cash price relative to a futures contract price result in a non-zero value for the intercept term. The value of the intercept term is a function of the average basis change during a period of the crop year and the average basis at the beginning of that period.

For the purpose of this study, the initial cash-futures price spread, or basis, is defined as the cash price minus the futures price at the beginning of the storage interval. The change in the basis is defined as the selling basis minus the buying basis.

The hypothesized relationship is not a causal relationship in the sense that the independent variable (the initial basis) causes a change in the basis. However, the initial spread between the cash and the futures price is caused by conditions in the market at that time, and may indicate the direction and magnitude of the change in this relationship during the coming period. The relationship can be used only to determine the average change in basis associated with a given initial basis. It cannot be used to predict a basis change for a specific year.

Storage Plans

The storage plans considered in this model are the same as the

storage plans considered by Heifner. However, one change is made in the procedure. Average returns from the conditional storage rule (storage conducted only when the basis change is expected to be greater than the variable costs of storage) are estimated using only the trials during which storage is involved, i.e., when the criterion is satisfied. Heifner estimated these returns as the average for all trials, with storage returns equal to zero for the trials in which the criterion was not satisfied. The present analysis also includes the proportion of times this criterion was satisfied.

Hedging Practices

Three alternative hedging practices are included in this study. These are: 1) the buying and selling bases are established using the Thursday cash price and the Thursday closing price of the futures contract expiring in the last month of the storage interval; 2) the buying and selling bases are established using the Thursday cash price and the Friday opening price of the futures contract expiring in the last month of the storage interval; and, 3) the buying and selling bases are established using the Thursday cash prices and futures prices, but the futures contract used is the one which is priced the highest (i.e., the basis is the smallest) with respect to the cash price at the beginning of the storage interval.

The first hedging practice will be denoted as anticipatory hedging in this study, the second will be denoted as simultaneous hedging, and the third will be denoted as "any month" hedging. These names are chosen for identification purposes only. An assumption of the analysis is that the cash price which will be used would pertain to all cash

market transactions which occur during the hours that the futures exchange is closed. The anticipatory hedging practice is visualized as a practice of conducting futures market transactions prior to the close of the futures market, and the cash market transactions take place prior to the open of the futures market the next morning. In the simultaneous hedging practice, the cash market transactions precede the futures market transactions. The primary difference between these two practices thus consists of anticipating cash market transactions versus establishing a cash market position before placing a hedge. Hopefully, the names chosen for these two practices reflect this difference. The "any month" practice removes the limitation of the other two practices that the hedge must be placed in the futures contract that matures at the end of the storage interval.

FOOTNOTES

[1]J. R. Hicks, Value and Capital (2d ed., London, 1946), p. 138.

[2]Lester Telser, "Futures Trading and the Storage of Cotton and Wheat," Journal of Political Economy, LXVI (1958), p. 234.

[3]Holbrook Working, "New Concepts Concerning Futures Markets and Prices," American Economic Review, LII (1962), pp. 445-447.

[4]Random walk may be illustrated by means of an example. Consider an experiment which consists of flipping a fair coin n times. Prior to each flip of the coin, move forward one step. After each flip, move one step to the right if a head appears, and one step to the left if a tail appears. If the results of this experiment were plotted on a graph, the resulting curve would exhibit random walk. A characteristic of random walk is that although the cause of a change is known, knowledge of what has happened on previous trials of the experiment cannot be used to predict what will happen on the nth trial.

[5]Working, "New Concepts Concerning Futures Markets and Prices," p. 446.

[6]Ibid., p. 447.

[7]Roger Gray, "The Characteristic Bias of Some Thin Futures Markets," Food Research Institute Studies, I (1960), p. 312, quoted in Seymour Smidt, "A Test of the Serial Independence of Price Changes in Soybean Futures," Food Research Institute Studies, V (1965), p. 133.

[8]Working, "New Concepts Concerning Futures Markets and Prices," p. 452.

[9]Ibid., p. 447.

[10]"Long basis hedging" and "short basis hedging" are sometimes used in place of "short hedging" and "long hedging" respectively. Any trader on a futures contract exchange may be short (sold futures) or long (bought futures) in his futures market commitments. However, only hedgers have established a position in both markets and thus may be described with respect to a basis position.

[11]This statement must be qualified in order to recognize that futures prices are not perfect estimates of the prospective price. If futures prices were perfect estimates, then no change in the price relationship necessarily means that the cash price would be unchanged. This definition then implies that both prices must move in the same

direction and have the same magnitude of change when futures prices are not perfect estimators.

[12]Holbrook Working, "Hedging Reconsidered," Journal of Farm Economics, XXXV (1953), p. 560.

[13]Working, "New Concepts Concerning Futures Markets and Prices," p. 432.

[14]Ibid., p. 438.

[15]Ibid., p. 442.

[16]Holbrook Working, "Futures Trading and Hedging," American Economic Review, XLII (1953), pp. 333-336.

[17]It is possible that spreads between the cash price in Oklahoma and the Chicago futures price may provide no basis for the formation of expectations. This question will be investigated in Chapter IV.

[18]Working, "Futures Trading and Hedging," p. 325.

[19]The prices may be approximately equal since inventory holders may purchase futures contracts and forego a small gain or accept or a small loss rather than deliver on the futures commitment. The major consideration may be to maintain control of the inventory.

[20]Roger Gray, Food Research Institute Studies, III (1962), p. 23, cautions "...against misinterpreting a loan induced seasonal price pattern as being a typical futures price pattern." Gray looks only at futures prices, but this conclusion also suggests that cash-futures price relationships were also affected by the loan programs in the high price support era.

CHAPTER IV

USEFULNESS OF THE INITIAL BASIS AS A PREDICTOR OF STORAGE EARNINGS

The usefulness of the cash-futures price spread, or initial basis, as a predictor of the prospective earnings from hedged storage of wheat is assessed in this chapter. The linear model developed in Chapter III is used to determine the degree to which basis changes are explained by the size of the initial basis. This procedure is utilized for basis changes with respect to the Kansas City and Chicago futures market prices.

Ten overlapping storage intervals are considered for each year. These intervals are set up to begin in the first week of a futures contract delivery month and to end in the first week of a later delivery month. Storage intervals are not set up to end late in the delivery month in order to exclude changes in the price of the expiring futures contract which may be caused by the efforts of traders to close out futures market commitments. Storage intervals ending in July are not considered since this would involve carrying wheat from one crop year to the next. Storage intervals are thus restricted to periods within a crop year, and were chosen to facilitate comparisons among delivery months.

The Data

Selection of a Relevant Historical Period

The profitable execution of a storage plan requires that the elevator manager evaluate the price prospects for the period during which the storage activity will be conducted. This evaluation is a difficult task for any commodity. For wheat, the task is even more difficult since production greatly exceeded disappearance for many years. This surplus, coupled with high price supports, may have caused a market response having different characteristics than more recent market conditions. The selection of an historical period or periods which would be comparable with the present could be accomplished in either of two ways. First, a certain period could be selected, and the data for that period might then be adjusted to approximate current conditions if this were necessary. A second method would be to select only the most recent years under the assumption that this period, however short it might be, could provide valid results.

Before a period can be selected to provide results which may be extended into the future, assumptions concerning future events must be outlined. As noted in Chapter II, federal legislation can have an impact upon the amount of disappearance. The wheat marketing system will be influenced by the type of legislation enacted to replace the Farm Act of 1965 when this legislation expires. There appears to be some sentiment for the passage of permanent legislation with respect to farm programs. Permanent legislation probably would not repeat the past mistakes of maintaining high price supports with relatively ineffective production controls. Producers may again prove unwilling to accept the

strict production controls which should accompany high price supports. Therefore, the assumptions included for the present analysis are that: 1) relatively low loan rates will be continued; 2) Public Law 480 will continue to provide a substantial outlet for wheat produced in the United States; and, 3) CCC owned stocks will not be permitted to accumulate to the levels attained during the late 1950's and early 1960's. These assumptions are consistent with a goal of allowing the price system to play a greater role in determining the price of wheat.

These assumptions concerning the future suggest that the period selected for analysis be one in which no high price support programs for wheat have been in force. However, during the time in which the technology of production and the marketing system are comparable with the present, only the crop years 1964-1967 are available. The desirability of using no years with high price supports was partially offset by the desirability of having more than four years included in the analysis. Therefore, the criterion was relaxed to include crop years immediately prior to the 1964 crop year in which disappearance exceeded production. This would allow all the crop years from 1961 through 1967 to be included.

Price Series Used in the Analysis

Evaluation of the initial basis as a predictor of average storage earnings for firms in Oklahoma requires that the cash price used for the analysis be an accurate reflection of the price at which transactions occur in Oklahoma. Also, this price should reflect the price at which transactions would occur for a significant portion of the state. The first choice of an ideal price series to satisfy this condition would

be a price series relating to a specific type and quality of wheat at a terminal location such as Enid. Unfortunately, such a price series could not be obtained.

The relationship of export prices for wheat and the price of wheat in Oklahoma suggests that a price series from the Gulf export market may be suitable for analysis. Such a price series is available. The price of wheat in various export markets has been published weekly since March, 1962 in the Grain Market News. The official title of this price series is "Grains: Export prices basis prompt or 30-day shipment." The price of wheat given for Gulf ports is the price of No. 1 Hard Red Winter wheat, f.o.b. vessel, for immediate shipment or shipment within the next 30 days.

The price reported in the Grain Market News is the prevailing asked price of exporters at the close of business on Thursday of each week. The price on Wednesday is given if Thursday is a holiday. This price is determined from the registrations with the CCC of wheat sales by exporters. These registrations are required for wheat exports from the United States. This price series is the longest series pertaining to a specific grade of wheat at a specific point which could be readily obtained. Although this price series does have the limitation of being relatively short, it does meet the requirements outlined and was selected for the analysis.

The price of No. 1 Hard Red Winter wheat, f.o.b. vessel at Gulf Ports is a secondary choice, and the precision of the results depends upon the accuracy of this price series as a reflection of wheat prices in Oklahoma. Specifically, the price which exporters pay for wheat delivered to an export elevator (f.o.b. track price) must be closely

related to the price of wheat loaded on a vessel. The price relevant to elevator operators in Oklahoma is the f.o.b. track price at the Gulf on any given day since this is the price which would be paid for wheat delivered that day. The f.o.b. vessel price provides a reliable measure of price changes in Oklahoma on a given day only if changes in f.o.b. track prices are closely related to changes in f.o.b. vessel prices.

The difference between f.o.b. track and f.o.b. vessel is the handling cost to unload the wheat from the transport vehicle and load it on the vessel plus a profit margin. Prices f.o.b. track which were reported for 1965 and 1966 indicate that during this period the difference of these prices, or the "fobbing charge," ranged from two to four cents and averaged about 3.5 cents per bushel. The data relating to the f.o.b. track prices were not directly comparable with the f.o.b. vessel prices since the reported track price may have been paid at a time during the day different from the time the vessel price was reported. A small variation between the two price series therefore would be expected. Thus, the price an exporter is willing to pay for wheat on a given day appears to be directly related to the 30-day shipment price on that day. Since a large amount of the wheat produced in Oklahoma is exported, the f.o.b. vessel price should reflect the prices in a large area of Oklahoma on any given day.

Preliminary Examination of the Data

The data used in this analysis include two years in which high price support programs were in effect, and during one of these years the transition from the high support programs to the lower level support program occurred. The data were examined to determine whether or

not the relationship of the cash and futures prices was the same in all the years included in this period. Use of the "r" test criteria proposed by Dixon (1962) indicated that many of the basis changes which occurred during the 1963 crop year could not reasonably be expected to come from the same structure which generated the remaining observations.

The 1963 data posed a dilemna. If inferences were desired about the structure which characterizes the cash-futures market relationship, including any contamination which might arise due to events such as changing price support levels, then all the observations should be used. On the other hand, if inferences were desired about the cash-futures market price relationships which existed in the absence of events such as this, then the 1963 crop year data should be omitted from the analysis. Therefore, it was necessary to consider the circumstances surrounding this event before deciding whether these observations should be included or excluded from the analysis.

The rejection of the wheat referendum by producers in 1963 was unexpected by many members of the grain trade and by the officials of the United States Department of Agriculture. No alternative programs had been seriously considered prior to the referendum. Consequently, there was some uncertainty concerning policies with respect to farm legislation. The circumstances of the 1963 crop year are not likely to be repeated in the future, and another period of transition (if it occurs) probably would have a different effect on the cash-futures market price relationships. For these reasons, the data for the 1963 crop year were excluded from the analysis.

Exclusion of the 1963 data leaves only 5 years of observations (the 1962 and 1964 to 1967 crop years). Since the regression equations

for the storage intervals are based on observations at two points in a crop year, only five values of the initial basis and the change in basis can be obtained for each of the storage intervals.

Regression Estimates of Basis Changes at Gulf Ports With Respect to Kansas City Futures Contract Prices

Anticipatory Hedging

A practice of selling futures contracts in anticipation of purchases of cash wheat during the hours that the futures exchange is closed would have strong appeal as a feasible hedging policy. The elevator operator can determine the size of the basis which exists in the market prior to the close of the futures market. There is little reason to expect a large change in the basis during the remaining time that the futures exchange will be open. There is a greater chance of significant new information during the hours that the futures exchange is closed, and the new information may have a significant effect on futures prices. If the overnight purchases were hedged at the open the next morning, then the buying basis of the elevator operator would differ from that prevailing in the market since cash prices probably would change by an equal amount.

The estimated functional relationships using this hedging practice for ten storage intervals are reported in Table III. These equations are estimated for a period extending from the first Thursday of the month at the beginning of the storage interval to the first Thursday of the month at the end of the interval. The second column (average initial basis) is the mean value of the spread between the price of the Kansas

TABLE III

STATISTICAL COEFFICIENTS FOR REGRESSION OF THE SEASONAL BASIS CHANGE ON THE INITIAL BASIS FOR NO. 1 HARD RED WINTER WHEAT STORED AT GULF PORTS AND HEDGED IN THE KANSAS CITY FUTURES MARKET WITH AN ANTICIPATORY HEDGING PRACTICE

Storage Interval	Average Initial Basis (s_x)	a	b (t)	$s^2_{y.x}$	R^2
	(Cents/Bu.)				
July-September	21.7245 (2.314)	26.21752	-1.13890 (-.4677)	1.88394	.83**
July-December	18.0250 (2.561)	25.01150	-1.02144 (-.1078)	1.03765	.90**
July-March	15.7500 (2.993)	25.38613	-1.12293 (-.6806)	1.16945	.93**
July-May	18.7000 (5.281)	15.10883	-.64887 (1.3916)*	11.72387	.57**
September-December	19.9000 (2.841)	29.30830	-1.23785 (-2.3734)*	.32432	.98**
September-March	16.7750 (4.174)	21.38772	-.87706 (1.0270)	.99886	.95**
September-May	19.6000 (5.728)	14.36502	-.62704 (1.3362)*	10.22368	.63**
December-March	24.0745 (2.354)	28.07766	-1.19222 (-.8722)	1.07689	.91**
December-May	26.6750 (4.688)	18.34157	-.87504 (.2943)	15.85065	.59**
March-May	25.4750 (5.108)	10.71496	-.56977 (1.3990)*	9.86972	.53**

*$t_{(3,\ 0.70)} = 1.250$. Therefore, $H_o: \beta = -1$ may be rejected in favor of $H_a: \beta \neq -1$.

**Hypothesis of no linear relationship between the variables may be rejected with $F_{[0.75,\ (1,\ 3)]} = 2.02$.

City futures contract in which the hedge was placed and the f.o.b. vessel price at the beginning of each storage interval during the observational period. The standard error of this statistic is enclosed by parentheses immediately under each of the ten values reported. The last four columns give the estimates of the coefficients of each equation and the coefficient of determination. Student's t statistics are in parentheses below the b values, and are for the test of the null hypothesis $H_o: \beta = -1$ against the two-tailed alternative $H_a: \beta \neq -1$.

The definitions of basis and basis changes utilized in this analysis require a positive sign for the intercept term and a negative sign for the slope coefficient. Cash prices at Gulf ports normally exceed the prices of all Kansas City wheat futures contracts within a crop year. The basis, defined as the Gulf cash price minus the futures price, is therefore positive. Since the intercept term reflects the location differential, its sign should also be positive. Similarly, a positive change in the basis (selling basis minus the buying basis) is a profit and a negative change in the basis is a loss. Profits would be expected at smaller values of the initial basis. This implies that the slope should be negative. As explained in Chapter III, the expected value of the slope for wheat of the quality priced by the futures contract is one.

The coefficients reported in Table III all have the algebraic signs which would be expected from the definitions of basis and basis change which are used in this analysis. The hypothesis of linearity in the relationship between the variables may be accepted in all cases. This also conforms with the theoretical expectations. Four of the slope coefficients given in the table may be considered as different from

minus one. Three of these are for storage intervals ending in May, and the fourth is for a storage interval ending in December. This indicates that a change in the price spread at the beginning of one of these four intervals from one year to the next tends to be accompanied by a change in the basis which is not proportional to the change in the initial basis. Thus, during certain periods of the crop year, a change of one cent in the basis from one year to the next does not tend to result in a one cent change in earnings. This factor should be considered when the basis in one year is compared with its past values.

The coefficients of determination indicate that there is a high degree of correlation (.90 or greater) between the initial basis and the change in basis for all storage intervals except those ending in May. This indicates that the initial basis would have been a good predictor of gross earnings from hedged storage during the five years used to estimate these equations. Under the assumption that the market will continue to exhibit the characteristics of these five years, the initial basis should continue to be a good indicator of probable changes in cash-futures price relationships during certain of the storage intervals. The relatively low degree of correlation exhibited by the storage intervals ending in May can be partially explained by a deviation from the normal movement of the basis during a crop year. A detailed analysis of these movements during the five years will not be attempted in the present study. These basis movements during a crop year are the subject of another study of wheat marketing in Oklahoma. However, normal basis movements during a crop year can be described by using the average initial basis figures given in Table III. Typical movements of the basis during a crop year may be inferred by choosing a distant futures month

(e.g., May) and comparing the average initial basis figures at the beginning of successive storage intervals ending in that delivery month.

Comparison of the average initial bases for the storage intervals ending in May show that there is a small average increase (.9 cent) from July to September, a substantial average increase (7.075 cents) from September to December, and an average loss (-1.2 cents) from December to March when the change in the cash price is measured with respect to the price of the May futures contract. The same characteristics are shown when storage intervals ending in a different delivery month (e.g., March) are compared, although the magnitude of the changes will be different.

The relatively low coefficients of determination for the storage intervals ending in May now can be explained. The large relief shipments of wheat to the Far East during the 1965 crop year caused a smaller decline in the basis during the early spring months of 1966 than the decline normally experienced in these months. Such behavior cannot be considered as an imperfection in the market (as contrasted to the 1963 data), and must be recognized as consistent with possible future events.

The estimates of the intercept terms of these ten equations cannot be evaluated against any fixed standard. However, the price of No. 1 Hard Red Winter wheat at the Gulf generally exceeded the price of the near futures by at least twenty cents during the period of analysis. This characteristic of the Gulf wheat market makes suspect any estimates of the intercept term which are less than twenty. All of the estimates which are less than twenty occur in the storage intervals ending in May. However, this result probably provides a better description of expected basis changes within the range of the observations. The equations in

which the intercept term is less than twenty include the period of the crop year in which the cash price exhibited an average decrease relative to the price of the May futures contract. The decline in the cash price indicates that negative carrying charges may be experienced during this portion of the crop year for hedges placed in the May futures contract. The coefficients of the equations for these storage intervals possibly indicate that positive carrying charges can be expected infrequently with the market conditions that prevailed during these five years.

Simultaneous Hedging

Some elevator operators may prefer to follow a different policy from the practice of anticipatory hedging described in the previous section. If the purchase of cash wheat fails to materialize as was anticipated, the futures contracts which were sold the previous day must be bought back. There is the possibility that the price of the futures contract will have increased, so that a loss will be incurred on the transaction.

The second hedging policy utilized for the evaluation of the initial basis as a predictor of earnings from hedged storage is denoted as simultaneous hedging. The practice could also be called delayed hedging since overnight purchases (made at the previous afternoon's cash price) are not hedged until the open of the futures exchange the next morning. The name of the practice is unimportant, and is only needed to distinguish this hedging policy from the others. This policy is evaluated to determine whether or not there is a substantial difference between selling futures contracts at the market close or at the open when the same cash price applies to both transactions.

Comparison of the average initial basis for each storage interval under the policies of anticipatory and simultaneous hedging reveals that the futures exchange averaged higher prices at the Friday open for the majority of the storage intervals (Table IV). The average initial basis under the policy of simultaneous hedging is smaller in seven of the storage intervals which indicates that the futures prices were higher at the opening of the Kansas City Board of Trade on the next day. The average initial basis is the same in one interval when these two practices are compared, and slightly larger in two of the intervals. The results of this comparison imply that the anticipations concerning overnight purchases should be relatively firm when the futures contracts are sold. The results are not conclusive. Daily comparisons during several crop years would be necessary in order to verify this hypothesis.

The initial basis would be expected to be less useful as a predictor of basis changes under this policy of simultaneous hedging than under the policy of anticipatory hedging since the hedger is, in effect, establishing a basis somewhat independent from the current market spread between the cash and futures prices. The purchase of the futures contracts at the end of the storage interval also may be made at a price which would result in a selling basis which is not entirely consistent with current market spreads. There is no way of knowing whether the futures price would be higher or lower at the open on the next morning, so that the gross returns from this practice could involve a certain amount of randomness. Basis changes could not be expected to be as highly correlated with the initial basis as they would be under a

TABLE IV

STATISTICAL COEFFICIENTS FOR REGRESSION OF THE SEASONAL BASIS CHANGE ON THE INITIAL BASIS FOR NO. 1 HARD RED WINTER WHEAT STORED AT GULF PORTS AND HEDGED IN THE KANSAS CITY FUTURES MARKET WITH A SIMULTANEOUS HEDGING PRACTICE

Storage Interval	Average Initial Basis (s_x)	a	b (t)	$s^2_{y \cdot x}$	R^2
	(Cents/Bu.)				
July-September	20.9500 (1.972)	23.25385	-1.01808 (-.0571)	1.56080	.77**
July-December	17.5745 (2.612)	27.97633	-1.18784 (-.6962)	1.98724	.87**
July-March	14.7500 (2.915)	22.21346	-.87040 (.6219)	1.47632	.85**
July-May	18.0745 (5.132)	11.68689	-.43911* (1.7319)*	11.05103	.38
September-December	19.8500 (2.452)	33.95758	-1.46764* (-3.0761)*	.55567	.97**
September-March	16.8500 (3.979)	20.76564	-.80063* (1.7439)*	.82766	.94**
September-May	19.2000 (5.754)	-14.06997	-.59609 (1.2042)	14.89866	.51**
December-March	24.0745 (2.420)	19.00228	-.78722 (.8987)	1.31314	.79**
December-May	26.5500 (4.669)	19.82799	-.92478 (.1499)	21.93554	.53**
March-May	25.6745 (4.862)	10.36985	-.55384 (1.0905)	15.82635	.38

*$t_{(3,\ 0.70)} = 1.250$. Therefore, H_o: $\beta = -1$ may be rejected in favor of H_a: $\beta \neq -1$.

**Hypothesis of no linear relationship between the variables may be rejected with $F_{[0.75,\ (1,\ 3)]} = 2.02$.

practice of initiating and terminating hedging transactions at prices which are consistent with current market spreads. This expectation is confirmed by the generally lower coefficients of determination given in Table IV. All of these statistics are lower than the corresponding statistics of Table III. However, the decline in the degree of correlation between these two variables does not appear to be sufficient to discredit the practice of simultaneous hedging as a feasible hedging practice.

The algebraic signs of the coefficients conform with the signs which were expected. The hypothesis of a linear relationship between the variables may be accepted in eight of the ten cases. The two exceptions are for storage intervals ending in May. This result, together with the generally lower coefficients of determination, is indicative of a greater uncertainty of returns when hedges are initiated and terminated at prices which do not completely reflect current market differentials. This method of simultaneous hedging could have one benefit. Instead of an overnight sale of wheat and a purchase of futures contracts at the open on the next day, the hedge could be terminated while the market was open. By doing this, the hedge would be terminated at a price spread equal to the spread currently prevailing in the market. Returns could be increased if the price at which the futures contracts were sold was higher than the previous day's closing price since the initial spread would be smaller than that existing in the market. The opposite would be true if the futures price was lower at the open than at the previous day's close.

Again, some of the slope coefficients may be considered as different from minus one. Two of these coefficients are for the same

storage intervals as under the anticipatory hedging practice. The third was not significant at the 70 percent probability level for the anticipatory hedging practice. However, it does occur during the same period of the crop year as the others. This result further illustrates that annual changes in the basis on a given date have tended to be accompanied by a change in earnings that is not proportional to the change in the initial basis during certain periods of the crop year.

Average initial bases at the beginning of each storage interval display approximately the same magnitude of change during the crop year as they did under the anticipatory hedging practice. In general, the equations for the practice of simultaneous hedging exhibit the same characteristics as those for the anticipatory hedging practice. A comparison of the returns from these two practices is given in Chapter V.

"Any Month" Hedging

The third hedging practice to be evaluated is denoted as "any month" hedging. This name does not precisely describe the practice since certain rules still will be followed. The hedge must be placed in a futures contract which expires after storage is terminated. The futures month to be used is the one for which the spread between the futures and the cash price is the least at the beginning of the storage interval. Thus, hedges could be placed in new crop futures contracts as well as current crop year contracts.

The practice of "any month" hedging could be used to minimize the effects of short run changes in the market. For example, a hedger may think that producers will be reluctant to sell during the next few

months. If this event does occur, the price of cash wheat may be bid up in view of the relative scarcity of the physical commodity. If this condition is expected to exist until the nearest delivery month, the price of this contract may also increase. However, this condition should not increase the prices of more distant futures contracts--these prices may decline to reflect a larger expected supply during these periods. The concept of hedging under this condition then is to avoid increases in the price of the near futures caused by short run changes in demand or supply expectations, but at the same time derive the benefits of the increased price in the cash market. It should be noted that losses probably will be incurred under this practice if the changes in short-run expectations cause price decreases.

Regression estimates of the relationship between the initial basis and the seasonal change in the basis with the practice of "any month" hedging are reported in Table V. Only eight storage intervals are given in this table. It was not necessary to consider either the July to May or the September to May storage intervals under this practice. The May contract is the most distant futures contract available during the month of July. Therefore, the May futures contract is the only contract which could be used during the July to May storage interval. During the five years included in this analysis, the basis with respect to the May contract was the smallest during the month of September. The hedges for the September to May storage interval would have been placed in the May contract in each of the five years. Thus, the prices which would be used to evaluate basis changes for the "any month" hedging practice for these two storage intervals would be identical to those used to evaluate the anticipatory hedging practice.

TABLE V

STATISTICAL COEFFICIENTS FOR REGRESSION OF THE SEASONAL BASIS CHANGE ON THE INITIAL BASIS FOR NO. 1 HARD RED WINTER WHEAT STORED AT GULF PORTS AND HEDGED IN THE KANSAS CITY FUTURES MARKET WITH AN "ANY MONTH" HEDGING PRACTICE

Storage Interval	Average Initial Basis (s_x)	a	b (t)	$s^2_{y \cdot x}$	R^2
	(Cents/Bu.)				
July-September	15.5500 (3.378)	2.94038	-.13282* (1.4603)	16.09617	.02
July-December	15.5500 (3.378)	20.58682	-.78372 (.5473)	7.12788	.57**
July-March	14.3250 (3.724)	24.31973	-1.06769 (-.4397)	1.31524	.94**
September-December	16.5250 (4.517)	24.51803	-1.03437 (-.1112)	7.80743	.79**
September-March	16.5250 (4.518)	21.09429	-.86349* (1.3052)	.89295	.96**
December-March	23.6500 (2.706)	22.79010	-.98901 (.0391)	2.31757	.80**
December-May	26.4750 (4.945)	17.04789	-.84222 (.3784)	17.00494	.58**
March-May	22.6000 (7.708)	5.25331	-.39727* (2.7575)	11.35508	.52**

*$t_{(3,\ 0.70)} = 1.250$. Therefore, H_o: $\beta = -1$ may be rejected in favor of H_a: $\beta \neq -1$.

**Hypothesis of no linear relationship between the variables may be rejected with $F_{[0.75,\ (1,\ 3)]} = 2.02$.

The results of using this practice during the five year period would have been mixed. A substantially lower degree of correlation between the initial basis and change in the basis would have existed early in the crop year. There is a substantial decrease in the coefficient of determination for the storage interval extending from July to September, and a lesser decrease for the storage interval extending from July to December. Smaller decreases occurred for the September to December and December to March storage intervals. Coefficients of correlation for the other four storage intervals are essentially equal to the coefficients of determination for the anticipatory hedging practice. The comparison is relative to the anticipatory hedging practice since the anticipatory and the "any month" practices both use the Thursday closing futures price and the Thursday cash price.

Since hedges could have been placed in new crop futures contracts under this hedging practice, the contracts in which the hedges were placed should be identified. For the first five storage intervals given in Table V, the hedges would have been placed in the March futures contract during the first four years, and in the May contract during the last year. For the December to March storage interval, hedges would have been placed in March contract during the first three years, and in the new crop September contract during the last two years. Hedges would have been placed in the May contract during the first three years and in the new crop September contract during the last two years for the December to May storage interval. Finally, the March to May storage interval would have been hedged in the May contract during the first year and in the new crop December contract during the last four years. Thus, hedges would have been placed in new crop futures

contracts only during the last three storage intervals given in Table V.

These results can provide some information concerning the appropriate futures months for hedging transactions. The decline of the coefficients of determination for the storage intervals ending in the first half of a crop year indicates that cash-futures price spreads provide fairly accurate forecasts of prospects of gross earnings from hedged storage only if the hedges are placed in futures contracts which mature during this period of the crop year. This implication is best illustrated by the results which pertain to the July to September storage interval. These results indicate that cash-futures price spreads are virtually worthless as predictors of gross earnings during this storage interval if the hedge is placed in a futures contract maturing late in the crop year. The coefficients of determination generally exhibit smaller changes from those obtained for the anticipatory hedging practice when the hedge is placed in a futures contract which matures either during or immediately after storage is terminated. There appear to be two exceptions to this general tendency. The coefficients of determination for the December to May and the March to May storage intervals are essentially unchanged although hedges were placed in new crop futures contracts. However, it should be recalled that the degree of correlation between the variables may have been substantially affected by the abnormal (for these five years) behavior of the basis during the 1965 crop year. Without this abnormality, these two storage intervals may have exhibited the same tendencies as the other six storage intervals.

Regression Estimates of Basis Changes at Gulf Ports With Respect to Chicago Futures Contract Prices

The nature of the Chicago wheat futures contract is such that it should provide a poorer indication of the price prospects for Hard Red Winter wheat at Gulf ports than does the price of the Kansas City wheat futures contract. The Chicago contract may be for a different type of wheat than is produced in the Southern Great Plains, and the cash export market in Chicago does not function for part of each year due to adverse weather. Wheat produced in the Southern Great Plains may be exported during the entire year through Gulf ports.

The procedure outlined in the previous sections is used to test the hypothesis that the initial spread between the price of wheat f.o.b. vessel Gulf ports and the price of a futures contract on the Chicago Board of Trade provides a poorer predictor of earnings from hedged wheat storage in Oklahoma than does the initial spread with respect to the Kansas City futures contract. The Thursday closing price of the relevant contract on the Chicago Board of Trade and the price of No. 1 Hard Red Winter wheat f.o.b. vessel Gulf ports are used to develop linear predictive equations for gross storage earnings from hedged wheat. The results of these regressions are reported in Table VI.

The results reported in Table VI indicate that the initial basis relative to the Chicago Board of Trade wheat futures contract generally provides a poor predictor of earnings from hedged wheat stored at Gulf ports. This is especially true for the shorter storage intervals, and for those early in the crop year. This result is opposite of the pattern of the Kansas City market, in which the shorter storage intervals

TABLE VI

STATISTICAL COEFFICIENTS FOR REGRESSION OF THE SEASONAL BASIS CHANGE ON THE INITIAL BASIS FOR NO. 1 HARD RED WINTER WHEAT STORED AT GULF PORTS AND HEDGED IN THE CHICAGO FUTURES MARKET WITH AN ANTICIPATORY HEDGING PRACTICE

Storage Interval	Average Initial Basis (s_x)	a	b (t)	$s^2_{y \cdot x}$	R^2
	(Cents/Bu.)				
July-September	24.1250 (3.194)	5.76149	-0.13208* (1.8305)*	9.17516	.02
July-December	18.4500 (2.862)	-4.59257	0.87765* (1.6193)*	44.05939	.16
July-March	15.0500 2.809	42.24318	-1.92479 (-0.5887)	77.94046	.33
July-May	16.025 (3.549)	40.01461	-1.75130 (-0.6892)	59.87783	.46**
September-December	20.7000 (3.978)	7.11404	0.10802 (1.1711)	56.66422	.00
September-March	16.1750 (4.983)	31.08359	-1.17055 (-0.1833)	85.98069	.34
September-May	16.9500 (5.307)	40.00918	-1.70998 (-1.0611)	50.43140	.68**
December-March	25.9750 (7.969)	17.21778	-0.57239 (0.8062)	71.46153	.28
December-May	25.1000 (7.905)	30.60160	-1.10464 (-0.1999)	68.44585	.60**
March-May	26.2750 (9.024)	13.52430	-0.45002* (1.9864)*	36.59144	.38

*$t_{(3,\ 0.70)} = 1.250$. Therefore, H_o: $\beta = -1$ may be rejected in favor of H_a: $\beta \neq -1$.

**Hypothesis of no linear relationship between the variables may be rejected with $F_{[0.75,\ (1,\ 3)]} = 2.02$.

and those early in the crop year had the higher coefficients of determination. This difference can be partially attributed to the structural differences between the two markets.

One difference between the Kansas City and Chicago wheat markets has already been noted--the Chicago wheat export market is inaccessible to ships during part of each year. However, the differing results cannot be attributed exclusively to this factor. The St. Lawrence Seaway normally is closed to shipping from mid-December until March. If the inaccessibility of the Seaway were the only factor causing the different pattern of basis movements, then the storage intervals ending in March should be affected the most. However, this is not the case. The reasons for the difference in the results obtained for the two markets must be more complex.

A second reason for the differing results in these two markets may be due to the differences in the harvesting season in the regions adjacent to the two markets. The wheat harvest normally begins in the southern United States in mid-May and progresses northward, and ends in late August or early September in the northern United States. The different timing of the movement of wheat to the markets in the northern and southern regions of the United States may be a cause of unpredictable basis movements of Gulf-stored wheat relative to the Chicago futures contract. This reason would also be consistent with the higher coefficients of determination in the Chicago market for the storage intervals ending in March and May. The March contract on both markets would be least influenced by uncertainty concerning the selling intentions of producers. This factor should also apply to the Chicago May contract.

The May contract may be subjected to greater uncertainty concerning new crop prospects on the Kansas City than on the Chicago market.

The average basis at the beginning of each of the storage intervals reveals a slightly different pattern in the seasonal changes in the basis when the basis is determined with respect to the Chicago futures prices. Comparison of the average bases with respect to the May contract shows a slight increase from July to September (.925 cent) and a substantial average increase from September to December (8.15 cents). This is the same general pattern as is shown by the cash price relative to the Kansas City May futures contract price for the early part of the crop year. However, the Gulf cash price continues to advance with respect to the Chicago May futures contract price until March, whereas a decline is shown with respect to the Kansas City May contract. The average advance of the Gulf cash price from December to March over the Chicago May contract was 1.175 cents.

The other hedging policies which were utilized to examine characteristics of the basis change for Gulf-stored wheat with respect to Kansas City futures contract prices will not be utilized for the Chicago futures market. A null hypothesis of no linear relationship between initial cash-futures price spreads and changes in this spread can be rejected (on the basis of an F test) in only three of the ten storage intervals. Gross earnings from wheat stored at Gulf ports and hedged in the Chicago futures market appear to arise from causes more complex than normal seasonal advances of cash prices relative to futures contract prices. Cash-futures price spreads of cash wheat at Gulf ports and Chicago futures contract prices do not appear to provide reliable estimates of gross earnings from hedged storage. A more complex model,

probably involving a simultaneous equation system, will be required to adequately predict these basis changes.

Summary

Under certain conditions, the spread between the price of wheat at Gulf ports and a Kansas City futures contract price appears to be a relatively good predictor of gross earnings from hedged storage. This variable appears to be of greatest value for the September, December, and March contracts. It is of lesser value when the hedge is placed in the Kansas City May contract. The variable also appears to be more closely related to basis changes (i.e., provides a better predictor) when the hedge is placed in the contract which matures immediately after storage is terminated. In this respect, spreads between the price of wheat at Gulf ports and Kansas City futures contract prices provide an indicator of the price of storage in those areas in which the price of wheat is derived from the price at the Gulf.

Spreads between the price of wheat at Gulf ports and Chicago futures contract prices do not appear to provide indicators of prices of storage for regions which price Hard Red Winter wheat with respect to the Gulf export market. This means that substantially greater knowledge of market conditions is required to successfully hedge stocks of stored wheat in this market. It does not mean that it is not possible for elevator operators in the Southern Great Plains to use the Chicago market for carrying charge hedging.

Firms in Oklahoma which maintain very close contacts with market conditions should be able to utilize their knowledge to pursue a successful program of carrying charge hedging during any period of the crop

year. The specialized knowledge of these firms would enable them to evaluate price prospects much better than the mechanical rules followed in deriving the results reported in this chapter.

This chapter has been concerned only with the usefulness of the initial basis as a predictor of gross earnings from hedged storage. The analysis must be considered as incomplete unless the average earnings from this practice are reported also. This topic is covered in Chapter V.

CHAPTER V

ESTIMATED AVERAGE NET RETURNS FROM HEDGED STORAGE

Changes in cash-futures price spreads appear to be predictable from the initial spread between these prices when wheat at the Gulf is hedged in the Kansas City futures market. Although these changes appear to be predictable, a question of interest to prospective users of carrying charge hedging is the amount of the earnings which may be expected from this practice. For some firms, the decision of whether or not to store wheat on the elevator's account (wheat owned by the elevator) will depend on the prospective earnings. Firms which must store owned wheat may use the prospective earnings as a guide for determining the volume to be stored.

Average Earnings From Alternative Storage Practices

Average earnings which would have been realized from fully hedged positions in the Kansas City and Chicago futures markets in the specified storage intervals during the 1962 and 1964 to 1967 crop years are given in Table VII. The average earnings from unhedged storage (cash price change) are also reported. These are gross earnings since no costs of storage or broker's fees have been deducted. Since the storage intervals are of varying lengths, these returns are converted to average earnings per month and tabulated in Table VIII.

TABLE VII

AVERAGE GROSS EARNINGS AND STANDARD DEVIATIONS OF GROSS EARNINGS FROM UNHEDGED STORAGE OF WHEAT AND FROM FULLY HEDGED POSITIONS IN THE KANSAS CITY AND CHICAGO WHEAT FUTURES MARKETS UNDER ALTERNATIVE HEDGING PRACTICES DURING SPECIFIED STORAGE INTERVALS, 1962 AND 1964 THROUGH 1967 CROP YEARS

Storage Interval	Hedged				Unhedged
	Kansas City			Chicago	Gulf Cash Price Change
	Anticipatory	Simultaneous	Any Month	Anticipatory	
			--Cents/Bu.--		
July-September	1.47 (2.89)	1.92 (2.28)	0.88 (3.50)	2.57 (2.23)	2.20 (7.73)
July-December	6.60 (2.76)	7.10 (3.33)	8.40 (3.51)	11.60 (6.27)	6.80 (8.17)
July-March	7.70 (3.49)	9.38 (2.75)	9.02 (4.10)	13.27 (9.36)	3.80 (11.37)
July-May	2.97 (4.53)	3.75 (3.66)	2.97 (4.53)	11.95 (9.14)	-1.80 (16.11)
September-December	4.67 (3.55)	4.82 (3.66)	7.42 (5.26)	9.35 (6.53)	4.60 (4.93)
September-March	6.67 (3.76)	7.27 (3.28)	6.82 (3.98)	12.15 (9.92)	1.60 (10.01)
September-May	2.07 (4.54)	2.62 (4.80)	2.07 (4.54)	11.02 (10.96)	-4.00 (12.39)
December-March	-0.62 (2.94)	0.05 (2.14)	-0.60 (2.98)	2.35 (8.62)	-3.00 (8.57)
December-May	-5.00 (4.66)	-4.72 (6.25)	-5.25 (5.48)	2.88 (11.30)	-8.60 (13.28)
March-May	-3.80 (3.98)	-3.85 (4.37)	-3.72 (4.20)	1.70 (6.62)	-5.60 (7.37)

TABLE VIII

MONTHLY AVERAGE GROSS EARNINGS FROM UNHEDGED STORAGE OF WHEAT AND FROM FULLY HEDGED POSITIONS IN THE KANSAS CITY AND CHICAGO WHEAT FUTURES MARKETS DURING SPECIFIED STORAGE INTERVALS, 1962 AND 1964 THROUGH 1967 CROP YEARS

Storage Interval	Hedged				Unhedged
	Kansas City			Chicago	
	Anticipatory	Simultaneous	Any Month	Anticipatory	Gulf Cash Price Change
	--Cents/Bu.--				
July-September	0.735	0.960	0.440	1.285	1.100
July-December	1.320	1.420	1.680	2.800	1.360
July-March	0.962	1.172	1.128	1.659	0.475
July-May	0.297	0.375	0.297	1.195	-0.180
September-December	1.557	1.607	2.473	3.117	1.533
September-March	1.112	1.211	1.137	2.025	0.267
September-May	0.259	0.328	0.259	1.375	-0.500
December-March	-0.207	0.017	-0.200	0.783	-1.000
December-May	-1.000	-0.944	-1.050	0.576	-1.720
March-May	-1.900	-1.925	-1.860	0.850	-2.800

The pattern of the average returns from a fully hedged position in either of the futures markets during a crop year displays the same characteristics as that of the average initial basis. Relatively small average earnings were realized in the interval from July to September, larger earnings were realized from September to December, and losses were realized during the remainder of the year when the hedges were placed in the Kansas City market. The small average basis decrease which occurred with respect to the Kansas City May futures contract during the interval from December to March is reflected in the small average loss during this interval under two of the hedging policies. A very small gain would have been realized under the simultaneous hedging policy. Relatively large losses occurred during the interval from March to May.

The seasonal pattern of the spread between the Gulf cash price and the Kansas City futures price may be partially caused by the selling habits of producers. Conversations with elevator operators in Oklahoma indicated that the heaviest selling periods of producers are the period during and immediately after harvest and during December and January. If the producers in the other areas in the Southern Great Plains which supply the Gulf export market also act in this manner, then the cash price at the Gulf would be expected to decrease relative to futures prices during the periods of heavy producer selling and to increase during periods with light producer sales. Depending on the amount of carryover held by commercial interests at Gulf locations, the price at the beginning of the harvest would be expected to be high relative to distant futures months, and this condition would exist until the market channels are filled with new crop wheat. A decline of the cash price

relative to futures contract prices would be expected until the period of lighter producer sales later in the summer. At this time, the price would again advance relative to the distant futures to reflect the condition of tighter supplies. This type of a pattern is exhibited by the spread between the Gulf cash price and both futures markets. The different pattern with respect to these two futures markets during the last half of the crop year probably is the result of different economic forces affecting these two markets.

The average returns from the three hedging practices when the hedges are placed in the Kansas City futures market are approximately the same in most of the storage intervals. Two major differences are evident. The average monthly earnings during the September to December storage interval are approximately nine-tenths of a cent greater from the "any month" hedging practice than from the other two practices. Average earnings in the storage interval from July to December also would have been slightly higher. This is a reflection of the large average advance of the cash price with respect to both the March and May futures contracts during the interval from September to December. With the "any month" hedging practice, the hedges were placed in either the March or May contracts. The hedges were placed in the December futures contract with the other two practices. Except for these two storage intervals, there would have been no particular advantage from using this practice. However, during the early part of the crop year, average gross earnings would have been lower from the use of the "any month" hedging practice relative to the other two hedging practices in the Kansas City market. These results strengthen the inference that hedges should be placed in a futures contract which matures soon after

storage is terminated.

Average gross earnings from hedges placed in the Chicago futures market would have been substantially larger in all of the storage intervals during this five year period. On the average, a loss would not have been incurred in any of the storage intervals by hedging in this market. This condition may be indicative of a greater preference for No. 1 Hard Red Winter wheat at Gulf ports relative to contract quality wheat delivered in Chicago. However, these higher gross earnings are also subject to greater variability than are the gross earnings from hedges placed in the Kansas City futures market. This increased variability is to be expected since the type of wheat priced by the Chicago contract is more likely to be Soft Red. This result illustrates the validity of the statement in Chapter III which states that risks are likely to increase when the type of wheat hedged differs from the contract type, or when the location is remote from the futures market.

Although the average gross earnings from hedging in the Chicago futures market would have been larger than from hedging in the Kansas City futures market, larger losses could also have been incurred in any given year. Comparison of the minimum and maximum basis changes under the anticipatory hedging practice in the two markets (Table IX) illustrates this tendency. Hedging in the Kansas City futures market during these five years would have resulted in a more favorable minimum basis change relative to the Chicago futures market in six of the ten storage intervals. Hedging in the Chicago futures market would have resulted in a more favorable minimum outcome primarily in storage intervals ending late in the crop year. This is not too surprising since the cash price at the Gulf showed an average increase relative to the Chicago

TABLE IX

MINIMUM AND MAXIMUM GROSS EARNINGS FROM UNHEDGED STORAGE AND FROM FULLY HEDGED POSITIONS IN THE KANSAS CITY AND CHICAGO WHEAT FUTURES MARKETS UNDER ALTERNATIVE HEDGING PRACTICES DURING SPECIFIED STORAGE INTERVALS, 1962 AND 1964 THROUGH 1967 CROP YEARS

Storage Interval	Kansas City Hedges						Chicago Hedges		Gulf Cash Price Change	
	Anticipatory		Simultaneous		Any Month		Anticipatory			
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
July-September	-3.000	3.75	-1.500	4.500	-4.375	5.500	-0.750	6.375	-7.000	14.000
July-December	3.750	10.750	4.000	12.375	3.750	12.375	0.750	16.625	-1.000	16.000
July-March	3.875	12.250	6.500	13.500	4.750	15.750	4.250	27.500	-13.000	11.000
July-May	-3.000	7.875	-0.750	7.250	-3.000	7.875	-2.500	20.250	-17.000	21.000
September-December	-0.250	8.125	0.000	8.625	-1.750	11.375	-2.000	14.750	-2.000	11.000
September-March	1.750	11.000	2.000	10.500	1.750	11.750	-0.125	25.375	-14.000	12.000
September-May	-3.000	6.875	-3.500	6.500	-3.000	6.875	-6.125	20.375	-18.000	10.000
December-March	-4.500	3.500	-1.625	3.750	-4.500	3.500	-11.000	10.875	-12.000	7.000
December-May	-13.500	0.750	-13.750	1.750	-13.500	0.750	-16.875	9.25	-25.000	5.000
March-May	-8.375	1.000	-8.000	1.750	-8.375	0.375	-5.875	8.000	-13.000	4.000

May contract during the entire year, whereas it showed an average decline relative to the Kansas City May contract during the latter part of the crop year. Hedging in the Chicago futures market would not have provided a more favorable minimum outcome in all storage intervals ending late in the crop year, so this cannot be called an advantage of hedging in the Chicago futures market. The data of Table IX cannot be used to indicate that one futures market is better than the other. Losses could have been incurred during these five years in most of the storage intervals with hedges placed in either market. However, a substantially larger range of possible outcomes did exist for hedges placed in the Chicago futures market.

Hedging in either market would have resulted in a more favorable average outcome during these five years than the outcome from holding unhedged wheat. Hedging would have resulted in larger average profits (or smaller losses) in every storage interval except the one from July to September with hedges placed in the Kansas City futures market. In addition, the minimum basis change for all storage intervals would have been greater than the minimum change in the cash price.

The data of Tables VII and IX thus suggest that, on the average, hedged storage is preferable to unhedged storage. On the average, the storage of wheat may have been profitable in some of the storage intervals, but quite possibly was not profitable in all the five years regardless of which hedging practice or futures market was used. On the other hand, the maximum price and basis changes indicate that storage would have been profitable at least one year in most of the storage intervals. Attention will now be turned to the estimation of the net earnings from hedged storage on the condition that this activity does

not occur every year.

Estimated Average Net Returns From Alternative Hedged Storage Practices

Under the assumption that the market structure will be essentially the same in future years as it was during the period of analysis, the average returns reported in Table VII provide estimates of the average gross returns that could be expected if these practices were followed in the future. Net returns from storage can be computed by subtracting the variable costs of storage from these gross returns. Variable costs of storage are specified as the appropriate costs since it will be assumed that elevator operators will be making decisions regarding fuller utilization of existing facilities. These storage facilities would be vacant if the operator did not elect to store wheat on the elevator's account. The type of decision which is considered is an annual decision regarding the use of storage space which is not utilized to store grain for other owners or for other facets of the elevator operation (such as a feed mill).

Only hedged storage of wheat will be allowed as an alternative to leaving the storage space vacant. Some attempts were made by the author to develop predictive equations for Gulf cash price changes during the five year period. These attempts were unsuccessful. The alternative of storing unhedged wheat thus will be ignored. Also, the hedging alternative will be analyzed only for the Kansas City wheat futures market. The doubtful validity of a linear hypothesis regarding the relationship of initial bases and changes in the bases between the Gulf cash market and the Chicago futures market makes the analysis of this

section inappropriate for the Chicago futures market. Curvilinear predictive equations also appear to be inadequate to predict basis changes for wheat hedged in the Chicago futures market. Plotting the data for the Chicago futures market revealed an apparent random relationship of the variables. This statement should not be used to imply that basis changes with respect to the Chicago futures market are random. This statement implies that cash-futures price spreads at Gulf ports with respect to the Chicago futures market do not provide a foundation for analyzing the prospects of the returns from hedged storage.

A Monte Carlo procedure was used to estimate the net returns from hedged storage on the condition that storage will take place only when the predicted basis change exceeds the variable costs of storage. The predicted basis change was compared to each of five cost levels. Average net returns were computed at these five cost levels for those trials in which the storage criterion was met. The trials in which the criterion was not met were excluded from the computation of the average net returns. The proportion of times the criterion was met at each cost level was also computed.

The initial basis generated for this procedure is defined as:

$$(1)\quad x_{it} = \bar{x}_i + s_x d_{jt}; \quad i = 1,\ldots, 10 \text{ storage intervals}, \quad t = 1,\ldots, T \text{ trials}$$

where $\bar{x}_i$ = the average basis observed at the beginning of storage interval i;

s_x = the standard deviation of the initial basis for storage interval; and,

d_{jt} = a random variable whose distribution is assumed to be standard normal.[1]

The results obtained from the Monte Carlo procedure cannot be accurate if the data utilized for the analysis are not realistic. Successful application of Monte Carlo procedure requires that the distribution of the random variables from which a sample is drawn be closely related to the distribution of the variable in question. The theoretical distribution of the initial basis is unknown. However, conditions underlying supply and demand should not exhibit radical year-to-year variability. Hence, there should be a small probability of an extremely large change in this value in either direction from the mean. Demand and supply conditions do change from year to year, but these changes should cause only relatively small variations in either direction from the mean. Therefore, the distribution of the initial basis was assumed to be normal.

The second step in the procedure was to establish a check on the results to determine how closely they conformed to the observed gross storage earnings. This step was accomplished by defining an "actual" basis change

$$(2) \quad \hat{y}_{it} = a_i + b_i x_{it} + s_{y \cdot x} d_{ht}$$

where the range of the subscripts i and t is defined as in (1), a_i, b_i and $s_{y \cdot x}$ are estimates of the corresponding parameters of the regression equation for the ith storage interval, d_{ht} is a second standard normal random deviate, and x_{it} is the initial basis generated in (1).

Equation (2) was not used for prediction but was used to determine whether or not the average value of y_{it} after T trials was approximately equal to the average gross storage earnings given in Table VII. The procedure of (2) consists of adding a random amount to the value of the

basis change associated with the value of the initial basis generated in (1). This random amount is the product of the unexplained variability about the regression line ($s_{y \cdot x}$) and a random deviate d_{ht}. The procedure thus generated T basis changes which would be concentrated within a known and constant interval about the regression line. The average value of y_{it} computed from these T observations should be equal to the average observed gross storage earnings if the procedure is accurate.

The third step of the procedure was to obtain a predicted value of the change in basis. The predicted value is defined as

$$(3) \quad \tilde{y}_{it} = a_i + b_i x_{it} + s_{y \cdot x} \left[\frac{1}{n} + \frac{(x_{it} - \bar{x}_i)^2}{(n - 1)\, s_x^2} \right]^{\frac{1}{2}} d_{mt}$$

where a_i, b_i, x_{it}, $s_{y \cdot x}$, $\bar{x}_i$, s_x^2 and the subscripts i and t are defined as previously, n is the number of observations used to estimate the regression equation, and d_{mt} is a third standard normal random deviate. The term

$$s_{y \cdot x} \left[\frac{1}{n} + \frac{(x_{it} - \bar{x}_i)^2}{(n - 1)\, s_x^2} \right]^{\frac{1}{2}}$$

is the error associated with predicting the mean value of the dependent variable associated with a given value of the independent variable.[2] The value of $\tilde{y}_{it}$ obtained for each value of the initial basis (x_{it}) was compared with each of the five cost levels. The average of $\tilde{y}_{it}$ minus a cost level is the expected net returns at that cost level from hedged storage which is conducted only when this activity is predicted to be profitable.

The estimated net returns from the three hedging practices are given in Tables X, XI, and XII. Columns with a heading of (1) give the estimated average net returns from storage every year, and columns headed with a (2) give the estimated average net returns from storage only when earnings are predicted to exceed variable costs. Columns headed by a (%) give the percent of the total trials in which the predicted earnings exceeded variable costs. A total of 5,000 trials for each storage interval and hedging policy was used to obtain these results.[3]

The estimated net storage earnings in the columns numbered (2) in the tables are derived from equation (3), and are computed by deducting the total variable costs of storage for the storage interval from the predicted gross average earnings. The estimated net earnings in columns numbered (1) are derived from equation (2). These estimates are provided primarily for comparison. At the zero cost level, estimates from equation (2) should be equal to the average earnings realized from these hedging practices during the period included in the analysis.

The absolute value of the deviations between the estimated average returns from equation (2) at the zero cost level and the average earnings from these practices during the 1962 through 1967 crop years (excluding 1963) are given in Table XIII. The estimates are nearly equal to the observed average returns from hedged storage in most cases. Eighty-nine percent (25 of 28) of these estimates are within 0.10 cent of the observed values. The deviations may have been reduced by generating more observations, but the estimates appear to be sufficiently accurate for general inferences about the feasibility of hedged wheat storage by Oklahoma firms when this activity is not conducted every year.

TABLE X

PREDICTED NET RETURNS FOR SPECIFIED STORAGE INTERVALS AND STANDARD ERRORS OF PREDICTED NET RETURNS FOR NO. 1 ORDINARY HARD RED WINTER WHEAT STORED AT GULF PORTS AND HEDGED IN THE KANSAS CITY FUTURES MARKET WITH AN "ANTICIPATORY" HEDGING PRACTICE

Storage Interval	Variable Costs of Storage, Cents Per Bushel Per Month														
	0.00			0.75			1.00			1.25			1.50		
	1[a]	2[b]	%[c]	1	2	%	1	2	%	1	2	%	1	2	%
	--Cents per Bushel--														
July - September	1.50 (2.99)	2.78 (1.99)	71.3	0.00	2.16 (1.77)	49.5	-0.50	2.01 (1.71)	41.8	-1.00	1.88 (1.65)	34.5	-1.50	1.80 (1.60)	27.5
July - December	6.55 (2.79)	6.63 (2.58)	99.1	2.80	3.49 (2.14)	86.3	1.55	2.78 (1.91)	72.5	0.30	2.23 (1.69)	54.5	-0.95	1.82 (1.50)	35.6
July - March	7.64 (3.50)	7.76 (3.29)	98.9	1.64	3.38 (2.42)	69.0	-0.36	2.59 (2.10)	45.6	-2.36	2.10 (1.87)	23.6	-4.36	1.85 (1.68)	9.7
July - May	2.80 (4.93)	4.34 (3.07)	79.1	-4.70	2.43 (2.37)	11.5	-7.20	2.37 (2.30)	4.2	-9.70	2.52 (2.18)	1.4	-12.20	2.19 (1.82)	0.5
September - December	4.73 (3.54)	5.34 (2.99)	90.9	2.48	3.89 (2.59)	76.0	1.73	3.52 (2.44)	68.6	0.98	3.19 (2.30)	60.6	0.23	2.87 (2.16)	52.5
September - March	6.67 (3.77)	7.00 (3.36)	96.2	2.17	3.86 (2.66)	72.5	0.67	3.19 (2.38)	57.1	-0.83	2.66 (2.14)	40.8	-2.33	2.34 (1.90)	25.2
September - May	2.08 (4.81)	3.92 (3.02)	73.3	-3.92	2.66 (2.46)	14.9	-5.92	2.44 (2.30)	7.5	-7.92	2.26 (2.24)	3.5	-9.92	2.46 (2.21)	1.3
December - March	-0.63 (3.00)	2.08 (1.66)	41.9	-2.88	1.52 (1.34)	16.2	-3.63	1.42 (1.26)	10.4	-4.38	1.30 (1.19)	6.6	-5.13	1.20 (1.16)	3.9
December - May	-5.11 (5.83)	3.13 (3.03)	13.2	-8.86	2.97 (2.96)	4.1	-10.11	2.98 (2.92)	2.7	-11.36	3.04 (2.90)	1.7	-12.61	3.25 (2.84)	1.1
March - May	-3.76 (4.25)	3.49 (3.71)	16.5	-5.26	3.64 (3.80)	10.4	-5.76	3.60 (3.82)	9.2	-6.26	3.54 (3.85)	8.1	-6.76	3.70 (3.89)	6.7

[a] Predicted net returns at the ith cost level from storage of wheat during the jth storage interval every year.

[b] Predicted net returns at the ith cost level from storage of wheat during the jth storage interval when the predicted returns were greater than the variable costs of storage.

[c] Percentage of trials in which the predicted returns from storage were greater than the variable costs of storage.

TABLE XI

PREDICTED NET RETURNS FOR SPECIFIED STORAGE INTERVALS AND STANDARD ERRORS OF PREDICTED NET RETURNS FOR NO. 1 ORDINARY HARD RED WINTER WHEAT STORED AT GULF PORTS AND HEDGED IN THE KANSAS CITY FUTURES MARKET WITH A "SIMULTANEOUS" HEDGING PRACTICE

Storage Interval	Variable Costs of Storage, Cents Per Bushel Per Month														
	0.00			0.75			1.00			1.25			1.50		
	1[c]	2[b]	%[c]	1	2	%	1	2	%	1	2	%	1	2	%
	--Cents Per Bushel--														
July - September	1.92 (2.38)	2.61 (1.73)	82.5	0.42	1.85 (1.51)	58.2	-0.08	1.69 (1.45)	48.1	-0.58	1.57 (1.40)	37.9	-1.08	1.50 (1.34)	28.7
July - December	7.09 (3.41)	7.25 (3.02)	98.0	3.34	4.17 (2.56)	86.1	2.09	3.42 (2.34)	75.3	0.84	2.83 (2.12)	60.9	-0.41	2.37 (1.92)	44.9
July - March	9.37 (2.83)	9.38 (2.62)	99.9	3.37	3.86 (2.22)	90.7	1.37	2.63 (1.87)	71.0	-0.63	1.87 (1.56)	39.8	-2.63	1.46 (1.36)	15.0
July - May	3.71 (4.00)	4.35 (2.56)	90.0	-3.79	2.00 (2.05)	9.6	-6.29	1.89 (2.00)	3.0	-8.79	2.56 (1.92)	0.7	-11.29	2.21 (1.48)	0.2
September - December	4.83 (3.74)	5.55 (3.13)	90.5	2.58	4.07 (2.74)	76.7	1.83	3.71 (2.60)	69.3	1.08	3.37 (2.46)	61.8	0.33	3.08 (2.32)	53.6
September - March	7.28 (3.29)	7.39 (3.11)	98.7	2.78	3.86 (2.53)	80.7	1.28	3.10 (2.24)	65.0	-0.22	2.46 (2.01)	47.6	-1.72	2.11 (1.80)	28.7
September - May	2.62 (5.15)	4.34 (3.21)	75.9	-3.37	2.93 (2.73)	18.2	-5.37	2.73 (2.66)	9.5	-7.37	2.80 (2.63)	4.4	-9.37	2.78 (2.56)	2.1
December - March	0.03 (2.20)	1.56 (1.32)	50.3	-2.22	1.17 (1.09)	12.6	-2.97	1.09 (1.06)	7.0	-3.72	1.12 (1.03)	3.4	-4.47	1.11 (0.93)	1.8
December - May	-4.46 (6.37)	3.56 (3.32)	16.4	-8.21	3.37 (3.10)	5.8	-9.46	3.35 (2.98)	4.0	-10.71	3.24 (2.80)	2.9	-11.96	3.15 (2.62)	2.0
March - May	-3.93 (4.74)	2.32 (2.33)	12.1	5.43	2.41 (2.32)	6.2	-5.93	2.37 (2.30)	5.1	-6.43	2.43 (2.27)	4.0	-6.93	2.37 (2.23)	3.4

[a] Predicted net returns at the i<u>th</u> cost level from storage of wheat during the j<u>th</u> storage interval every year.

[b] Predicted net returns at the i<u>th</u> cost level from storage of wheat during the j<u>th</u> storage interval when the predicted returns were greater than the variable costs of storage.

[c] Percentage of trials in which the predicted returns from storage were greater than the variable costs of storage.

TABLE XII

PREDICTED NET RETURNS FOR SPECIFIED STORAGE INTERVALS AND STANDARD ERRORS OF PREDICTED NET RETURNS FOR NO. 1 ORDINARY HARD RED WINTER WHEAT STORED AT GULF PORTS AND HEDGED IN THE KANSAS CITY FUTURES MARKET WITH AN "ANY MONTH" HEDGING PRACTICE

Storage Interval	Variable Costs of Storage, Cents Per Bushel Per Month														
	0.00			0.75			1.00			1.25			1.50		
	1[a]	2[b]	%[c]	1	2	%	1	2	%	1	2	%	1	2	%
	--Cents Per Bushel--														
July - September	0.80 (3.96)	3.99 (3.32)	58.0	-0.70	3.48 (3.18)	44.5	-1.20	3.37 (3.15)	39.8	-1.70	3.28 (3.12)	35.2	-2.20	3.20 (3.10)	30.9
July - December	8.42 (3.74)	8.54 (3.09)	98.9	4.67	5.18 (2.75)	93.1	3.42	4.18 (2.61)	88.1	2.17	3.36 (2.43)	78.4	0.92	2.72 (2.29)	63.9
July - March	9.02 (4.10)	9.17 (3.85)	98.8	3.02	4.54 (3.02)	78.1	1.02	3.57 (2.66)	60.4	-0.97	2.89 (2.32)	39.8	-2.97	2.40 (2.04)	22.4
September - December	7.44 (5.45)	8.09 (4.36)	93.9	5.19	6.44 (4.02)	86.2	4.44	5.92 (3.92)	83.1	3.69	5.48 (3.79)	78.7	2.94	5.11 (3.66)	73.2
September - March	6.76 (3.95)	7.14 (3.53)	95.9	2.26	4.08 (2.79)	72.2	0.76	3.40 (2.50)	57.8	-0.74	2.84 (2.26)	42.6	-2.24	2.45 (2.02)	27.9
December - March	-0.55 (3.05)	2.06 (1.80)	40.0	-2.80	1.70 (1.62)	14.6	-3.55	1.61 (1.60)	9.8	-4.30	1.64 (1.60)	6.0	-5.05	1.68 (1.56)	3.8
December - May	-5.28 (5.88)	3.40 (3.25)	12.7	-9.03	3.13 (3.17)	4.4	-10.28	3.34 (3.10)	2.8	-11.53	3.40 (3.01)	1.9	-12.78	3.29 (2.82)	1.4
March - May	-3.83 (4.58)	3.46 (3.49)	17.8	-5.33	3.53 (3.49)	11.4	-5.83	3.59 (3.49)	9.7	-6.33	3.64 (3.46)	8.3	-6.83	3.62 (3.44)	7.3

[a] Predicted net returns at the ith cost level from storage of wheat during the jth storage interval every year.

[b] Predicted net returns at the ith cost level from storage of wheat during the jth storage interval when the predicted returns were greater than the variable costs of storage.

[c] Percentage of trials in which the predicted returns from storage were greater than the variable costs of storage.

TABLE XIII

ABSOLUTE VALUE OF THE DEVIATIONS BETWEEN THE ESTIMATED STORAGE RETURNS AND THE OBSERVED STORAGE RETURNS FROM HEDGES PLACED IN THE KANSAS CITY FUTURES MARKET DURING SPECIFIED STORAGE INTERVALS UNDER ALTERNATIVE HEDGING PRACTICES

Storage Interval	Hedging Policy		
	Anticipatory	Simultaneous	Any Month
		--Cents/Bu.--	
July-September	.03	.00	.08
July-December	.05	.01	.02
July-March	.06	.01	.00
July-May	.17	.04	
September-December	.06	.01	.02
September-March	.00	.01	.06
September-May	.01	.00	
December-March	.01	.02	.05
December-May	.11	.26	.03
March-May	.04	.01	.09

The Profitability of Hedged Wheat Storage

An assessment of the relative profitability of hedged wheat storage as a regular activity of country elevators in Oklahoma requires a realistic appraisal of the variable costs associated with this activity. As shown in Tables X, XI, and XII, the variable costs would greatly affect the net returns from this activity.

Normal storage charges of Oklahoma country elevators for storing producer-owned wheat range from one to one and one-half cents per bushel per month.[4] Fixed as well as variable costs are included in these charges. The size of the warehouse is partially dependent upon the needs of producers for off-farm storage, and producers should be charged for the costs of constructing, operating, and maintaining that portion of the warehouse which they utilize for this purpose. The remainder of a country warehouse is needed only to hold stocks of grain when transport equipment is temporarily unavailable, and to maintain working stocks for allied enterprises (such as a feed mill).

Terminal elevators have nearly the same needs as country warehouses, but generally are required to maintain relatively large stocks to meet the needs of the business. However, the type of storage considered in this analysis is the same for both types of elevators. This is the storage of wheat which is acquired in the normal business operations of the firm. The firms will not be regarded as seeking wheat specifically for the purpose of storage - e.g., the elevator operator would not seek to purchase wheat outside his normal supply area. The wheat which is to be stored on the account of the elevator is purchased from producer-owned stocks which were stored in the elevator. Thus, any costs which would be necessary to prepare the wheat for storage

would already have been incurred.

Given the above assumption, one variable cost which might be incurred from the physical use of the storage space would be the costs associated with turning the inventory if this should be necessary. However, this cost is quite low. Some cost data for a country elevator which engaged in an all-grain operation (no feed mill, fertilizer plant, gasoline station, etc.) indicate that the elevator had handled 816,000 bushels of grain during 1960, and had a utility cost of $1,220.[5] The utility cost per bushel, assuming two elevations of each bushel of wheat, would be .14 cents per bushel if the electricity cost were solely for the warehouse. However, some of this cost should be assessed against the office, and any additional elevations which were involved in handling this amount of wheat would have reduced the cost per bushel still further. This evidence suggests that the monthly variable cost for this purpose is insignificant. Increased handling, if it were necessary, may also lead to a greater frequency of breakdowns as the machinery is used more intensively. This cost also appears to be extremely low. The study cited above indicates that the mill repair costs per bushel are lower than electrical costs.

The monthly variable costs per bushel associated with the use of the warehouse for the type of storage operation considered in this analysis thus appear to be quite low, and would not be incurred if the inventory was not turned during the storage period. However, there are additional costs incident to the ownership of grain, and these costs are unrelated to the costs of utilizing storage space. These costs are the financial costs of inventory ownership.

The variable financial costs of storage consist of four elements: 1) the opportunity cost (or the interest cost) of capital invested in the inventory; 2) insurance costs; 3) commission fee; and, 4) interest costs on margin requirements.

Some of these costs are fixed in amount but variable with respect to the length of the storage interval. Other costs are constant per month regardless of the length of the storage interval. For example, the monthly interest cost of the capital invested in inventory will be constant regardless of the length of the storage interval. The monthly variable costs for commission fees will vary with the length of time the grain is held in storage and the volume held since these fees are a fixed amount per transaction. However, all four of these cost items are variable costs of storage since they would not be incurred if hedged wheat were not stored by the elevator.

Margin requirements are stated in cents per bushel and are subject to revision as the exchange deems necessary. Typically, initial margin requirements and maintenance requirements are equal for hedging transactions, but brokerage firms usually require higher initial deposits than the exchanges prescribe in order to avoid frequent margin calls. The amount of margin which brokers require may vary from customer to customer and depends largely on the customer's credit rating.

The insurance expense of a grain elevator is partially dependent upon the amount of inventory which is stored in the elevator. Since the type of storage considered in this analysis would result in an increase in the utilization of the warehouse, an increase in the insurance premium could be expected. The amount of this premium increase is difficult to specify since the insurance against physical loss is

partially dependent upon factors unique to a given elevator, such as cleanliness, type of construction, etc.

The above discussion indicates that "the" monthly variable cost of storage is impossible to determine. This cost is dependent upon the price of the wheat when it is purchased, the interest rate at which the inventory is financed, the length of time the inventory is held, the amount of the required margin, and any handling of the wheat which may be necessary. Any estimates of the monthly variable costs of hedged storage thus become dependent upon rather strict assumptions which underlie the estimates.

The monthly variable costs of storage were estimated for six situations as listed in Table XIV. Situation one in this table was formulated as a base. The price under situation one is $1.20 per bushel, the interest rate is seven percent, the required margin is ten cents per bushel ($500 per 5,000 bushel contract), insurance costs are assumed to be $5 per thousand dollars value of the inventory, and the commission fee is $22 per 5,000 bushel contract. The variables are increased successively for the next four situations. The changes are: situation 2) the price is increased to $1.21 per bushel; 3) the interest rate is increased to eight percent; 4) the insurance premium is increased to $5.10 per thousand dollars value of the inventory; and, 5) the required margin is increased to eleven cents per bushel ($550 per 5,000 bushel contract). For situation six, the previous changes are aggregated. These changes were made so that the effect of a change in individual variables could be estimated. Monthly storage costs for storage intervals ranging from one to twelve months in length were estimated. These estimates are given in Table XV.

TABLE XIV

SPECIFIED VALUES OF THE VARIABLES USED TO COMPUTE STORAGE COSTS UNDER ALTERNATIVE SITUATIONS

Variable	Situation					
	1	2	3	4	5	6
Price ($/bu.)	1.20	1.21	1.20	1.20	1.20	1.21
Interest rate (percent)	7.00	7.00	8.00	7.00	7.00	8.00
Margin ($/bu.)	.10	.10	.10	.10	.11	.11
Insurance ($/$1000/year)	5.00	5.00	5.00	5.10	5.00	5.10
Commission fee ($/transaction)	22.00	22.00	22.00	22.00	22.00	22.00

TABLE XV

ESTIMATED MONTHLY VARIABLE COSTS OF STORAGE FOR ALTERNATIVE LENGTHS OF STORAGE INTERVALS UNDER THE SITUATIONS SPECIFIED IN TABLE XIV

Situation	Length of Storage Interval (Months)											
	1	2	3	4	5	6	7	8	9	10	11	12
	--Cents per Bushel--											
1	1.248	1.028	.955	.918	.896	.882	.871	.863	.857	.852	.848	.845
2	1.255	1.035	.961	.925	.903	.888	.877	.870	.863	.859	.855	.851
3	1.357	1.137	1.063	1.027	1.005	.990	.979	.972	.965	.961	.957	.953
4	1.249	1.029	.956	.919	.897	.883	.872	.864	.858	.853	.849	.846
5	1.254	1.034	.961	.924	.902	.888	.877	.869	.863	.858	.854	.851
6	1.371	1.151	1.078	1.041	1.019	1.005	.994	.986	.980	.975	.971	.968

The estimates of Table XV are based upon the assumptions given in Table XIV and the additional assumptions that 5,000 bushels of wheat are held against the futures contract and that no physical handling is required. Interest is computed only on the value of the inventory and on the margin requirement. Although these assumptions are restrictive, the monthly costs of storage may be approximated for other conditions. For example, an increase of one cent in the price increased storage costs .007 cent per bushel. The effect of a ten cent increase could be approximated by adding (10)(.007) = .07 cent to the estimated cost under situation one. For a storage period of one month, the approximate costs of storing wheat priced at $1.30 per bushel would be 1.248 + .07 = 1.318 cents. The cost computed for these conditions would be 1.311 cents. The error is due primarily to rounding.

Although the price used to compute these storage costs is low (but consistent with early 1968 market conditions), storage costs are at least 1.25 cents per bushel for hedged wheat held one month. For two months, the cost is approximately one cent, and is generally slightly less than a cent per bushel for a storage period of three months or more. However, in order to establish a foundation for assessing the profitability of hedged storage, one cent per bushel per month will be regarded as the estimate of the variable costs of storage.

Comparing expected returns from storage every year at the one cent cost level in Tables X, XI, and XII reveals that a profit can be expected, on the average, only in a few of the storage intervals beginning early in the crop year. Among the three hedging practices considered, the positive net returns from storage every year range from .67 cent to 4.44 cents per bushel. Average net returns per month at

this cost level range from .112 cent to 1.48 cents per bushel. The returns are lower at the two higher cost levels, and reach a point at which the expected returns are only slightly greater than the costs.

The intervals in which hedged storage may be expected to show a profit are the intervals in which a country elevator in Oklahoma would feel the least need to store on its own account. Substantial quantities of producer owned wheat are usually in the elevators during these intervals. In addition, barley and grain sorghum are also stored by producers during these intervals in some areas. Late in the crop year, when country elevators would have a greater amount of space to store on their own account, the expected returns from storage every year are negative. Under the condition that storage is not conducted unless storage returns exceed variable costs, positive returns are possible. However, the percent of times which this condition occurred for the storage intervals late in the crop year indicates that these returns will be realized only infrequently. The expected frequency of positive returns during those storage intervals late in the crop year ranges from approximately one year in thirty to one year in ten years.

The results indicate that terminal elevators and other firms in Oklahoma that must maintain stocks of wheat to conduct their business transactions generally would have benefited from hedging. Average losses on hedged storage during the latter part of the crop year during the period analyzed were less than the average losses from unhedged storage (Table VII), and the average gains during the early part of the crop year were approximately equal to or greater than the average increase in the cash price. For stocks of wheat that must be held, hedging would have been preferable during most of the crop year regardless of which

futures market was used. However, during individual crop years, larger losses could have been realized by hedging in the Chicago futures market instead of the Kansas City futures market.

Two alternatives available to grain elevators in Oklahoma during the crop year are: 1) wheat could be sold as soon as possible after it is purchased; or, 2) wheat could be held after its purchase if the prospects of a profit appear favorable. Since basis changes at Gulf ports with respect to Kansas City futures contract prices appear to have been correlated with the initial basis in past years, analysis of price spreads could enable firms in Oklahoma to profitably increase the use of their fixed storage facilities. The first alternative could be utilized whenever the prospects of a profit appear unfavorable, and the second alternative could be utilized whenever the prospects of a profit from storage appear favorable. The Chicago futures market also could be utilized in this manner, but price spreads appear to be less valuable as decision variables for this market.

It was indicated in an earlier chapter that seasonal variations in the cost of transportation wheat to the Gulf would affect the effective price of wheat at locations in Oklahoma. If the transportation rate is constant, then basis changes at locations in Oklahoma will be equal to basis changes at the Gulf, and the estimated storage earnings given in this chapter are applicable to firms in Oklahoma.

A problem arises when transportation rates are variable. Depending on the sequence of the higher transportation rate, the basis change in the country will be increased or decreased relative to the basis change at the Gulf. The basis change at the country point will be increased if the higher transportation rate occurs when the wheat is placed in

storage. Expected returns are the advance in the cash price relative to the futures plus the decrease in the transportation rate. The reverse would be true if the wheat were placed in storage at the lower transportation rate. Expected returns then would be the advance in the basis minus the increase in the transportation rate.

It is debatable whether the returns caused by changes in the transportation rate should be classified as storage earnings, merchandising earnings, or windfall profits. The fact that firms may derive additional benefits from changes in transportation rates by a well-timed practice of hedged storage is only recognized.

Significance of the Results

The results reported in Chapters IV and V are strictly applicable only to the storage of wheat at a Gulf port location during the specified storage intervals. However, since the price of wheat in the Gulf cash market is a major factor in determining the price of wheat in Oklahoma, the results may be interpreted as the expected earnings from hedged storage of wheat in Oklahoma. Certain other inferences also may be made.

The coefficients of determination of the linear regression equations reported in Chapter IV indicate that basis changes at Gulf points have been highly correlated with the initial basis during certain periods of the crop year. This indicates that a well-managed hedging policy is feasible and could be used successfully as a means of reducing risks associated with inventory ownership.

The hedging policies utilized in determining the expected returns from hedged storage should not be interpreted as optimum policies since

they are mechanical rules which disregard any opportunities for more favorable outcomes. The hedges were initiated and terminated at preselected dates, and it is possible for larger returns (or smaller losses) to be realized. As an illustration, a consistent practice of selling Kansas City May futures contracts at the market closing price on the first Thursday in September, buying cash wheat on the first Thursday in December, and liquidating the position on the first Thursday in May would have resulted in lower average losses during the five years considered in the analysis. Average losses from this practice would have been about 2.5 cents per bushel, compared to the average loss of approximately 3.8 cents per bushel from the three hedging policies used in the analysis. This is another mechanical rule which employs sales of futures contracts three months prior to the purchase of the wheat. Undoubtedly, many additional examples which exhibited returns larger than those reported in this study could be constructed. However, the purpose of this analysis was not to select historically favorable outcomes. The primary purpose was to demonstrate the degree of relationship between initial cash-futures price spreads at a point in time during a crop year and changes in this spread during a specific period.

FOOTNOTES

[1]A standard normal variate has a zero mean and unit variance, with a range of minus infinity to plus infinity. The process of generating the initial basis consists of transforming a N(0, 1) variate to one having a $N(\mu, \ ^2)$ distribution.

[2]The best linear unbiased estimator of the mean value of the dependent variable corresponding to a given value of the independent variable is

$$\hat{Y}_0 = a + bX_0.$$

The variance of this estimator is

$$E\left\{\left[\hat{Y}_0 - E(\hat{Y}_0 \middle| X_0)\right]^2\right\} = \text{var } (a) + X_0^2 \text{ var } (b) + 2X_0 \text{ cov } (a, b).$$

Substitution of the various expressions for the variances yields

$$\text{var } (\hat{Y}_0) = s^2_{y.x}\left[\frac{1}{n} + \frac{(X_0 - \overline{X})^2}{\sum_{i=1}^{n} x_i^2}\right].$$

The term in equation (3) is the square root of this statistic. This expression for the variance of Y_0 yields a curvilinear interval about the regression line, i.e., the variance of the prediction increases as X_0 increases relative to $\overline{X}$.

[3]The Monte Carlo procedure consists of subjecting a known relationship to a number of random outcomes to simulate the effect of unknown forces. The distribution of a random variable is sampled to obtain these random outcomes. As the number of trials increases, the mean of the random variable in question should converge to some value. Theoretically, deviations of an estimate from a population characteristic can be made as small as desired by increasing the number of trials. A large number was necessary in this analysis since it would be possible that only a small proportion of the predicted basis changes would be greater than the cost. For example, if only ten percent of the predicted basis changes in a sample of 500 exceeded a cost level, then the estimated average returns at that cost level would be based on only 50

sample values.

[4]James Enix, "Grain Marketing at Country Elevators," OSU Extension Facts No. 405, p. 405.3.

[5]Charles W. Brown, "Cost Characteristics and Management Decisions of Oklahoma Cooperative Grain Elevators," (unpub. Ph.D. dissertation, Oklahoma State University, 1963), p. 59.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

Changes in the institutional structure of the wheat marketing system in the United States have resulted in a more nearly "free" marketing system. The marketing system is more nearly free in the sense that price support programs of the Government have been set at levels which have had less direct influence on the level of the domestic price since 1964. New programs have also been enacted so that the disappearance of wheat has been actively encouraged. These programs have been relatively successful, and the disappearance of wheat exceeded production for six consecutive crop years (1961 to 1966). CCC inventories of wheat decreased approximately one billion bushels from 1961 to 1967.

The decline in CCC inventories has resulted in substantially reduced opportunities for elevator operators to utilize owned storage capacity in excess of that required for handling operations. Some firms may desire to utilize excess storage space by storing wheat owned by the elevator. However, this practice exposes the firm to greater price risks than it would face in a handling operation or by storing wheat for other inventory owners. Such price risks may be greater under the new structure than under the high price support programs.

Hedging has been advocated as a means of reducing price risks associated with inventory ownership. However, some persons in Oklahoma

view hedging as relatively ineffective for grain elevators in Oklahoma. This belief is based upon the premise that the price of wheat in Oklahoma is determined by the price in the Gulf export market and that futures prices are strongly influenced by domestic market conditions. According to this belief, the conditions affecting the price in the two markets are sufficiently different so that an unpredictable relationship exists between the two prices. This contention was the principal question investigated in this study.

Hedging is not necessary for all grain elevators operating in the state of Oklahoma. Firms which do not maintain an inventory position may not derive any benefits from hedging. Firms which sell wheat immediately after its purchase for a known price would fall in this category.

Some firms, especially terminal elevators, must maintain a certain amount of uncommitted inventories to meet unforeseen increases in demand and to facilitate the operations of the firm. A convenience yield may be derived from such stocks. The decision of whether or not to hedge these stocks must be guided by price expectations. Hedging also may enable these inventory firms to carry larger stocks for transactions purposes than would otherwise be justified.

All grain elevators have the option of accumulating uncommitted inventories of wheat for sale later in the crop year. These stocks are carried only in anticipation of a profit from this activity. If these stocks are carried unhedged, then the cash price must increase more than storage costs in order for this activity to be profitable. If the stocks are hedged, then the cash price must increase relative to the price of the futures contract in which the hedge is placed by an amount

greater than storage costs and commission fees for this activity to be profitable.

In an equilibrium situation, the cash price should be discounted relative to the expected cash price at a point in time later in the crop year by an amount which reflects the cost of storing the commodity until this later date. An equilibrium would be achieved when the supply of the commodity is sufficient to satisfy the needs of consumers and the commodity moves into consumption at the rate desired by consumers. This ideal situation will rarely, if ever, be achieved. However, the marketing system still must ration a fixed supply among alternative users during a crop year. Futures markets can assist the marketing system in the performance of this function by providing price signals which may be used for inventory accumulation, production scheduling, etc.

The contribution of futures markets to the marketing of a commodity has been subject to controversy. Futures markets have been accused of contributing to excessive variability in the price of a commodity. Opponents of futures markets have attempted to outlaw their operations in the past, and have been successful in forbidding futures trading in certain commodities. A basic premise of the arguments in favor of the abolition of futures trading was that futures markets existed primarily for speculative purposes. Hedging was viewed only as a fortunate by-product of the operations of futures markets.

Keynes and Hicks were perhaps the first economists to formulate what might be called a theory of futures markets and prices. These men viewed futures markets as analogous to insurance. Hedgers (the insured) purchase price insurance from the speculators (the insurors). Hedgers must expect to pay a premium for this insurance, and the futures

price must therefore be less than the expected cash price at maturity by an amount sufficient to induce speculators to assume the risk. According to this theory, futures prices must be biased estimators of expected cash prices.

The theory of Keynes and Hicks appears to be invalid. Research guided by this theory has failed to detect consistent trends in futures prices. Further, this research has indicated that futures prices generally are not biased in favor of either hedgers or speculators. One conclusion which has been drawn from research into the nature of futures prices is that, on the basis of currently available information, these prices are the best estimates of what the price should be on the maturity date of the futures contracts. This definition does not imply that futures prices are perfectly accurate estimates of what the price will be on the maturity date of the futures contracts. New information, as it becomes available, may indicate that an adjustment in the estimate is necessary. A function of the futures market is the evaluation of information as it becomes available and the determination of the direction and magnitude of the change in the price which is warranted by this new information.

Other research has indicated that current cash prices tend to respond to changes in futures prices. For example, if new information indicates that a one cent adjustment in futures prices is necessary, the current cash price tends to adjust by the same amount. This means that, in the short run, current market differentials between a cash price and a futures contract price are maintained. Market differentials at the delivery point for the contract type and grade of wheat thus have come to be regarded as the price of storage, and measure the

earnings which could be earned by storing the wheat until the maturity date of the futures contracts. In this respect, cash-futures price spreads tend to measure the competitive price of storage facilities at any time during the crop year. These prices of storage are strictly applicable only at the delivery point and for the delivery grade, but also may provide good estimates of the storage returns for other locations and for other types and grades of the commodity. The price of storage is sometimes called the carrying charge.

Hedging is done by firms in the grain trade for many different purposes, and any futures market transaction which is incident to the normal functioning of the firm should be classified as hedging. Therefore, this study cannot be interpreted as evaluating the effectiveness of hedging. Only the specialized purpose of carrying charge hedging was evaluated. This evaluation was conducted by determining whether or not the change in the cash-futures price relationship can be predicted from the spread between these prices at the beginning of a specified storage interval. Changes in this spread, commonly called the basis, determine the gross returns from a fully hedged position. The study thus is an application of the price of storage concept to wheat stored at a location other than the location of the futures market.

The returns to Oklahoma grain elevators from the practice of carrying charge hedging were determined by using the price of No. 1 Hard Red Winter wheat, f.o.b. vessel at Gulf ports. Futures contract prices used in the analysis were from the Kansas City and Chicago Boards of Trade. The price of a futures contract on the Kansas City exchange is also a price of Hard Red Winter Wheat, but it refers to a different grade than the cash price which was used. The Kansas City futures contract price

generally is for "skin" No. 2 Hard Red Winter Wheat, i.e., the lowest possible quality of wheat that may be delivered with no penalty. The Chicago futures contract allows delivery of several types and grades of wheat at the contract price. The Chicago futures contract differs from the Kansas City futures contract in that it allows delivery of soft as well as hard wheats. The cash price and the futures prices used in the study refer to two separate but related markets. The cash price is the price at which exporters have sold wheat which is to be loaded on a vessel within the next 30 days. The price which exporters would be willing to pay in order to obtain the wheat to fulfill this commitment is the selling price minus handling charges and profit. The price exporters are willing to pay at that point in time pertains only to contracts for delivery which they negotiate with country suppliers. The 30-day f.o.b. vessel price may change by the next day, and this change should be reflected in the price paid to country suppliers. The f.o.b. vessel price thus should reflect the price which country suppliers could expect to receive on any given day.

Several hedging practices were evaluated to determine the expected returns from a consistent application of each of them. This evaluation was performed in a static framework. The hedging transaction takes place at the same points in time each year. Thus, any changes during the storage interval which would provide a more favorable outcome for the hedger are ignored. For example, a higher average return may have been possible if the hedger had kept informed of market conditions and terminated the transaction when he felt that further gains were impossible. This procedure was not attempted in the study since application of a procedure such as this may not reveal underlying

characteristics of the market, but instead may reveal the ability of the author to select historically favorable outcomes.

Conclusions

The price of wheat at Gulf ports does show a predictable relationship with the Kansas City futures price. A high degree of predictability is attained for those storage intervals which end in the near month futures contract. A lower degree of predictability is attained for other intervals, but in all cases there is a relatively high degree of correlation between the initial spread of the cash and futures prices and changes in this spread when hedges are placed in the Kansas City futures market.

A substantially lower degree of predictability is attained when hedges are placed in the Chicago wheat futures market. This result was expected and implies that the wheat contract of the Chicago futures market provides a less reliable price upon which to base price expectations concerning Hard Red Winter wheat. Spreads between cash prices at Gulf ports and Chicago futures contract prices appear to provide a less reliable foundation upon which to predict the earnings from hedged storage at Gulf ports than do price spreads with respect to Kansas City futures contract prices. However, for storage intervals ending in May, the degree of predictability with respect to both markets is approximately the same.

The pattern of seasonal changes in the basis with respect to the May contract is approximately the same for the two markets during the first half of the crop year. There is a relatively small average increase in the basis from July to September and a large average increase

from September to December when the change in the cash price is taken with respect to the May futures contract.

The pattern differs for the two markets during the period from December to March. The Chicago futures market shows a small increase in the cash price relative to the May contract, whereas the cash price decreases relative to the Kansas City May contract during this period.

Average returns from hedges placed in the Chicago futures market are generally greater than the average returns from hedges placed in the Kansas City futures market. However, the results indicate that these higher returns cannot be expected with any degree of certainty when the initial price spread is used as the variable to analyze prospects for hedges placed in the Chicago wheat futures market. This implies that substantially greater knowledge is required before the Chicago futures market may be intelligently and effectively used by grain elevator operators in Oklahoma.

The results must be interpreted only as a measure of general tendencies of seasonal changes in price relationships. As indicated in Chapter IV, the postulated relationship of the initial basis and changes in the basis is not a causal relationship. The spread between cash and futures prices can be indicative of the direction and magnitude of adjustments, but the change does not occur simply because the initial spread between the two prices has a certain value. These results thus cannot be extended to any particular year, i.e., the exact basis change that will occur in a given year cannot be predicted. Seasonal premiums are subject to year to year variability, and prospects in a given year must be evaluated in the light of conditions existing in that year.

The results indicate that hedged storage may not be particularly

favorable for elevators with options to choose whether or not to engage in this activity. If hedged storage is conducted regularly, the expected returns are relatively low. The returns possibly are not large enough to induce elevator operators to subject themselves to the increased risk of inventory control. Although the expected returns from hedged storage are small, those firms which must engage in a storage activity probably could benefit through the use of hedging. The expected returns from hedged storage are greater than or approximately equal to the average cash price increase which occurred during certain of the intervals considered in this analysis when hedges are placed in the Kansas City futures market. During the intervals that the cash price decreased on the average, the average basis decrease on wheat hedged in Kansas City futures market was smaller than the cash price decrease.

Larger average returns with respect to both the cash price change and the basis change in the Kansas City futures market could have been earned from hedges placed in the Chicago futures market during this period. However, these higher average returns appear to be subject to a greater amount of variability. In some cases, the greatest loss from a hedge placed in Chicago was nearly as large as the greatest loss which may have been incurred on unhedged wheat. In most instances, however, a systematic program of hedging could have avoided the greatest loss which might have been incurred on unhedged storage. The Kansas City futures market displayed a better minimum outcome in six of the ten storage intervals. The minimum return during these five years was larger than the corresponding outcome in either the Chicago futures market or in the cash price. These results further imply that greater

care may be necessary if the Chicago futures market is to be effectively utilized by firms in the Southern Great Plains.

The results also provide some indications concerning the desirability of alternative hedging practices. The sale of futures contracts at the market close in anticipation of overnight purchases of cash wheat appears to be slightly less favorable than a practice of selling futures contracts at the open after the purchase of cash wheat has been made. These two practices are denoted in this study as anticipatory and simultaneous hedging respectively. Average returns from the two practices were approximately the same during the historical period which was analyzed. However, the futures price tended to be higher at the open of the futures market, and futures contracts that had been sold the previous day would be purchased at a loss if the cash market transaction did not materialize. Since the average returns were approximately the same, the simultaneous hedging practice may be preferable since the possibility of a loss on the futures contract transaction would be avoided.

Placing hedges in futures contracts that mature later than the month storage is terminated also appears to be a less desirable practice during certain periods of the crop year. This practice was denoted as "any month" hedging in this study. During the early part of the crop year (July to September) this practice would have yielded smaller average returns than from simultaneous or anticipatory hedges placed in the Kansas City futures market. Average returns from this practice also would have been smaller than from hedging in the Chicago futures market or from unhedged storage. However, even during the early part of the crop year, the "any month" hedging practice still would have

reduced the largest loss which would have been incurred on unhedged storage.

Average returns from the "any month" hedging practice exceeded the average returns from the other two hedging practices during the July to December and the September to December storage intervals. The degree of correlation between the variables is approximately the same for all three hedging practices during the September to December storage interval. This would seem to imply that the "any month" practice would be preferable during this period of the crop year.

However, the higher average returns from the "any month" practice indicate that the average spread between the December futures contract and the March or the May futures contract decreased during the first half of the crop year. If the spread between these contracts had remained constant from July to December, average returns from the "any month" hedging practice would have been approximately equal to the average returns from the other two hedging practices. Similarly, an increase in the spread between the contracts would have reduced the average returns from "any month" hedging during this period. Thus, "any month" hedging cannot be designated as preferable to the other hedging practices for storage intervals ending in December.

These results may be summarized by the following rule: if storage is to be terminated prior to the near futures month, a hedge should be placed in a later futures month only when the spread between the near month contract and the later contract is expected to decrease or remain unchanged. During the five years analyzed, this action would have been appropriate primarily for storage intervals ending in December.

There appears to be no reason why grain elevators in Oklahoma cannot effectively utilize hedging in those operations of the business which require the storage of wheat. Most grain elevator operators have access to more information regarding market conditions than was used in this study. This knowledge, along with an understanding of the nature of hedging transactions and the normal seasonal pattern of the basis, can be effectively utilized by grain elevator operators in Oklahoma.

The belief that the Kansas City futures price is unrelated to prices at Gulf ports thus is questionable. This indicates that the problem may be: 1) a lack of understanding of the nature of hedging by members of the grain trade in Oklahoma; 2) that the hedging transactions conducted by these firms are not carefully defined in terms of the needs of the firm; or 3) that the low returns which have been exhibited during the past few years have discouraged some firms in Oklahoma. Hopefully, this study will provide some assistance to firms in the grain trade of Oklahoma.

Suggestions for Further Research

The time series utilized in this study is too short to allow a detailed analysis of the causes of basis changes. The study thus can be regarded as only a preliminary look at the usefulness of hedging for firms in Oklahoma. A major problem is the inability to determine the anticipated carrying charge associated with the initial cash-futures price spread in any given year. The exact prediction of the carrying charge in a given year on the basis of an initial cash-futures price spread may never be possible. However, statistical decision theory as used by Eidman, et al. (1967) may be applicable to the analysis of the

profitability of hedged storage of wheat for Oklahoma grain elevator operators. This procedure involves the use of the probabilities of various outcomes to evaluate the usefulness of price predictive equations. This method also allows a researcher to determine the usefulness of the prediction as a basis for formulating business decisions. However, this approach is not feasible for the analysis of basis changes in Oklahoma at the present time. Data limitations must be overcome before this approach would be practical.

This study has concentrated upon defining situations in which hedging would be applicable and of determining the expected returns from the purpose of hedging which has been named carrying charge hedging. No other purposes of hedging were considered, especially those involving short term hedging transactions. Research could be directed in this direction.

Analysis of seasonal differences between the Chicago and Kansas City futures markets is needed. Since harvesting occurs at different times in the regions relevant to these two markets and the timing of other operations also differs, "back-spreading" may be a profitable operation for Oklahoma elevator operators. Basically, this practice would involve selling the futures contracts in the Chicago futures market when the Kansas City market looks unfavorable and then liquidating this position into Kansas City whenever prospects looked better. This practice may or may not be feasible, and an analysis of spreads between these markets may provide an answer to this question.

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VITA

James Lawrence Driscoll

Candidate for the Degree of

Doctor of Philosophy

Thesis: AN ANALYSIS OF EXPECTED RETURNS TO OKLAHOMA GRAIN ELEVATORS FROM ALTERNATIVE HEDGED WHEAT STORAGE PRACTICES

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Billings, Montana, February 24, 1941, the son of James and Inez Driscoll.

Education: Graduated from Billings Central High School, Billings, Montana, in May, 1959; received the Bachelor of Science degree from Montana State College, Bozeman, Montana, in June, 1964, with a major in Agricultural Business with an option in Agricultural Economics; received the Master of Science degree from Oklahoma State University in August, 1966, as a National Defense Education Act Fellow, with a major in Agricultural Economics; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in May, 1969, as a National Defense Education Act Fellow.

Professional Experience: Employed as a Graduate Research Assistant in the Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma, September, 1964 to September, 1965, June, 1966 to September, 1966, and June, 1967 to present.

Professional Organizations: Member of the American Agricultural Economics Association, Phi Kappa Phi and Alpha Zeta.