AN EMPIRICAL INVESTIGATION OF THE GULF-KANSAS CITY HARD-RED WINTER WHEAT BASIS

By

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CHAPTER I

INTRODUCTION

The wheat industry is international in scope and involves many stages before the food products or by-products reach their final destination. Many intermediate marketing firms help transform wheat into products demanded by users and consumers. These firms perform the following functions: assembly, handling and storage, merchandising, transportation, grading and inspecting, cleaning, processing, and exporting. In order to perform these functions with a seasonally produced product, holding stocks of wheat and finished products is required. Firms holding stocks face the risk of changes in the value of inventories. Cash(spot) market transactions, which require immediate transfer of ownership from one individual to another do not allow risk transfer. Futures markets allow forward pricing and provide valuable risk bearing functions for managing inventory positions and planning, buying, selling, and other commercial activities.

Hedging has a dual role of avoiding risk and locking in profit opportunities. The effect of changes in the overall level of prices is avoided. Futures transactions coupled with astute spot market transactions allow traders to take advantage of profitable merchandising opportunities. For a firm with volatile prices, large turnover and narrow margins, the avoidance of the risk from changes in

price levels may mean the difference between the prospect of consistent profits as against the probability of a series of good years mixed with lean ones. In such businesses, most managers favor the greater stability of a hedged operation. This preference is reinforced when it is realized that new profit opportunities based on intelligent trading patterns are opened up to the hedger who thinks in terms of the difference between the cash price and futures price. This difference, known as the "basis", has been described by notable authors such as Working (1948), Gray (1962), and Ikerd as being the "key" to successful hedging. Therefore, it is imperative for those firms or individuals who wish to be efficient and effective in the market place, to have a full understanding of the basis and the economic factors which contribute to it. Information which expands or develops this knowledge should be useful to most, if not all, of those involved within the individual stages of the wheat industry.

The economic variables which explain the Gulf-Kansas City Hard-red Winter wheat basis are identified and explained. Due to the importance of basis relationships to successful hedging, definitions and fundamentals of these concepts are explained first.

The Importance of Hedging and Basis

A hedging transaction has been defined as that of taking an equal (in volume), but opposite, position in the futures market as a hedger holds or expects to hold in the cash market. It is expected that the markets behave in such a way that any loss realized in one market may be offset by an equivalent gain in the other. Hedges may be of two types: short (selling) hedges and long (buying) hedges. The producer

of wheat is always a short hedger. He holds the cash crop (perhaps, even a growing crop) and sells futures to protect against falling prices and a subsequent wheat value loss. Processors may be either short hedgers or long hedgers. If higher cash prices are expected by their analysts, buying an equal futures contract provides protection against rising prices of cash wheat. This is a long hedge. Expectations of lower prices would entice selling of futures by processors, to offset long cash positions which would be a short hedge.

The hedger is insured against price risk only if cash and futures prices move in predictable patterns. The literature (Meinken, 1955; Working 1934 and 1962; Gray 1962 and 1966), however, is replete with examples that indicate that cash and futures prices are not perfectly predictable. To the extent that bases are not predictable, hedged transactions are still risky. Researchers have been able to muster considerable support for the proposition that a change in cash prices frequently results in a <u>similar</u> change in futures prices, particularly if some unexpected event causes a dramatic price change.

Hedged transactions are less risky because of the tendency for cash and futures prices to react similarly and also to converge to predictable levels due to arbitrage among buyers and sellers in the market place as the contract matures. The hedger is, in effect, passing to the speculator (market participant who accepts price level risks) the risk of price level changes and retaining the "basis risk", that risk associated with the predictability of the basis. Cash and futures prices move in patterns such that their difference will change less abruptly than will absolute cash or futures prices.

This traditional risk transferal concept of hedging has evolved into a dynamic concept of risk management, which accents the maximization of an expected return given a particular level of risk. Hedging carried out to profit from movements in the basis, depends on understanding variation in the cash-futures spread. Each time this price spread differs from expectations when offsetting transactions are made, the hedge is not "perfect" and there is profit or loss to be made. Holbrook Working, in his 1953 article "Hedging Reconsidered", produced data on wheat prices that indicate that basis fluctuations are predictable. Many researchers, studying other commodities, have shown that the predictability of the basis is considerably better than that of the absolute cash/futures price levels. In addition, Working's conclusions provided possible motivations for hedging:

1. It reduces business risk, thereby increasing returns to producers and lowering consumer prices through reduced marketing margins.
2. It allows for the use of a reliable basis, when making decisions as to storing or moving wheat.
3. It facilitates buying and selling decisions simply by minimizing the need to consider absolute price levels.
4. And hedging tends to reduce the unexpected fluctuations in cash prices, because of the better predictability realized from using futures.

The significance of the hedge/basis relationship can thus be stated quite simply. The commodity futures market provides a measure of the value which a large number of traders place upon a commodity, to be delivered at a specified time in the future. The hedger can

segregate that portion of his total risk, that will result from price changes in this "benchmark" measure, and transfer it to others by entering a futures contract (long or short). He then retains the basis risk, which remains due to the imperfect match between his cash and futures positions, and ideally manages this net smaller risk in such a way as to realize a profitable outcome.

Sometimes hedging is appropriate, sometimes inappropriate; sometimes it is more costly than the prospective benefit could justify and often, it provides a degree of flexibility in marketing that would be unattainable otherwise. Hence, most all participants of the grain industry should understand the concepts and the potential rewards (or losses) of hedging, and indeed, this demands a sound understanding of the key to hedging - the basis. This knowledge should benefit these participants as they plan their marketing strategies.

Objectives

The primary objectives of this study are to: 1) identify the major explanatory variables of the Gulf-Kansas City Hard-red Winter (HRW) wheat basis, and 2) to estimate each variable's quantitative impact on this price spread. To develop a conceptual foundation, the underlying principles of basis theory as established through past research is examined. The competing market forces, which ultimately determine cash and futures prices, that are at work in the HRW wheat market are addressed. This will include a look at the supply and demand factors as well as government programs and policies which affect the market.

With this foundation, the second objective is addressed by developing an empirical model based on those variables expected to contribute to the basis over the crop years 1979 to 1985. The basis is calculated across futures contracts reflecting a constant period from maturity (CPM) (Malick and Ward, 1985). The basis is defined as the Gulf closing price minus the futures contract price that is nearest to but greater than a specific time from maturity. To identify each variable's empirical contribution to the HRW wheat basis, models for one, two, three, four, five, six, seven, and eight months from maturity are estimated. Economic and statistical interpretations of each explanatory variable are also presented.

It is to be noted, that the aim of this study is to conceptually and empirically explain the basis components, over the above stated crop years, and not intended to be a forecasting analysis. Although many of the components would be applicable to a forecasting model, the continual and unexpected changes in the wheat industry proves this to be a very difficult task. The intent here is to reap the benefits of understanding the history of the basis, while gaining new knowledge into this price relationship as reflected by today's markets.

CHAPTER II

CONCEPTUAL FACTORS INFLUENCING BASIS

The conceptual factors that are expected to explain the Gulf cash price minus the Kansas City Hard-red winter (HRW) futures price wheat basis are outlined in this chapter. Based on past research and theory, it is established that the basis is a function of selected variables that relate to storage and transportation costs, to a risk premium, and to a convenience yield of holding inventory stocks. It will be shown that these concepts depend on the levels of current inventories as well as the extent to which these stocks are available to be traded. To develop an understanding of the makeup of inventory levels, the basic supply and demand factors associated with the HRW wheat market and government programs and policies that have affected wheat supply and demand will be discussed in Chapter III.

Cash and Futures Prices

Cash Price

The cash market price for wheat depends upon the local supply and demand conditions at a given time and place. Factors which contribute to its determination include: the price offered the previous day, seasonality, changes in government wheat programs, availability of storage at the location, competitors' actions, and the activity of buyers in the marketing channel. Cash wheat prices are generally low

during harvest months, late May through mid-August for the HRW wheat, and then rise as the crop year progresses. The degree of impact of the economic factors mentioned above will determine the variation around the seasonal price level. The Gulf cash price depends on the supply and demand conditions there, the storage situation, and the handling costs of moving grain from inland terminals.

Futures Price

A futures price, as stated by Bailey (1983, p.2), "is truly a 'consensus' price." A "consensus" on the value of wheat at a specific time in the future, of farmers, feed manufacturers, livestock feeders, grain merchandisers and others involved in the wheat industry. Futures prices reflect what buyers and sellers expect the price to be in a given contract month on the basis of currently-available information. This understanding is from Working's (1958) "theory of anticipatory prices", and is based on the "efficient market" hypothesis. An efficient market is defined as one in which there are large numbers of equally informed, actively competing people attempting to maximize profits (Working 1958). In such a market, at any moment in time, price reflects all available information, as well as those supply and demand events expected to transpire in the foreseeable future.

Principles of Basis Theory

Cash/futures price spreads (the basis) are recognized as a function of stocks in the case of seasonally-produced commodities that need to be stored and are storable in significant quantities. This

price, the price of storage, is determined by the supply and demand for storage in the same way as any other price (Working, 1934). Moreover, like any other market price, it tends to equal the marginal cost of production. Production, in this case, refers to provision of the storage service. In other words, distant future prices will exceed the cash price by the cost of storage and transformation, assuming both prices are for similar qualities.

These conclusions were first developed by Working (1933, 1934) out of empirical studies of wheat and stocks, then elaborated in later articles by Kaldor (1939), Working (1948, 1949, 1953), Brennan (1958), and Weymar (1966).

Working (1949) showed, contrary to popular belief at the time, that the cash price and futures price are not independently determined and that expectations regarding upcoming or current economic events would tend to affect both prices by approximately the same degree. However, depending on the time interval between the prices and the timing of the event, one price may be affected slightly more or less than the other. Working indicated that this relationship would hold even if the two prices occurred in separate crop years or within the same crop year, due to the storability of wheat. In answering the question, "What are the influences which determine the price difference relationship?", Working (1949) concluded, as far as supplies are concerned, that it was only those supplies "already in existence" that have any significant bearing on this price relationship. He notes that this understanding lays the foundation for basis theory and that special or complex cases may be subject to minor qualifications.

Supply of Storage

When a market is characterized as having adequate supplies, which are carried forward to allow for a constant flow, a direct economic reward must be payed to those who supply the storage service. This reward, or price, is dependent upon the "cost" of carrying the stocks and will vary according to appropriate competitive supply and demand conditions for storage. Accumulation and dispersal of commercial inventories are guided by the relationship between cash and futures prices. When inventory adjustments are accompanied by the sale and purchase of futures contracts, as is typical in the commercial movement of wheat, price relationships reflect the inventory position very closely. With these understandings, Working (1949) constructed what is commonly known as the "supply of storage curve". Figure 1 represents the general form of the curve, where d equals the marginal cost per bushel stored.

The price of storage (vertical axis) is associated with costs of carrying stocks and is positively related to the length of time the wheat is stored. As a result it is expected that for a marketing year distant futures price will exceed nearer futures and the current cash price. For a wide range of inventory levels, the additional cost per bushel of storage is believed to be approximately constant. This, in particular, is the case for the costs associated with existing warehouse or other storage space. As storage space becomes limited, the cost (price) of this service will increase sharply. Due to the potential for storing competing crops, say corn rather than wheat, the amount of storage supplied (horizontal axis) depends, in part, on the

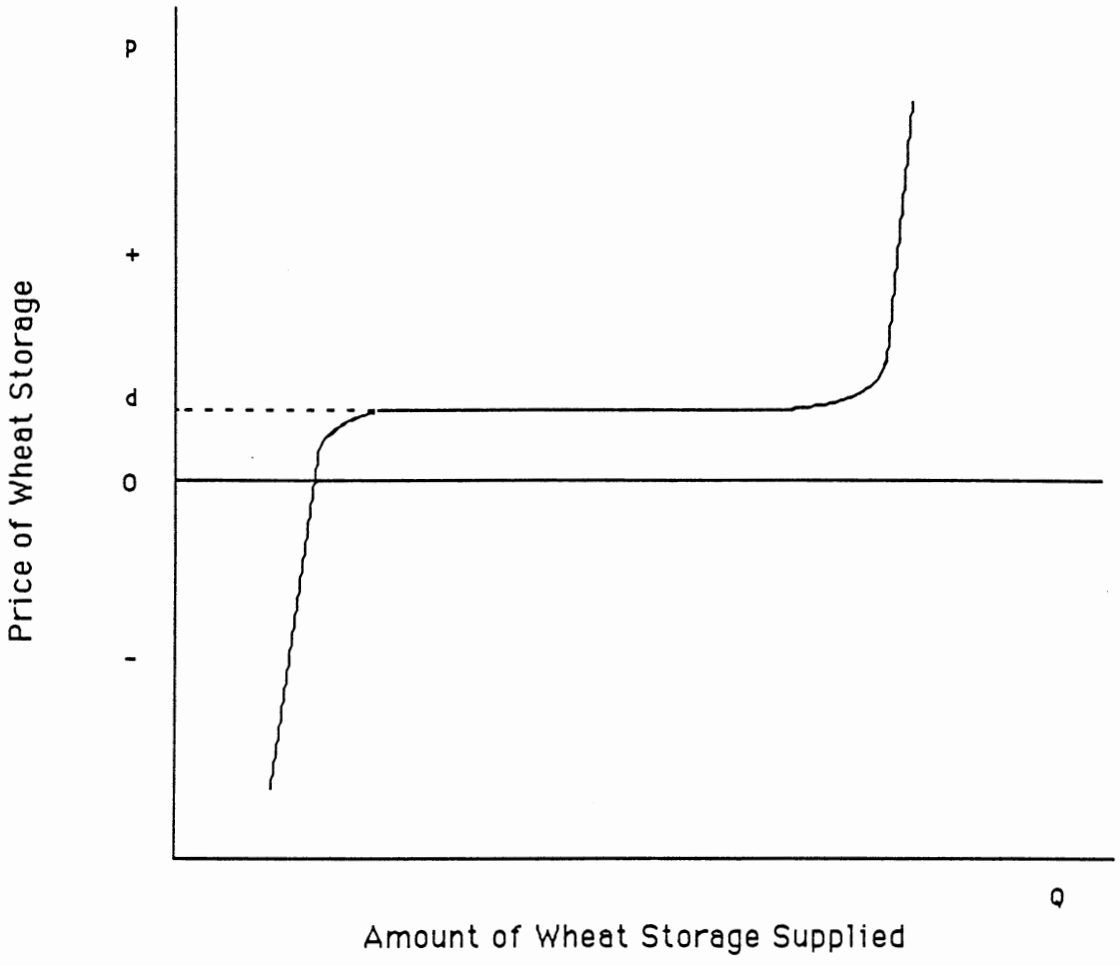

Figure 1. Working's Supply of Storage Curve

time of the year. Cash/futures price differences, which may be positive or negative, provide the incentive or disincentive to store between the two points in time. A positive return to storage (basis) will lead to an increase in storage use, where basis is defined as futures price minus cash price (Working, 1949).

The limit to the positive price of storage is the cost of storage between the two points in time. However according to Tomek and Gray (1970, p. 373), "there is no such practicable limit to the negative price of storage, yet the principle is the same in that it represents the price of using stocks now instead of holding them for later use." During times of stock shortages, the cash price may rise above the futures price creating a large negative basis. Thus, when the price of storage is negative, commonly referred to as an "inverted" basis, the amount which is stored tends to be less. Practical limits on the size of a negative basis have, however, been introduced into the market place, via government price support programs. Cash prices above support level prices encourage producers to sell government subsidized stocks, thus, increasing available wheat supply and ultimately decreasing cash prices.

Working (1948) points out two possible reasons why stocks would be stored when the price of storage is zero or negative. The first involves the fact that much of the costs associated with storage services are fixed, thereby hindering any movement out of such services. This is often referred to as an "asset fixity" problem (Edward, 1959). In addition, many firms who offer storage services do so as a necessary adjunct to their main operation. Merchandisers and processors are examples of such firms. Negative returns to storage

services may well be compensated for by profitable outcomes in a firm's merchandising or processing operation. A third reason would be to reap a "convenience yield" from the market for holding stocks.

Convenience Yield

Kaldor (1939), building on Working's concept by addressing the negative return to storage issue, coined the term "convenience yield" to express the benefits realized from holding a minimal amount of stocks, during times of supply shortage. Actual benefits can accrue to those who maintain a working level of stocks because they will encounter fewer delays and operate more efficient, lower cost production schedules. If the demand for grain is strong relative to the available supply, buyers may push the cash market price up relative to the futures price. Thus, the convenience yield, from maintaining a working inventory, should reduce (offset) a portion of the storage and transformation costs or simply stated, results in a "narrowing" of the basis. As supplies increase the convenience yield declines eventually to zero and the expected future price exceeds the cash price by the normal carrying cost (storage and transformation).

Risk Premium

Brennan (1958), in support of Working's and Kaldor's contribution to the price of storage theory, expands it to include a "risk premium" of holding stocks, as he details the makeup of the marginal costs of storage and their relationship to observed price spreads. Brennan (1958, p. 53) defines the net marginal cost of storage as, "... the marginal outlay on physical storage plus a marginal risk-aversion

factor [risk premium] minus the marginal convenience yield on stocks." Here, total costs of physical storage is the sum of rent for storage space, handling charges, interest, insurance, and spoilage loss. Convenience yield, as discussed earlier, is a decreasing function of stocks and offsets a portion of the physical storage cost.

The "risk premium", however, is shown by Brennan (1958) to be an increasing function of stocks and may add to the marginal costs of storage. The risk of a commodity value loss given a drop in price is small when inventories are low. As stock levels rise, the risk of value loss associated with holding stocks also rises and eventually could threaten a firm's credit position. Brennan contends, that indeed, the risk of value loss constitutes a part of the cost of storage and that the market must pay a risk premium to entice firms to increase inventories. As the amount of risk goes up, so must the expected return.

Weymar (1966) proposed extending the theory of the supply of storage to include "expected inventory behavior over the intervening interval" between cash and futures dates. In other words, if expectations of inventory sizes change prior to the end of the crop year or to the maturity of a futures contract, then the price of storage (basis) is a function of inventory level expectations. Weymar's empirical work was in the cocoa market, one characterized by a harvest which spreads substantially through time. He explicitly notes that the level of current inventory is a good proxy variable for expected inventory for seasonally produced commodities harvested over a short time period. This is the case for hard-red winter wheat. In addition, he too, acknowledges that firms who have available storage,

can be induced to carry additional stocks when a risk premium can be expected.

Prior theoretical and empirical work suggests that the basis components are the supply and demand for storage, convenience yields, and risk premiums. For seasonally produced, storable commodities like HRW wheat, all of these components are in some way related to inventories. In the following chapter, the basic supply and demand factors that determine HRW wheat inventories are reviewed.

CHAPTER III

HARD RED WINTER WHEAT SUPPLY AND DEMAND

Prior research strongly suggests that for storable, seasonally produced commodities like HRW wheat, inventory levels are very important determinants of the basis components. The purpose of this chapter is to discuss the fundamental supply and demand factors that ultimately influence the HRW wheat basis.

Supply

The annual U.S. wheat supply originates from three sources: production, carryin stocks, and imports. Production accounts for the largest percentage of total supply. Carryin stocks (beginning inventories) also makeup a significant portion of total supply, especially in recent years, as shown in Table 1. Imports have been negligible, accounting for much less than one percent of total U.S. wheat supply, and are not considered to be a major supply factor. The United States accounts for about 13 percent of world production, while hard-red winter (HRW) wheat has historically accounted for 50 percent of total U.S. production.

Production

The total production output of HRW wheat is a function of acreages planted and yields. Many market and nonmarket factors affect

TABLE I

U. S. WHEAT SUPPLY AND DISAPPEARANCE[1]

ITEM	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87[2]
	- - - - - - - - - - - - - - - - - - -Million Bushels- - - - - - - - - - - - - - - - - - -								
All wheat:									
Beg. Stocks	1177.8	924.1	902.0	989.1	1159.4	1515.1	1398.6	1425.2	1900.1
Production	1775.5	2134.1	2380.9	2785.4	2765.0	2419.8	2594.8	2424.8	2164.7
Imports	1.9	2.1	2.5	2.8	7.6	4.0	9.4	14.7	5.2
Total Supply	2955.2	3060.3	3285.4	3777.3	3932.0	3938.9	4002.8	3864.7	4070.0
Food	592.4	596.1	610.5	602.4	616.4	642.6	650.9	678.1	690.0
Seed	87.0	101.0	113.0	110.0	97.0	100.0	93.0	88.0	85.0
Feed	157.6	86.0	59.0	134.8	194.9	369.1	409.5	283.2	300.0
Total Domestic Use	837.0	783.1	782.5	847.2	908.3	1111.7	1153.4	1049.3	1075.0
Exports	1194.1	1375.2	1513.8	1770.7	1508.6	1428.6	1424.2	915.3	1150.0
Total Demand	2031.1	2158.3	2296.3	2617.9	2416.9	2540.3	2577.6	1964.6	2225.0
Ending Stocks[3]									
Gov't. Owned	51.1	187.8	199.7	190.3	192.0	188.1	377.6	601.7	875.0
Privately Owned[4]	873.0	714.2	789.4	696.1	1323.1	1210.5	1047.6	1298.3	970.0
Total Carryover	924.1	902.0	989.1	1159.4	1515.1	1398.6	1425.2	1900.1	1845.0

TABLE I (Continued)

ITEM	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87[2]
					-Million Bushels-				
Hard-red Winter:									
Beg. Stocks	632.0	423.0	440.0	541.0	538.0	754.0	745.0	717.0	1004.0
Production	830.0	1089.0	1181.0	1112.0	1243.0	1198.0	1251.0	1230.0	1029.0
Total Supply[5]	1462.0	1512.0	1621.0	1653.0	1781.0	1952.0	1996.0	1947.0	2033.0
Domestic Use	429.0	347.0	379.0	361.0	348.0	503.0	562.0	548.0	557.0
Exports	610.0	725.0	701.0	754.0	679.0	704.0	717.0	395.0	630.0
Total Demand	1039.0	1072.0	1080.0	1115.0	1027.0	1207.0	1279.0	943.0	1187.0
Ending Stocks[3]	423.0	440.0	541.0	538.0	754.0	745.0	717.0	1004.0	846.0
					Dollars per Bushel				
Price									
Received by farmers	2.97	3.78	3.91	3.65	3.55	3.53	3.38	3.16	2.30
Loan Rate	2.35	2.50	3.00	3.20	3.55	3.65	3.30	3.30	2.40
Target	3.40	3.40	3.08	3.81	4.05	4.30	4.38	4.38	4.38

1/ Imports and exports include flour and products in wheat equivalent. For HRW data are approximations, except for production.
2/ Projected.
3/ As of May 31st.
4/ Includes outstanding and reserve loans.
5/ Includes imports.

Source: U.S. Department of Agriculture, Wheat Outlook and Situation Report, Washington, D.C., Economic Research Service, various issues. 1978-1986.

these two components of production, and they include: weather and pests, technological improvements, previous season's wheat prices, and government price support and acreage control programs.

The profitability of competing crop alternatives, which depend on relative expected cash price differences, and input costs is an important factor for many agricultural crops. However, this is generally not the case for hard-red winter wheat. Competing crops are those that can be produced with the same resources. If the profitability of one crop becomes greater than competing ones, perhaps due to changes in product prices or yields, then producers may shift production to the more profitable commodity causing a reducing shift in the less profitable one.

Generally speaking, variations in the price of wheat and other crops that compete for the same land are not important in determining the acreages of wheat planted in the major HRW wheat-producing areas. Hard-red winter wheat, many times, is grown on land having insufficient moisture for most other cash crops. Returns from other systems of farming, such as grass-livestock, frequently are so low as not to constitute a practical economic alternative. Investments in specialized equipment and patterns of production based on wheat as the principal commodity, also serve as deterrents to acreage change. Off-farm employment may constitute as an alternative to producing HRW wheat, but many times coincides with it. The lack of competing alternatives limit the potential for increasing returns from them, and hence, this production factor is of little importance to the HRW wheat market.

Weather and Pests. Short-run changes in output, over one crop season, are influenced by the weather and pests. Weather conditions can affect seedbed preparation, the growing process, and the harvesting of wheat. Insect and disease damage mainly impacts on production of wheat during the growing season. The uncertainty which surrounds these factors contribute to their potential impact on production, as both acreages planted and yields may be affected. As an example, in 1981 favorable weather conditions partially contributed to an increase in acreages planted of 7 percent over 1980's crop (USDA, Wheat Situation, No. 255). The initial forecast estimated 1981's crop to be 1.2 billion bushels, slightly above the 1980's record level of 1.18 billion bushels. However, a late spring freeze in the western Wheat Belt held the 1981 HRW wheat crop to 1.11 billion bushels, 7 percent below that of 1980 (Table 1). This example emphasizes the potentially significant affect that weather conditions can have on estimated production and final output.

In addition to affecting the production level, weather and pests damage can have an influence on the quality (protein) of HRW wheat. If severe rains or drought hamper the growing process, then protein and milling qualities may suffer. And, if these conditions are severe enough the production level of normally high quality HRW wheat will be reduced. Because of the above reasons, changes in production resulting from unusual weather or pest damage is usually treated as a temporary and random shift in inventories (Oury, 1965).

Technological Improvements. Improvements in technology are important causes of long-term shifts in production. An improvement in technology is defined as something that enables firms to produce more

output with the same quantity of input as previously used (Cochrane 1955). Examples include: higher yielding varieties, better methods of insect, weed, and disease control as well as better tillage techniques and equipment. All of these serve to potentially increase production, but it is often difficult to identify and measure precisely how much of a given change in output is due to technical improvements and how much is due to changes in weather, product prices or input prices. High product prices many times lead to the adoption of new production techniques or higher yielding varieties, and this "response relation" is the reason for the measurement problem (Cochrane, 1955).

As a further contrast, Heid (1980) argues that the technological benefits of commercial fertilizer and new varieties have nearly reached their limits. Heid maintains that, "increased production would have to come from increasing wheat acreages rather than increasing yield, unless a new technological breakthrough occurs." The confusion that surrounds the impact of technology versus price changes, lead to the assumption that effects of technology on production will be picked up in the time series data which covers the data period.

Government Influences. Government programs obviously have had a marked influence on the production and marketing of commodities, such as wheat, since the depression years of the 1930's (Houck, et al., 1976). The programs have supported farm prices and attempted to reverse supply trends. The government can hold prices above equilibrium levels in the short-run simply by accumulating surpluses in storage, but unless additional outlets can be found, this becomes

very expensive. In the long-run, it is cheaper for the government to limit production, including paying farmers not to produce, rather than to purchase commodities and then attempting to dispose of them (Meiken, 1955). Two primary supply-adjustment programs used are acreage restriction and payment-in-kind programs.

Acreage restriction programs have been a major feature of agricultural support programs in the United States since first established by the Agricultural Adjustment Act of 1933. The government has relied mainly on acreage control or land-retirement programs in an attempt to curb production, and ultimately reduce supply. In effect, the acreage restriction provisions provide a mechanism for adjusting supply to demand. These programs have been voluntary, on the part of producers, and have used direct payments to encourage participation. During the 1978 to 1985 crop years, deficiency payments were paid based on the positive difference between the target price, an administratively set price, and the higher of the 5-month weighted national average price received by all farmers or the national loan rate (USDA, 1985). The purpose of the target price is to establish one end of a price range that indicates the magnitude of direct payments that would be paid to farmers if prices were below levels considered appropriate by the policy makers. The deficiency payment amounted to a direct payment during periods of low prices without interfering with the market price.

As further encouragement to participate, the government has almost always tied the acreage restriction (set-aside) program to a price support program. Growers who comply with the set-aside program's provisions are eligible for "nonrecourse" loans and any

other disaster payments. Although participation rates have been relatively high, attempts to regulate supply via acreage reductions have proven very frustrating, and many times fallen short of the program's intended production cutback. Good weather conditions, high yields, and farmers laying out their worst producing acres have for the most part compensated for planted acreage reductions. As previously emphasized, the acreage reduction program's objective is ultimately to stabilize and reduce surplus stocks by cutting production and thus, is an indirect influence on cash and futures markets wheat prices. The program's effect on prices is based on its impact through production on supplies.

In the fall of 1982, with surplus stocks mounting to new highs, the U.S. government announced a payment-in-kind (PIK) program for 1983 crops. The plan that evolved was designed to simultaneously make sharp cuts in production, reduce government stocks, and avoid increasing federal budget outlays. The idea behind the payment-in-kind program was to pay farmers not to produce, with payments in the form of government held wheat. The PIK program first required wheat farmers to divert 20 percent of their producing acres to be eligible for the price support program at all. Then, they had the option of diverting between 10 to 30 percent more for PIK payments. In addition, farmers could bid to remove their whole base acreage from production. To encourage participation, especially since the January announcement came after the planting season for the HRW wheat areas, payments for PIK wheat were set at 95 percent of the farmer's base program yield per acre. The payment was to be determined by multiplying the designated PIK acreage by the farm

program yield by 95 percent. As an additional inducement, the CCC was authorized to pay storage at an annual rate of 26.5 cents a bushel from when the PIK grain was received until disposition, but not for more than 5 months (USDA, 1985).

Although enrollment in the total acreage reduction program was surprisingly high, the expected drawdown in stocks did not result. The 1983 HRW wheat crop of 1.19 billion bushels was the second largest on record, and adding the large carryover from 1982 increased HRW wheat supplies to 1.9 billion bushels - a record level at that time (Table 1). Ideal growing conditions, coupled with the previously mentioned factors that have consistently plagued acreage restriction programs, offset a significant reduction of nearly 7 million acres (USDA, Wheat Situation, No. 266). This sizable stock volume was a significant negative pricing factor, as PIK entitlements, and delayed entry into the farmer-owned reserve, increased readily marketable supplies. Thus, it can be observed that acreage reduction programs, including PIK, may indirectly influence both cash and futures market prices, via their anticipated and realized impact on production and total supplies.

Carryin

Carryin stocks include those stocks that are not utilized during the previous marketing seasons. They represent the net result of past imbalances of the supply and demand for wheat. Because of their dependency on the total supply/demand picture, individual factors which contribute to carryin inventories include those which influence production, domestic usage, and exports. As these areas of supply and

demand are discussed, a clearer understanding of the makeup of carryin inventories will be developed.

Demand

Demand for wheat comes from two broad sources: domestic usage and exports. Export demand for wheat historically has accounted for about 60 percent of the total U.S. demand (Heid, 1980). Hard-red winter wheat is the major class of wheat exported, accounting annually for approximately 50 percent of total export demand (Makus, 1985). Domestic usage of wheat breaks down into food, feed, seed and industrial use. In analyzing domestic consumption, industrial usage is usually grouped with the food classification and not considered to be a major demand factor individually. The wheat industry faces a relatively stable domestic demand and a growing, but highly unstable, export market (Anderson, 1985). Due to fluctuating export demand, total U.S. wheat demand has ranged from 2.61 billion bushels to 1.96 billion bushels within this data period (Table 1).

Domestic Usage

Food Consumption. The largest source of domestic wheat demand is food consumption, which varies little from year to year because it is primarily dependent on per captia consumption and the number of consumers. Over one-half billion bushels are used for domestic food annually (Table 1). Our food needs account for approximately two-thirds of the annual domestic disappearance, with flour being the major product derived from wheat. Per capita consumption of wheat flour and cereal products has declined slowly but steadily over the

past two and one-half decades (Agricultural Statistics, 1985). However, increasing population has prevented a drop in total volume of wheat consumed for food (Epp and Malone, 1981). Thus, although food consumption is the largest source of domestic disappearance, it is not necessarily the most influential domestic demand factor, due to its relative stability.

Feed. Demand for feed wheat has varied in recent years, reaching a high of 409 million bushels or 15.7 percent of total U.S. production in 1985 (Table 1). Although feeding wheat to livestock occurs to some extent in all years, it can represent a substantial percentage of the demand when wheat prices are low relative to other feed grains. The quantity of wheat fed will vary inversely with the spread between its price and prices of other feed grains, such as corn. In addition, the nutritional value of wheat is important as it has a higher nutritional value than any of the major feed grains (Gomme, 1972).

According to Meiken (1955, p. 55), "On a pound-for-pound basis, wheat is worth approximately 105 percent of corn in most livestock feeding operations." As the ratio of the price of wheat to the price of corn approaches this value, use for feed increases rapidly. Conversely, when the price of wheat is substantially above its value in relation to corn, wheat fed to livestock declines to a minimum, representing mainly wheat unfit for human consumption (Meiken, 1955). Feed use was particularly heavy in 1983, 1984, and 1985, and constituted a noticeable increase in the quantity of wheat demanded (Table 1). Thus, the use of wheat as a feed grain provides for potential variations in total domestic demand.

Seed. Seed usage historically represents 3 to 7 percent of the total demand for U.S. wheat and only randomly varies enough to affect total U.S. domestic demand (Heid, 1980). The factors that control seed usage are primarily farmer's expectations based on current prices and new-crop futures prices, expected beginning inventories, and the expectations or announced intentions of the USDA in regard to its proposed price support program for the following year. For example, in the 1980/81 crop year farm prices were nearly $4 a bushel and new-crop futures (Wheat Situation 1980) pointed to even higher prices. This outlook coupled with no set-aside requirements because of expected record level exports, resulted in winter wheat growers seeding nearly 57 million acres - 8 percent more than the previous season. In sum, seed usage is a relatively stable domestic demand factor, however, it may in selective years cause a moderate variation in expected wheat demand.

Exports

Exports are a major position of total U.S. demand and thus, are very important in determining current inventories. Historically, over half of the cash receipts from U.S. wheat have come from exports. Exports increased until 1982/83 and decreased thereafter. One important factor which governs U.S. export demand is the stock levels of U.S. wheat importers and export competitors, relative to those in the U.S. Many of the factors which affect world stocks are the same as those that affect domestic stocks, such as weather, yields, acreages planted, and carryin stocks. In years when foreign crop prospects are low, other things constant, the United States'

commercial exports will be high. In reality, other factors are not constant and consequently, these factors can influence export demand. An "other" factor of particular importance, is the implication of government programs and policies, both here and abroad, as interpreted by world market participants.

According to Paarlberg (1985, p. 5), U.S. agricultural and macro economic policies are "inseparably linked to our trade policies and export volumes." The choice of a domestic policy set by the United States largely determines an implicit trade policy, which may conflict with the objectives of commodity programs. Other exporting countries can interpret the effect of U.S. policies on world prices and react in a way that is to their advantage. An indepth look at the implications of U.S. policies on export demand is beyond the necessary scope of this study. However, a brief overview of the important farm policies (loan rates, target prices, acreage restrictions) and macroeconomic policies as they relate to export demand should be instructive. The following examination will draw largely from Paarlberg's (1985) work on government policies and their relationship to agricultural exports. To illustrate and clarify these issues, a simply graphically model will be used which represents the workings of international trade. For simplicity, Paarlberg (1985) assumed that the world consists of two countries, the United States and the rest-of-the-world (ROW). Other assumptions are that all other prices, income, population, technology, and consumer tastes are constant, and that transportation and handling charges are nonexistent.

Export Subsidies. An export subsidy is any government intervention that lowers the net costs to the foreign buyer and may include direct cash subsidies, transportation subsidies, and subsidized credit. Interest in targeted subsidized credit (to specific countries) was renewed in the early eighties as farm prices fell and wheat stocks accumulated. Programs of these type have included the Public Law 480 program, the GSM-5 Direct Credit program, and the credit guarantee program (GSM-102). For example, in 1982 the P.L. 480 and GSM-102 program were used to ship a total of 7.2 million tons of wheat.

According to Paarlberg (1985, p. 13), "a targeted subsidy can have one of three effects on U.S. exports, depending on how the importer reacts." First the target importer may simply use the subsidized imports to offset the normal commercial purchases from the United States, resulting in no expansion of U.S. exports. Second, the importer may use the subsidy to offset imports from competing exporters. Whether or not this results in expanded U.S. exports depends on the actions of the displaced exporters. If they sell wheat to other U.S. customers, there may be no net gain in U.S. exports rather simply a rerouting of world trade. Thirdly, the subsidized importer could increase U.S. purchases causing an increase in U.S. exports. In reality, all three responses are likely to occur to some extent, thus the net effect may be difficult to evaluate.

Loan Rates. The U.S. government acts as the buyer of last resort under the nonrecourse loan program by purchasing commodities for stocks at the loan rate. Thus, U.S. prices are prevented from dropping much below the loan rate. The nonrecourse loan program has

supported U.S. and world wheat prices in most years since 1950 (Heid, 1980). Although market prices were above the loan rate for most of the seventies, the rise in the loan rate and the leveling off of farm prices caused the loan rate to act as a floor for U.S. commodity prices. Figure 2 represents this relationship. The nonrecourse loan distorts the U.S. demand curve by making it perfectly elastic (flat) at the loan rate. The distorted demand curve then becomes DaD'. As a result, the excess supply curve (ES) is also perfectly elastic at the loan rate. The market equilibrium price and the quantity of U.S. exports are determined where the excess supply curve of the U.S. intersects the excess demand curve of the ROW. When the loan rate is the market price, this intersection occurs in the perfectly elastic portion of the U.S. excess supply curve. The level of U.S. exports is given by X_W.

If there were no U.S. loan rate policy, the equilibrium world price and U.S. export quantity would be determined by the intersection of the undistorted U.S. excess supply curve (ES) with the excess demand curve (ED). The resulting equilibrium world price is given by P_F and the quantity of U.S. exports by X_F. The world market equilibrium price is lower and the quantity of U.S. exports is greater than the solution with the loan rate policy. Thus, from the perspective of foreign nations, the U.S. loan rate appears as an implicit export tax which raises the world price and lowers U.S. exports. U.S. wheat prices were at the loan rate during the 1982/83 crop year, whereby functioning as an export tax by raising world prices. Paarlberg (1985) estimated that had there been no loan rate, U.S. wheat exports would have been about 3 million tons greater.

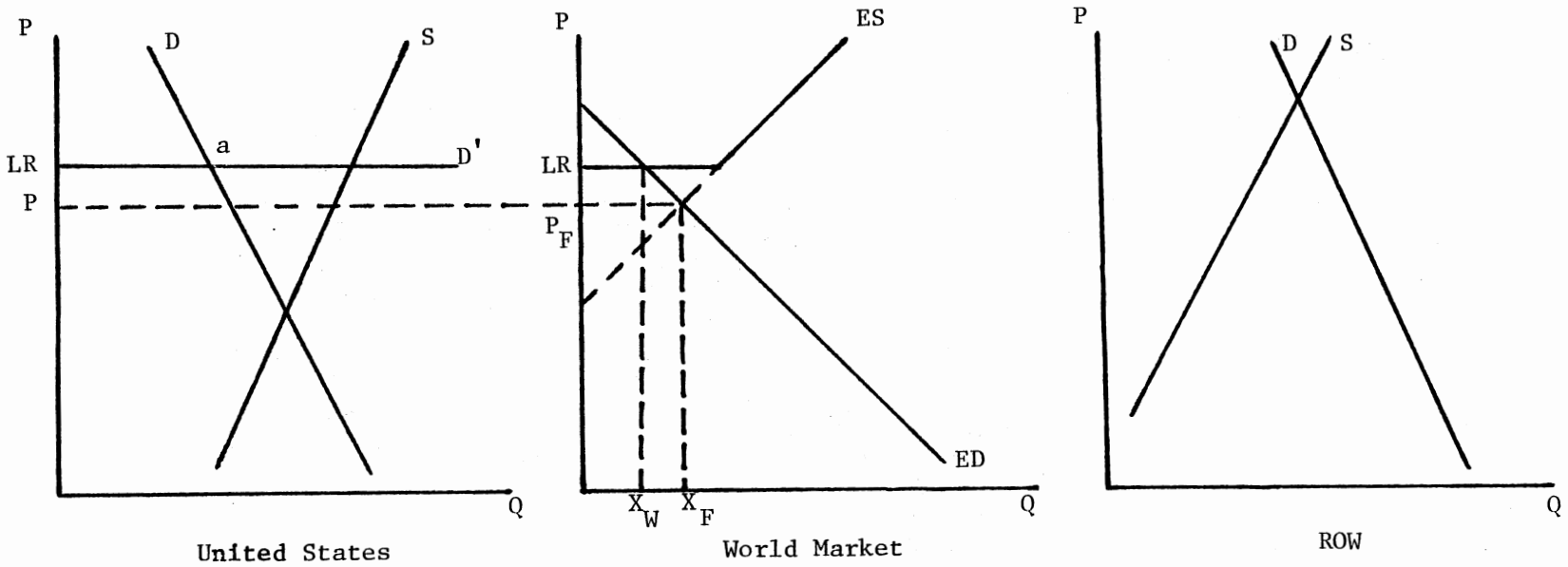

Figure 2. Trade Implications of the U.S. Loan Rate Policy

Direct export subsidies and concessional sales however, offset a portion of the potential export loss.

Target Prices. The target price and deficiency payment program distorts the U.S. domestic supply curve, making it perfectly inelastic (vertical) for prices between the target price and the loan rate. Figure 3 shows their price relationship as if it occurred in the late seventies. The market clearing price would be P_F and the quantity of U.S. exports X_F without the price support offered by the target price and deficiency payment. When the target price policy is in effect, the distorted U.S. excess supply equals excess demand at a world price (P_W) and a U.S. trade quantity of X_W. Figure 3 shows that under the program, P_W is less than the price that would have prevailed without the distortions, P_F. Because the world market price is lowered by U.S. policy, exports (X_W) are corresponding greater than the free-trade level(X_F). The U.S. target price and associated deficiency payments appear to the ROW as an export subsidy which lowers the world price and promotes U.S. exports. The fall in the world market price can be explained by recognizing that in absence of acreage restrictions programs, payments to farmers encourage additional production. Consumer prices must fall to absorb this additional production, thereby, expanding use. During 1978/79, the season's average farm price of wheat in the U.S. was between the target price and loan rate. Paarlberg (1985) estimated that without this program U.S. wheat exports would have been 3 million tons less for 1978/79.

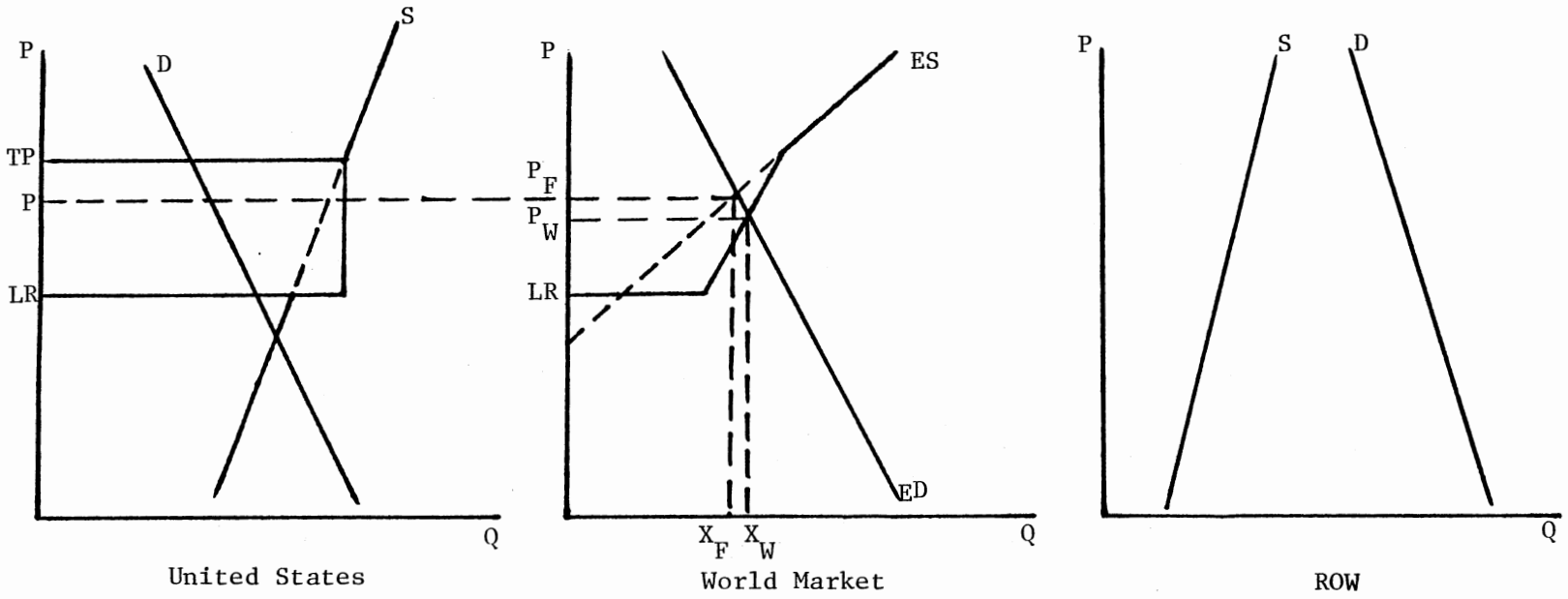

Figure 3. Trade Implications of the U.S. Loan Rate and Target Price Policy

Acreage Restriction. The analysis of the effects of the target price and the loan rate assumed that the U.S. government did not have acreage restriction programs. Compliance with U.S. set-aside or paid diversion programs, however, is necessary in most years for producers to receive price support benefits. According to Paarlberg, (1985, p. 24) "tying program benefits to participation can offset the export subsidy aspects of the target price policy, but does not change the export tax effects of the loan rate". The consequences of an acreage restriction program when the target price policy is in effect are shown in figure 4. Acreage restriction programs shift the U.S. domestic supply and the U.S. excess supply curves left, depending on the amount of land taken out of production and the yield of that land. The initial equilibrium price, which would have prevailed without the target price policy, is assumed to be P_F. The quantity of U.S. exports with the target price policy is X_W, and X_F without the policy. The portion of the excess supply curve above the loan rate shifts to the left in a parallel fashion.

As a result of the acreage restriction program, the resulting world equilibrium price exceeds the original target policy trade price, and is assumed to be back at free-trade levels (P_F). The program raises the world price and reduces U.S. exports from X_W to X_F, where X_F is assumed to be the free-trade level. From the perspective of the ROW the imposition of the acreage restriction program offsets the export subsidy resulting from the target price policy. If the actual supply shift is greater than that shown, than the implicit export subsidy would become an implicit export tax. If the shift is smaller, the implicit subsidy, although less, remains.

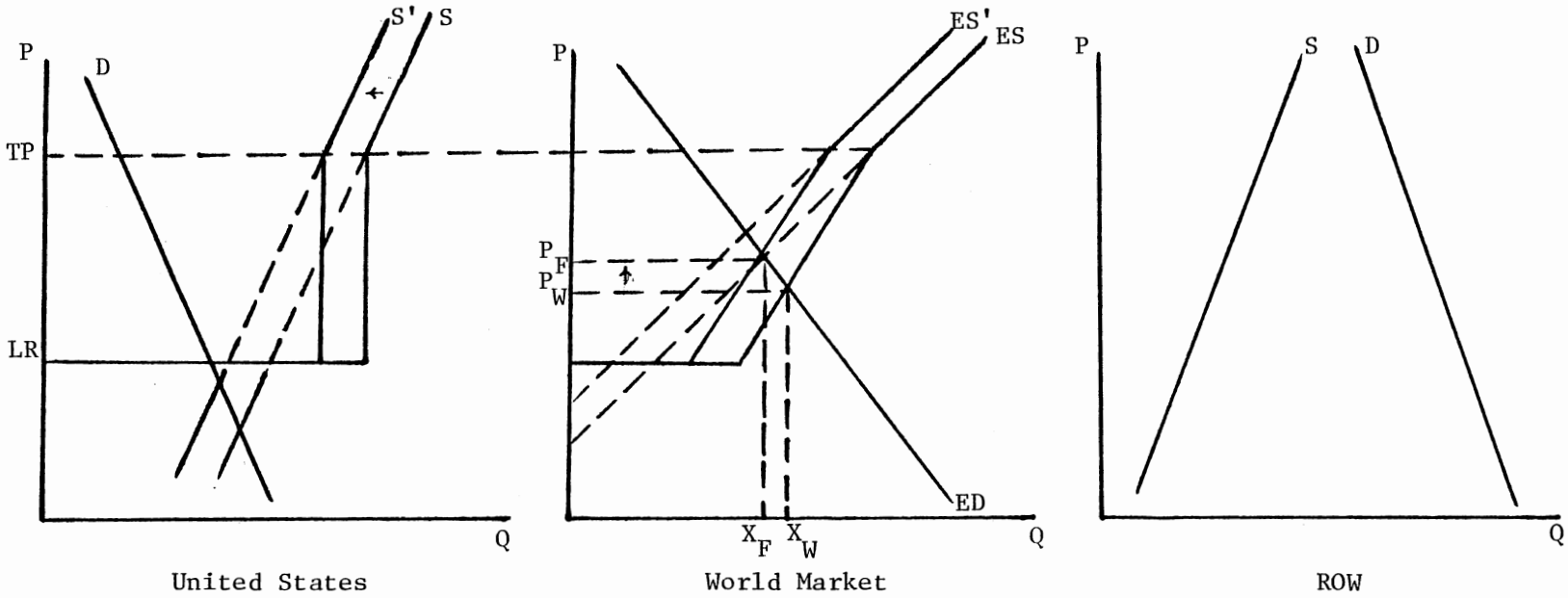

Figure 4. Trade Implications of the Acreage Restriction in Conjunction With a Target Price

When prices are at the loan rate, as in figure 2, the shift in the U.S. excess supply curve does not change the world market price, which remains at the loan rate. Because the world market price is unaffected, exports are unchanged, and the loan rate continues to act as an export tax.

Decisions about target prices, the loan rate, and acreage restriction programs project a U.S. trade policy to other nations. The wider the range between the target price and the loan rate, the more likely the U.S. is to impose an export subsidy, from the perspective of the ROW. The higher the loan rate, the more frequently the U.S. implicitly taxes exports.

Macroeconomic Policies. Although macroeconomic factors lie outside the agricultural sector, they can play an important role in determining the competitive position of U.S. wheat in the world market. The adoption of floating exchange rates in 1973, the oil price shocks of 1978-81, and the increased economic efficiency of markets, particularly financial, have considerably increased the intergradation of the world economy in which wheat competes (Paarlberg, 1985). Paarlberg (1985, p. 56) goes on to state that, "U.S. macroeconomic policies affect agricultural exports because of the size of the U.S. economy relative to the world economy, and because of the high degree of integration in international financial markets."

Because of this economic efficiency and interdependency of international capital markets, it is generally assumed that international capital flows freely between markets. As a result, changes in interest rates will cause rapid shifts in the flow of funds

among countries.

U.S. interest rates can be affected by both U.S. monetary and fiscal policies. Monetary policies which tighten the money supply increase U.S. interest rates. Expansionary U.S. fiscal policies raise U.S. interest rates due to an increased demand for money. High U.S. interest rates, coupled with the stability of our government and the potential for capital gains from holding U.S. dollars while their value is rising, increases the total demand for U.S. dollars (Henneberry, Henneberry and Glecker, 1986). The resulting capital inflow can lead to an appreciation of the U.S. dollar, as was seen in the early 1980's. The measure of the value of the U.S. dollar relative to other foreign currencies is through the exchange rate.

U.S. macroeconomic policies which lead to an increase in the interest rate relative to other countries results in an appreciation of the U.S. dollar, consequently a higher exchange rate. This says that it takes more foreign currency to purchase U.S. dollars, which may be used to purchase U.S. exports, such as wheat. According to Henneberry and Sanders (1986, p. 2), "Many economists have concluded from analysis of such events that a strong 'inverse' relationship does indeed exist between U.S. exchange rates and exports: when the dollar gets stronger, or more valuable in terms of the exchange rates with another country, exports to that country decline; alternatively, exports increase when the dollar weakens." In addition, an increase in capital inflow into the U.S. means that less capital is available in the foreign countries for which to purchase U.S. exports.

Besides exchange rates, other factors contribute to the level of export demand from those countries which import U.S. wheat. Although

the dollar fell in value on the international market in early 1986, the anticipated increase in exports did not result. Henneberry and Sanders(1986) reason that an explanation for this may partially rest with the way in which the depreciation of the dollar is measured. They conclude that even though the dollar has fallen with respect to the currency of other countries, such as the German mark, it has not fallen relative to those currencies of the major wheat importing countries. Hence, the value of the U.S. dollar relative to the major U.S. wheat importers is important when analyzing expected export demand and the resulting inventory levels.

Government Held Versus "Free" Supplies

The makeup of inventories and the significance of their relationship to the Gulf-Kansas City HRW wheat basis has been established. However, in looking at this relationship, it is also important to analyze the amount of stocks available to the market ("free" supplies) versus the amount held off the market via government programs, particularly the nonrecourse loan and the farmer-owned reserve. The degree of use of the loan and, conversely, the amount of wheat available in private trade channels is a price determining variable throughout the crop year. As Gray (1962) states, "The loan is said to be 'working' as more wheat moves into loan, tightening up free market supplies and forcing prices up to or beyond loan levels." If free stocks are tight for example, Gulf cash prices will increase relative to the futures prices in an attempt to draw existing stocks to the Gulf. Under these conditions, the basis would increase to reflect the incentive to bring wheat out of storage and place it on

the market.

The amount of wheat placed under loan and the amount taken over by the Commodity Credit Corporation (CCC) depends largely on the relationship between market cash prices and support prices (Ehrich 1966). Certain nonprice factors also affect the degree of loan use, and they include: lack of approved storage space, ineligibility in the loan program due mainly to noncompliance with acreage restrictions, lack of full information and understanding of the program, and political hostility on the part of producers. In addition, eligible producers may prefer to speculate on free market price being pushed high enough by the loan entries of other producers to provide a better outlet than the loan itself provides. These farmers may delay their choice until near the program's signup deadline, thus prolonging the uncertainty that surrounds the influence of loans on supplies.

Movement into loan constitutes at least a temporary reduction in free supplies, although redemption of the wheat put up as collateral is permitted, and there are, of course, other means by which wheat placed under loan can re-enter the free market. One such means is when the national average farm price surpasses the farm-owned reserve (FOR) release price, thus allowing for the release of FOR wheat. Gray (1967) goes on to say, "the mechanism by which the loan support price is through such supply removal as actual loan entries entail, plus what ever influence the threat of such supply removal exerts upon prospective buyers - in other words, price and inventory availability is influenced by loan entries, actual and anticipated." Due to this well-recognized influence, a measurement of the degree of loan use

should be included in a meaningful price analysis. The spread between cash prices and government support prices in an indirect measure of the degree of loan use (Ehrich 1966). If cash prices are high relative to support prices, producers place less wheat under loan, so a larger amount will move into private trade channels. Greater loan use will occur when cash prices are low relative to support prices.

Summary of Inventories Relationship to the Basis

The weekly price of storage (the basis) is determined by the supply of and the demand for the storage service. Because the supply-of-storage is relatively stable, the basis is dependent upon the demand for storage, which is a function of the level of inventories and the cost of carrying these stocks over time. Inventory levels are a reflection of the past, current, and anticipated wheat supply/demand picture. In addition, government programs via their implicit and explicit impacts on production, carryin stocks, and export demand can play a dominating role in inventory level determination. Past empirical research supports the hypothesis that basis is a function of inventory levels. In a 1980 study, Martin, Groenewegen and Pidgeon empirically investigate the factors which affect the corn basis in Southwestern Ontario, Canada. These researchers conclude that this basis is cheifly a function of variables which represent the local inventory situation.

With an understanding of both basis theory and the makeup of HRW wheat inventories, a conceptual model to explain the Gulf-Kansas City HRW wheat basis can be hypothesized. It is hypothesized that the

basis is a function of actual exports, export expectations, government loan program usage, free stocks, inland storage problems, and transportation problems. An empirical model, using variables which represent these conceptual expectations is developed in Chapter IV.

CHAPTER IV

EMPIRICAL MODEL AND DATA

As stated in Chapter I, basis for this study is defined as the Gulf cash bid less the futures contract price that is nearest to being a specific time from maturity. This definition is an adoption of Malick and Ward's (1987) constant period from maturity (CPM) model. A CPM basis model was developed for this analysis mainly to alleviate statistical problems associated with discontinous data sets. Data gaps between contract years can lead to missing observations when looking at the basis of each HRW wheat contract individually over time.

The basis was calculated as cash minus futures so that the results would be readily applicable to most participants in the wheat industry. Many of these participants are "basis traders", i.e. they conduct trades on the number of cents over or under a selected futures contract price. The basis could have been defined as futures minus cash, as Working (1948) and others did, with the direction of influence of the variables reversed.

Thursday Price

Thursday's cash and futures prices were used in calculation of the weekly basis for the model. The use of one day of the week as a representative of the entire week should restrict the analysis to a

mid-week price. On Friday, there may be liquidation of contracts by traders who do not wish to hold their position over the weekend. This is in contrast to Monday where speculation reaction to weekend news may be greatest. Having removed both Monday's and Friday's price from consideration there was little difference among the other three days of the week. Thursday's price was selected because of the availability of data on related variables. For instance, export data, which is diseminated by the Foreign Agriculture Service through U. S. Export Sales, is released as of Thursday for the week. Weekly price adjustments, which occur as a result of changing information, should consistently be as unbiased on Thursday, as on Tuesday or Wednesday. Indicator variables (qualitative) which are employed in the model will be entered such that their impact is reflected on the Thursday following their release.

The Data Period

The analysis will cover January, 1979 through the 1985-86 crop marketing year. This time span should sufficiently represent the pricing factors that have dominated recent HRW wheat seasons. The starting crop year was determined largely by the need for a breakdown of total wheat stocks. The USDA began separating free stocks from government-held stocks in late 1978 (USDA 1978). The data period was ended in 1985-86 to avoid the impacts of recently enacted agricultural government programs upon the basis determination. Although these programs may impact on inventories, and thus the basis, their full effect is certainly not observable in the marketplace as of yet. The data period covers several years in which there were large government

surpluses, due to noticeable increases and decreases in production and exports, respectively. Encompassing almost eight full crop years, the weekly data set provides 387 useable weekly observations.

Constant Period From Maturity Basis

The HRW wheat basis, using the 1-month constant period from maturity for illustrative purposes, is defined as

$$B1_t = GP_t - FPMay_t; \text{ if weeks to maturity for the March HRW wheat contract are less than 5 weeks (1 month),} \quad (1)$$

$$B1_t = GP_t - FPJuly_t; \text{ if weeks to maturity for the May contract are less than 5 weeks,}$$

$$B1_t = GP_t - FPSept._t; \text{ if weeks to maturity for the July contract are less than 5 weeks,}$$

$$B1_t = GP_t - FPDec._t; \text{ if weeks to maturity for the September contract are less than 5 weeks,}$$

$$B1_t = GP_t - FPMar._t; \text{ if weeks to maturity for the December contract are less than 5 weeks.,}$$

where:

$B1_t$ = Basis in period t for the 1-month from maturity model (dollars per bushel),

GP_t = HRW wheat Gulf cash bid, delivered to the Gulf (dollars per bushel), and

$FP(\text{contract month})_t$ = Kansas City's HRW futures contract settlement price for each respective contract month (dollars per bushel).

At this stage, the basis reflects the cost of storage and

transportation of HRW wheat plus any interest on the initial investment. Storage cost can be defined as

$$TSC1_t = (WKMAT1/52)*SC1 + [(WKMAT1/52)*PIR/100* Gulfclose] \quad (2)$$

where:

$TSC1_t$ = total storage and interest cost in period t for the 1-month from maturity model (dollars per bushel),

$WKMAT1_t$ = seek to maturity for 1-month CPM basis model (not less than 5 weeks),

$SC1_t$ = annual weighted average storage rate to warehouses for storage of CCC wheat (USDA, Agricultural Stabilization and Conservation Service).

PIR_t = prime interest rate (Federal Reserve Bulletin, various issues), and

Gulfclose = HRW wheat cash bid, delivered to the Gulf (dollars per bushel).

By eliminating the known component of total storage cost ($TSC1_t$) from the basis (B1), the remaining unknown components yield a basis residual [(Brennan (1958), Ward and Daase (1977), Malick and Ward (1985)]. Since basis is defined as the cash price minus the futures price, total storage costs must be added. Thus, the basis residual (BR1), is defined as

$$BR1_t = B1_t + TSC1_t \quad (3)$$

where:

$BR1_t$ = basis residual in period t for 1-month from maturity model (dollars per bushel),

$B1_t$ = basis in period t for 1-month from maturity model (dollars per bushel), and

$TSC1_t$ = total storage cost (actual physical cost plus interest on investment) in period t for 1-month from maturity model (dollars per bushel).

This remaining basis residual represents the convenience yield and risk premium of holding inventory stocks, transportation costs as well as variables specifically related the HRW wheat industry.

Previous basis models have substracted out transportation costs between delivery points. The difficulty in obtaining an accurate single estimate of transportation rates over the data period, due largely to the passage of the Staggers Rail Act of 1980, preclude netting out transportation costs. The Staggers Act deregulated the rail industry and allowed for private contracting of transportation rates, which are unpublished. Because of the importance of transportation cost to the basis, a indicator variable is used in the model to account for unseasonal pressure upon the basis due to short-term problems in the transportation of wheat to the Gulf. Examples would include railroad workers strikes, railway problems, or barge transportation problems.

The remaining basis residual is the focus of our empirical analysis. The empirical model hypothesized to represent the conceptual model from Chapter III is shown below.

HRW Wheat Basis Residual Model

The CPM basis residual model is specified where (m) represents the months to maturity period, which will range from one month (the

nearby) to eight months. The (m) will initially be dropped for clarity reasons until final specification of the model is presented. Definition of the variables included will be explained subsequently.

A partial adjustment model will be used in this analysis to account for the time required for new information to be assimulated by the market. "Traders may not react to every market signal simply because longer term hedging positions are adjusted in a consistent manner with forward pricing needs and not to interim market price changes", (Malick and Ward, 1985, pg. 5). Hence, it is hypothesized that the observed value of BR_t adjusts to its equilibrium value according to

$$BR_t - BR_{t-1} = \phi (BR^*_t - BR_{t-1}) \qquad (4)$$

where:

BR_t = the observed basis residual in period t,

BR^*_t = the fully adjusted basis residual equilibrium value as explained by the static conditions of the hypothesized variables in equation (5) below, and

ϕ = the adjustment coefficient.

The "adjustment coefficient" measures the proportion by which the difference between BR^*_t and BR_{t-1} is reduced during period t. When $\phi = 1$, the observed basis residual is equal to the fully adjusted basis residual ($BR_t = BR^*_t$), the adjustment is total and immediate, and we are back in the static case. The model implies that $0 < \phi < 1$. The smaller ϕ is, the smaller is the immediate adjustment and the adjustment period is longer.

The fully adjusted basis residual (BR^*_t) model is defined by

$$BR^*_t = B_0 + B_1ML_t + B_2CMYSALES_t + B_3DIFF_t + B_4ACAVGEX_t + B_5USESTEX_t + B_6GE_t + B_7TS_t + B_8IS_t + B_9DUM3_t + B_{10}DUM7_t + B_{11}DUM9_t + B_{12}DUM12_t \quad (5)$$

where:

BR^*_t = The fully adjusted basis residual given the static conditions of period t (dollars per bushel).

ML_t = The ratio of trading volume to open interest for the HRW wheat contracts.

$CMYSALES_t$ = The ratio of current-marketing year's outstanding export sales OES_t to estimated free stocks (FS_t). Outstanding sales equal beginning sales plus new sales minus purchases from foreign sellers minus buy back and cancellations minus exports. Free stocks were estimated by substracting estimated domestic usage, estimated government stocks, and accumulated weekly exports for the current marketing year, from estimated total availability (million bushel units).

$DIFF_t$ = The Gulf cash bid minus the national loan rate for wheat. This variable represents an indirect measure of the degree of loan use (dollar per bushel).

$ACAVGEX_t$ = The CMY's weekly average exports given the number of weeks into the crop year (million bushel units).

$USESTEX_t$ = The USDA's estimated average weekly exports for the CMY (million bushel units). Estimates are first projected in July of the CMY and updated monthly.

GE_t = The 1980-81 government grain embargo to the Soviet Union. Entered into the model as 1 when the embargo was in effect, otherwise 0.

TS_t = Transportation indicator variable. When there is problems in transporting wheat to the Gulf this variable is entered as 1, otherwise 0.

IS_t = Inland storage indicator variable. When inland storage is reported to be tight, this variable is 1, otherwise 0.

$DUM3,7,9,12_t$ = Indicator variables which are entered into the model as intercept shifters to account for contract month influences on the basis. DUM3, DUM7, DUM9, and DUM12 are defined as 1 when the March, July, September, and December contract months, respectively, are used to calculate the basis in period t. They are zero otherwise.

Substituting equation (5) into equation (4) yields,

$$BR_t - BR_{t-1} = \phi(B_0 + B_1 ML_t + B_2\ CMYSALES_t \ldots - BR_{t-1}) \qquad (6)$$

Rearranging equation (6) yields the estimatable, partial adjustment model for the "m"-month from maturity basis residual, such that

$$BR(m)_t = B_0+(1-\phi)BR_{t-1}+\phi B_1 ML_t+\phi B_2 CMYSALES_t+ \quad (7)$$
$$\phi B_3 DIFF + \phi B_4 ACAVGEX + \phi B_5 USESTEX + \phi B_6 GE_t +$$
$$\phi B_7 TS_t + \phi B_8 IS_t + \phi B_9 DUM3 + \phi B_{10} DUM7 +$$
$$\phi B_{11} DUM9 + \phi B_{12} DUM12$$

where:

$BR(m)_t$ = The (m)-month from maturity basis residual in period t (dollars per bushel),

m = 1, 2, 3, 4, 5, 6, 7, 8.

The independent variables in equation (7) are as explained in equations 4, 5, and 6. The remainder of Chapter IV will discuss the expected sign of the effect of each variable on the basis residual.

Hypothesized Relationships

The explanatory variables used to construct the CPM basis residual model were based on past research and theory. In addition, an extensive overview of the HRW wheat industry was conducted in an attempt to identify those unique variables which have led to basis variation over the data period. The presence of correlation among the independent variables was also a selection criteria. Independent variables which are highly related to each other can lead to biased coefficient estimates. Although the correlation testing procedures (Pearson) showed ACAVGEX and USESTEX to be highly correlated, there was no other evidence of potential multicollearnity problems. Both variables were left in the model to measure the uniqueness of actual exports versus USDA estimated exports. Table II presents each

TABLE II

DATA SOURCE, MEAN, AND VARIANCE FOR EACH VARIABLE OF THE CPM BASIS RESIDUAL MODEL

Independent Variable	Source	Mean	Variance
BR_{t-1}	N/A	.0929	.0821
ML	Wall Street Journals, Thursday's issues	.1878	.0037
CMYSALES	Outstanding Export Sales: USDA, FAS, U.S. Export Sales Free stocks: USDA, FAS, World Agricultural Supply and Demand Estimates	.2253	.0081
DIFF	Gulf Cash Bid: Wall Street Journal, Thursday's issues Loan Rates: USDA, ASCS Commodity Fact Sheet, May 1986	.9746	.4580
ACAVGEX	USDA, FAS, U.S. Export Sales	27.5267	27.0326
USESTEX	USDA, FAS, World Agricultural Supply and Demand Estimates	27.6784	20.6353
GE	USDA, Grain Market News Weekly Summary	.1757*(68)	N/A
TS	USDA, Grain Market News Weekly Summary	.1705*(66)	N/A
IS	USDA, Grain Market News Weekly Summary	.0930*(36)	N/A
DUM3	N/A	.2403*(93)	N/A
DUM7	N/A	.1757*(68)	N/A
DUM9	N/A	.1731*(67)	N/A
DUM12	N/A	.2326*(90)	N/A

USDA = United States Department of Agriculture; FAS = Foreign Agriculture Service.
N/A = Not Applicable; * = Proportion of times this variable was one.

variable's source, as well as the mean and variance of the quantitative variables.

Market Liquidity (ML)

The total size of the volume and open interest indicates the degree of current liquidity in a specific futures market (Tewels, Harlow, and Stone, 1977). Considerable research has been done to identify whether speculation does or does not cause excessive price movement. No final conclusions have yet been drawn on this subject, but the weight of evidence indicates that speculation probably does more to smooth price fluctuation than to increase it (Larson, 1961). Thus, any lack of speculation in the futures market may have potential price-distorting effects.

Trade volume should be high enough such that any participant wishing to liquidate a contract can do so without bearing added entry and exit costs. If the volume of trade can adequately cover total commitments then market liquidity is not a problem. If, on the other hand, lack of speculation adds to futures price fluctuation then liquidity problems may arise. The conflicting research into the liquidity issue, coupled with the uncertainty of how futures prices will respond, leads to an indeterminable hypothesized sign, a priori.

Ratio of Current Marketing Year's Export Sales to Estimated Freestocks(CMYSALES)

This variable represents the ratio of CMY's weekly outstanding export sales to estimated free stocks. Each variable's relationship to the basis must be analyzed to determine the ratio's overall

hypothesized sign. The numerator represents the export demand for wheat during the current-marketing year (CMY). Increasing sales signify greater CMY demand, thus the Gulf cash bid should react by rising relative to the futures price and increasing the basis residual.

Free stocks, as defined here, represent the expected market-available supply of wheat for CMY. As free stocks increase, the additional stocks are expected to push Gulf cash prices down relative to the futures price.

To summarize, it is hypothesized that the basis residual is positively related to exports and negatively related to free stocks. By putting the variables in the ratio, the partial derivatives are

$$\frac{\partial BR_t^*}{\partial FS_t} = -B_2 \left(\frac{OS_t}{FS_t^2} \right) \tag{8}$$

and

$$\frac{\partial BR_t^*}{\partial OS_t} = B_2 / FS_t \tag{9}$$

Therefore, B_2 is expected to be positive so that equation (8) is negative and equation (9) is positive. It is also clear from (8) and (9) that the effect of FS_t on BR_t depends on OS_t and the effect of OS_t on BR_t depends on FS_t.

Difference Between the Gulf Cash Price and the Loan Rate(DIFF)

DIFF represents the difference between the Gulf cash bid and the national loan rate for wheat. This indirect measure of the degree of loan use is hypothesized to be negatively related to the basis. If

cash prices are low relative to this support price, producers are anticipated to place more wheat under loan, so less is available in private trade channels. Smaller loan use will occur when cash prices are high relative to support prices. Thus, when anticipated loan use is down more wheat is expected to be available to the market, causing the Gulf cash price to fall relative to the futures. The result is a decrease in the basis.

Actual Average Weekly Exports(ACAVGEX)

Actual exports relative to the number of weeks into the current marketing year is reflective of the actual demand for wheat at the Gulf ports. As actual exports increase, the need to draw wheat out of storage should cause the Gulf cash price to increase relative to the K.C. futures price. Hence, the hypothesized sign of ACAVGEX to the basis residual is positive.

USDA Estimated HRW Wheat Weekly Exports(USESTEX)

USDA estimated exports are hypothesized to be negatively related to the basis. When total estimated exports for the crop year are reported to be high, traders who anticipate higher cash prices in the future will push the futures price up relative to the current cash price. As a result, the basis will decrease.

Grain Embargo(GE)

The government grain embargo's relationship to the basis residual is hypothesized to be negative. The embargo cut off shipments from

the U.S. to the Soviet Union. The reduced demand at the Gulf led to lower Gulf cash prices relative to the futures prices. The purchasing of the wheat committed to the Soviet Union by the U. S. government aided in stabilizing the futures prices. Thus, the embargo's effect on market prices is expected to inversely impact on the basis.

Transportation Situation(TS)

The transportation indicator variable enters the model for periods when problems in transporting wheat from inland points to either the Gulf or a par delivery point are reported in the Grain Market News weekly summary of market conditions.

When transportation of wheat to the Gulf is reported to be slowed, then the associated costs are expected to rise. To compensate the seller of wheat for this added cost, perhaps due to alternative transportation modes, the Gulf cash price is expected to show a short-term increase. Thus, relative to the futures price, a widening or positive impact on the basis is hypothesized.

Inland Storage(IS)

The inland storage indicator variable is included to reflect periods when inland storage facilities for Hard-red Winter wheat are in short supply, as reported in the Grain Market News weekly summary of market conditions.

This variable should be inversely related to the basis. When inland storage for HRW wheat is reported to be tightening, the unstored wheat provides incentive for the Gulf cash bid to drop. The futures price, realizing that the unstored wheat will clear the

market, reflects a stable future cash price. This price squeeze then results in a narrowing of the basis. This relationship describes in general the post-harvest reaction and, should be more observable in the shorter maturity periods.

Contract Month Indicator Variables(DUM3,7,9,12)

The indicator variables, DUM3, DUM7, DUM9, and DUM12, indicate the contract month used in calculation of the basis. They represent the March, July, September, and December contract months, respectively. May is omitted and is in the intercept. No algebraic sign is hypothesized, a priori.

CHAPTER V

EMPIRICAL RESULTS AND INTERPRETATION

Estimation Procedures

Least squares estimation procedures are used in the analysis. All of the ordinary least squares (OLS) assumptions are not likely to hold for the basis residual model (equation 7). As with any weekly time series, the error terms of the model are potential serially correlated, i.e. possible autocorrelation problems exist. When autocorrelation is present the OLS parameter estimates are not efficient and the standard error estimates are biased. In assuming autocorrelation problems exists, the basis residual model is estimated using a maximum likelihood (ML) procedure. The ML estimates employ a Guass-Marquardt algorithm to maximize the log likelihood, using the OLS estimates as starting values (Judge, et al., 1985). This procedure corrected for up to a specified third-order autocorrelation where the significance level of the autoregressive parameters was set at .1, and nonsignificant autoregressive parameters were eliminated.

Evaluation of Independent Variable

Parameter estimates and their associated t-values for the eight models are presented in Table III. Independent variables included in the model are listed down the left side of the table and the months to maturity periods across the top. Various statistics are presented in

TABLE III

ESTIMATES FOR THE CPM HARD-RED WINTER WHEAT BASIS RESIDUAL MODEL /1

Independent Variable	Months to Maturity							
	1	2	3	4	5	6	7	8
Intercept	0.2029	0.1893	0.1485	0.1328	.1635	.10969	0.1689	0.0788
	(4.490)	(4.991)	(3.893)	(3.237)	(3.337)	(2.193)	(3.348)	(1.568)
BR_{t-1}	0.6429	.7820	0.8215	0.8431	0.8334	0.8603	.8684	0.8362
	(13.962)	(25.443)	(28.882)	(29.874)	(29.564)	(30.679)	(31.357)	(29.562)
ML	0.1496	-0.1226	0.0656	0.0232	0.0069	-0.0307	0.0411	-0.018
	(2.230)	(-1.768)	(.952)	(0.333)	(0.093)	(-0.425)	(0.551)	(-0.238)
CMYSALES	0.2515	0.1524	0.1456	0.1094	0.1208	0.1778	0.1516	0.1376
	(2.764)	(2.005)	(1.982)	(1.412)	(1.506)	(2.210)	(1.901)	(1.653)
DIFF	0.0023	-0.0021	-0.0044	-.0032	-0.0005	-.0021	-0.0038	0.0014
	(0.231)	(-0.267)	(-0.573)	(-0.392)	(-0.061)	(-0.243)	(-0.435)	(0.163)
USESTEX	-0.0011	-0.0009	-.0013	-0.0011	-0.0010	-0.0018	-0.0013	-0.0011
	(-0.722)	(-0.749)	(-1.084)	(-0.880)	(-0.826)	(-1.410)	(-1.014)	(-0.799)
GE	-0.0727	-0.0518	-0.0518	-0.0438	-0.0543	-0.0442	-0.379	-0.0540
	(-4.083)	(-3.646)	(-3.617)	(-2.943)	(-3.436)	(-2.759)	(-2.349)	(-3.320)
TS	-0.0014	0.0134	.0143	0.0198	0.0086	0.0150	0.0217	0.0181
	(-0.132)	(1.203)	(1.312)	(1.733)	(0.724)	(1.193)	(1.698)	(1.403)
IS	-0.0098	-0.0147	-0.0178	-0.0249	-0.0210	-0.0139	-0.0194	-.0130
	(-1.655)	(-1.393)	(-1.230)	(-1.636)	(-1.324)	(-0.852)	(-1.212)	(-0.804)
DUM3	-0.0262	-0.0178	-0.0168	0.0120	-0.0132	0.0362	-0.519	0.0693
	(-1.839)	(-1.393)	(-1.279)	(0.764)	(-0.436)	(1.562)	(-1.827)	(2.848)
DUM7	-0.0126	0.0085	0.0199	0.0321	0.0163	0.0585	0.0389	.0396
	(-0.750)	(0.621)	(1.494)	(1.954)	(0.516)	(2.841)	(2.534)	(2.851)
DUM9	-0.0511	-0.0305	-0.0384	-0.0083	0.0049	0.0420	-0.0383	0.0997
	(-2.779)	(-1.851)	(-2.644)	(-0.507)	(-0.157)	(1.568)	(-1.193)	(4.338)
DUM12	-0.0441	-0.0380	-0.0325	-0.0270	-0.0452	0.0214	-0.0556	-0.0939
	(-2.635)	(-2.553)	(-1.084)	(-1.533)	(-1.439)	(0.840)	(-1.813)	(3.435)
AR	0.2858	-	-	-	-	-	-	-
	(-4.674)	-	-	-	-	-	-	-
Statistics								
$Total_2R^2$ 2/	0.7595	0.8315	0.8705	0.8747	.8747	.8753	.8753	0.8700
Reg R^2 3/	0.6262	0.8315	0.8705	.8747	.8747	.8753	.8753	0.8700
F(4) - values 4/	1.743	2.7734	4.3617	3.2818	3.9164	3.6060	4.6658	5.6299
Mean BR_t	0.615	.683	.739	.789	.843	.890	.935	.983

1/ t-values are in parentheses. 2/ Includes autoregressive parameters in measurement.
3/ Includes only the structural variables in the model. 4/ F-test for including DUM3,7,9,12.

the last five rows of Table III and include total R^2, regression R^2, and F-values for the contract month indicator variables as a group. The mean basis residual is reported in the last row of the table.

The coefficient of determination (R^2) measures the percent of variation in the basis residual (BR_t) that is explained by the model. Total R^2 includes the autoregressive parameter, which indicates the order of autocorrelation, in its measurement. To illustrate, the total R^2 value of .7595, for the one-month period, means that 75.95 percent of the variation in the $BR(7)_t$ is explained by the model. In contrast, regression R^2 represents only the given model's structural variables. This definitional difference accounts for their observed value difference in the one-month model. As a note, subtracting regression R^2 from total R^2 yields the percent of variation explained by the autoregressive parameter. In all eight of the CPMs, both-sets of the R^2 values are high, thus indicating a significant amount of the variation in the BR_t is explained.

The F(4)-values report tests for the significance of DUM3, 7, 9, and 12 as a group. This is done to determine the existence of significant regression for the contract month indicator variables. F(4)-values are significant at the .95 percent level in all except the one-and-two month models.

Delineation of each of the thirteen variables' estimated relationship to the basis residual is discussed below. The discussion will emphasize and interpret the results of the one-month (nearby) CPM, as it is probably of most importance to the grain trade.

Variables

Lagged Basis Residual(BR_{t-1})

Many participants of the wheat industry use the Kansas City HRW wheat futures market to maintain long-term hedging positions, which are adjusted to meet forward pricing needs. These traders do not play the game of jumping in and out of their futures position simply because market conditions may be changing slightly. This action is left to speculators. Understanding traders' responses to market conditions which impact on the basis residual requires recognition of the rigidities associated with traders maintaining their futures position.

The basic hypothesis is a partial adjustment process in which the fully adjusted basis residual in this period is proportional to the basis residual in last period. Thus, BR_t is proportional to BR_{t-1}. The lagged basis residual is included in the model to represent this hypothesis.

The parameter estimates of BR_{t-1}, across all eight CPM periods, show a consistent to increasing, positive relationship to BR_t. The estimate's associated t-values are all highly significant. These results support the hypothesis that the BR_t is proportional to BR_{t-1}, due to some traders slow adjustment to changing market conditions. This relationship is perhaps more fully observed due to the use of weekly data.

The coefficient of BR_{t-1} for the one-month to maturity period (nearby) is .6429. This implies that the adjustment coefficient (ϕ) equals 1.36. The interpretation of this is that slightly over

one-third of the difference between BR^*_t and BR_{t-1} is reduced during period t. The magnitude of parameter for BR_{t-1} for the one-month period is the lowest of all the models. The size of the parameter on BR_{t-1} indicates the strength of the rigidites operating in the market. As the parameter approaches 1, the adjustment period is longer. The results suggest that the longer CPM bases generally are more rigid and take longer to adjust to new information. The overall results show the partial adjustment hypothesis is supported.

Market Liquidity(ML)

As the level of trade commitments increase, the volume of trading must be substantial enough, such that participants can enter and exit the market without bearing added costs. The analysis indicates that the participation and level of activity in the HRW wheat futures market, may have a significant effect on the basis in the shorter maturity periods.

The ML regression coefficient for the one-month basis residual, $BR(1)_t$, is +.1496, with an associated t-value of 2.764. These results suggests that a one percentage point increase in the ratio of total volume to total open interest leads to a .15 cent per bushel increase in the $BR(1)_t$, ceteris paribus. Conversely, an increase in the ratio would result in an increase in the $BR(1)_t$. Implications are that lack of speculation in the Kansas City HRW wheat futures market, may result in added entry and exit costs for the one-month to maturity period.

The market liquidity variable was not significant at the .05 level in any of the other models and the signs of the parameters were

both positive and negative. It appears in the longer basis periods it is possible to enter and exit without encountering liquidity problems.

Ratio of Current Marketing Year Export Sales to Estimated Free Stocks(CMYSALES)

Current-marketing year export sales is as a ratio of sales to free stocks a demand and supply variable. The level of export demand is an important determinant of the Gulf price. An increase in CMY export demand pushes the Gulf price up relative to the futures price, thus increasing the basis residual. This relationship is particularly true if the futures price used in calculation of the BR_t is beyond the current marketing year. Free stocks are those stocks available to the market. As free stocks increase, the needed Gulf price to draw wheat out of storage is less, causing the basis residual to fall. As a ratio, the negative correlation between the two stock variables yields a positive impact on the basis residual.

The CMYSALES coefficients show a strong, positive relationship to the basis residual for six of the eight CPM periods. As expected, the relationship is less significant in longer months to maturity periods, specifically the 4.5 and 8 month periods. The ratio of CMY export sales to free stocks clearly reflects a significant relationship to the basis residual.

The estimated regression coefficient of CMYSALES on $BR(1)_t$ is .2515 with a significant t-value of 2.76. As the ratio of CMY export sales to free stocks increase by one percentage point, an accompanying decrease of a .25 cent per bushel is expected. If the CMYSALES ratio increased 10 percent, then $BR(1)_t$ would fall by 2.5 cents per

bushel, ceteris paribus.

Difference Between the Gulf Cash Price and the Loan Rate(DIFF)

DIFF represents a measure of the degree of anticipated loan use. As the cash price increases relative to the government's established loan rate, DIFF increases. And, the incentive for producers to place wheat under loan decreases. As more wheat is available to the free market, the Gulf cash price is expected to feel downward pressure, consequently decreasing the basis residual. Therefore, DIFF, as a measure of anticipated loan use, is inversely related to the basis residual.

The estimated coefficients for all eight CPM periods do not confirm the expected relationship of DIFF to the BR_t. It appears that the effect of tightening free stocks is sufficiently accounted for by CMYSALES.

Actual Average Weekly Exports(ACAVGEX)

Actual exports at the Gulf are expected to reflect current Gulf demand. As actual export levels show an increase, Gulf demand rises causing its cash price to rise relative to the futures price. Thus, the hypothesized relationship between ACAVGEX and the basis residual is positive. ACAVGEX was excluded from the model because it was correlated with USESTEX (.8) and with CMYSALES (.5).

USDA Estimated HRW Wheat Weekly Exports(USESTEX)

The U. S. Department of Agriculture releases their first report of estimated HRW wheat exports early in the marketing year. And although market prices react in a similar fashion, export estimates are projections for the future of the CMY, thus causing the futures price to respond more so than the Gulf cash price. High estimates of U. S. exports will entice traders to push the anticipated future cash price up relative to the Gulf price. This action-reaction response leads to a decrease in the basis residual.

The statistical coefficients for USESTEX show a consistent, negative relationship to the basis residual for all eight CPM periods. The range of the coefficients is from -.0009 to -.0018. The estimates confirm the expectation that USDA estimated exports are inversely associated with the basis residual although the associate t-values are not large.

Grain Embargo(GE)

The imposition of a U. S. government grain embargo is expected to cause export demand at the Gulf to fall. Reflecting the lower demand, the Gulf cash bid will decrease relative to the futures price. For the 1979 U. S. grain embargo to the Soviet Union, the futures price was somewhat supported by the U. S. government's purchases of the Soviet Union export commitments. This price squeeze is expected to cause the $BR(1)_t$ to decrease, as the need to draw wheat to the Gulf ports was weakened.

The sign and magnitude of the GE coefficients are consistent (negative 4 to 7 cents per bushel) and significant across all of the CPM periods. However, it must be recognized that the results are indicative of the particular Soviet Union embargo and not necessarily indicative of all such actions. The implications are that government intervention, through embargoes or similar action, which affect the short-term or longer-term export demand can significantly impact on market prices, causing the basis residual to adjust.

The coefficient for the estimated impact of the 1979-81 U. S. grain embargo to the Soviet Union, for the $BR(1)_t$, is -.0727 with a t-value of -4.083. The magnitude of the coefficient indicates that the embargo inversely impacted on the $BR(1)_t$ by 7.27 cents per bushel, ceteris paribus.

Transportation Situation(TS)

A short-term disruption in the transporting of HRW wheat to the Gulf, due to reasons such as low barge availability or a railroad workers strike, will potentially increase the cost of shipping wheat. In compensating the seller for this added cost, the Gulf cash price will show a short-term increase relative to the futures price and consequently, a positive adjustment in the basis residual will occur.

A positive one to two cent per bushel impact on the BR_t is consistent and significant across all eight CPM periods. In general, the t-values are relatively small with somewhat larger parameters estimates and t-values in the longer maturity periods. Two of the eight estimates are significant at the .05 level (4 and 7 months to maturity). The results hint that cash prices rise relative to more

distant futures prices when transportation problems are encountered.

Inland Storage(IS)

When inland storage begins to fill up, usually following the harvest months, the needed price incentive to draw unstored wheat to the Gulf is lowered. Thus, the Gulf cash bid will fall relative to the futures price. The futures price, which is an indication of the expected future cash price, reflects the anticipation of the wheat clearing the market and thus, holds steady to increasing. The result is a short-term, somewhat seasonal, decrease in the basis residual.

The analysis estimates show a negative relationship to hold for all eight CPM periods. The t-values are relatively small, however. The results do suggest a one to two cent per bushel decline in cash prices relative to futures prices when inland storage problems are encountered.

Contract Month Indicator Variables(DUM3,7,9,12)

With a few exceptions, the results support the hypothesis that the contract month used to calculate the basis is important in determining the basis residual. An anticipated adjustment in the BR_t intercept can be expected when changing the contract month.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

Hard-red winter wheat, is a seasonally-produced grain, and thus forces the cost efficient firms of the grain industry to maintain minimum stock levels. This operational requirement increases the amount of absolute price risk that a firm will face. By hedging in the futures market, which require full understanding of cash prices, futures prices, and their difference, a firm is able to reduce its price risk and potentially increase profits.

Cash prices of HRW wheat are tied by economic and political forces to prices of future contracts. Specifically, the cash-future price spread (basis) is the market price for the wheat storage service and coordinates decision making in the industry. Price determination in futures markets has been explained through the "supply of storage", according to which the basis is related to inventory behavior over the time horizon.

The behavior of the basis from the time a hedge is placed until the time it is lifted is of considerable importance to the hedger. As previously emphasized, the very essence of hedging involves an exchange of risk - price level risk for basis risk. It is well documented that the variation in the basis is considerably less than that of the cash and futures prices. The importance of hedgers

understanding the basis and the factors which affect it has led to this study.

The primary purpose of this study is to identify and quantitatively estimate the effect of major explanatory variables on the Gulf-Kansas City Hard-red winter (HRW) wheat basis. To support the research, the underpinnings of basis theory are examined, as are the supply/demand factors and governmental influences of this market. A constant period to maturity basis residual (basis minus storage costs) is hypothesized to be related to the ratio of futures contract volume traded to open interest, export sales relative to free stocks, USDA estimated exports, average actual exports, imposition of a grain embargo, government policies influencing wheat storage, transportation problems, inland storage problems, and the contract month used in calculating the basis. The basis residual is hypothesized to follow a partial adjustment process so that effects of new information are not fully reflected in the week when the new information becomes available. Data used in the analysis were from January 1979 through May 1986. The models are estimated using regression procedures that allow for correction of autocorrelation.

Conclusions and Implications

The analysis suggest that the weekly hard-red winter wheat basis residual is related to the ratio of futures contract volume traded to open interest, and negatively related to USDA estimated exports, and imposition of a grain embargo. A positive relationship is indicated for export sales relative to free stocks. In addition, the contract month used in calculating the basis is indicated to significantly

affect the basis residual.

The results show that a substantial amount of the variation in the Gulf-Kansas City HRW wheat basis residual (BR_t) is explained by the specified model. Significant F-test values and R^2 values lend support to this conclusion.

The partial adjustment hypothesis is supported and indicates that the reaction of traders to new information is not immediately reflected in the market, particularly for the longer maturity periods. This study provides hard-red winter wheat market participants with a better understanding of the Gulf-Kansas City basis. By understanding the factors which influence the basis, traders are in a better position to make intelligent and potentially profitable marketing decisions. Although the magnitude of the variable's coefficients should be interpreted with caution, due to changing market conditions and changing degrees of importance, the direction of influence is expected to hold.

Suggestions for Further Research

A problem remains regarding the appropriate specification of transportation costs. The indicator variable included in the model to account for transportation problems obviously does not pick up the effects that a transportation rate variable would. Transportation costs from Kansas City to the Gulf need to be specified and either removed from the basis residual or included in the model as an explanatory variable. An attempt at quantitatively specifying inland storage availability should also improve the explanation power of the basis residual model.

The results of this analysis suggest that possible market liquidity (defined as the ratio of total volume to total open interest)problems exist in the HRW futures market. This controversial issue needs to be more fully researched. A complete analysis of the composition of trader's commitments (levels of short versus long hedging, unbalanced hedging, net speculation) in the Kansas City futures market is needed. The analysis should identify the volume of trade needed, relative to open interest, to keep participants from incurring above normal transaction costs that result out of a thin market.

A SELECTED BIBLIOGRAPHY

Anderson, Ronald W. "Some Determinants of the Volatility of Futures Prices." Journal of Futures Markets. 5(1985): 331-348.

Arrow, Kenneth. J. "Futures Markets: Some Theoretical Perspectives." Journal of Futures Markets. 1(1981): 107-115.

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

Castelino, Mark G. and Jack C. Francis. "Basis Speculation in Commodity Futures: The Maturity Effect." Journal of Futures Markets. 2(1982): 195-206.

Chambers, Robert G. "Interrelationships between Monetary Instruments and Agricultural Commodity Trade." American Journal of Agricultural Economics. 63(1981): 934-941.

Cochrane, Willard W. "Conceptualizing the Supply Relation in Agriculture." Journal of Farm Economics, 37(1955), 1161-1176.

Conklin, Neilson C. "Grain Exports, Futures Markets, and Pricing Efficiency." Review of Research in Futures Markets. Vol. 1, No. 2, 1982: 1-25.

Cornell, Bradford. "The Relationship between Volume and Price Variability in Futures Markets." Journal of Futures Markets. 1(1981): 303-316.

Dewbre, Joe H. "Interrelationships Between Spot and Futures Markets: Some Implications of Rational Expectations." American Journal of Agricultural Economics. 63(1981): 926-933.

Ehrich, R. L. "Cash - Futures Price Relationships for Live Beef Cattle." American Journal of Agricultural Economics. 51(1969): 26-40.

Ehrich, Rollo. "The Impact of Government Programs on Wheat Futures Markets: 1953-1963." Food Research Institute Studies, 6, No. 3(1966).

Gomme, Frank. "Wheat Feeding in the United States." Wheat Situation, ERS, USDA, February, 1972.

Gray, Roger W. "Seasonal Pattern of Wheat Futures Prices Under the Loan Program." Food Research Institute Studies. III(1962): 23-34.

Heid, Walter G. Jr. U. S. Wheat Industry. USDA ESCS Agricultural Economic Report No. 432, April, 1980.

Ikerd, John E. Basis: The Key to Successful Livestock Hedging. Oklahoma State University. Agricultural Extension Facts No. 433.

Johnson, D. Gale. "The Nature of the Supply Function For Agricultural Products." American Economic Review, 40(1950), 539-564.

Judge, George G. et al. The Theory and Practice of Econometrics. 2nd Ed. New York: John Wiley and Sons. 1985, pp 295-297.

Kofi, T. A. "A Framework for Comparing the Efficiency of Futures Markets." American Journal of Agricultural Economics. 55(1973): 584-594.

Larson, Arnold. "Estimation of Hedging and Speculative Positions in Futures Markets." Food Research Institute Studies, 2(1961).

Malick, William M. and Ronald W. Ward. "Stock Effects and Seasonality in the FCOJ Futures Market." Florida Agricultural Experiment Station Journal Series #7452.

Makus, Larry and Nashwan Abdulrazak. "A Geographic Analysis of U.S. Hard Red Winter Wheat Export Shipments." Current Farm Economics, Agricultural Experiment Station, Oklahoma State University, Vol. 58, No. 4, Dec. 1985.

Martin, Larry, John L. Groenewegen, and Edward Pidgeon. "Factors Affecting Corn Basis in Southwestern Ontario." American Journal of Agricultural Economics. 62(1980): 107-112.

Meiken, Kenneth W. The Demand and Price Structure for Wheat. Tech. Bull. #1136, Agr. Mktg. Ser., USDA Washington D.C., Nov. 1955.

Paarlberg, Phillip L., Alan J. Webb, Authur Morey, Jerry A. Sharples. Impacts of Policy on U.S. Agricultural Trade. ERS, USDA, International Economics Division, Washington, D.C. December 1984, No. AGES 840802.

Scherr, B. A., and H. C. Madsen. "Observations on the Relationship between Agricultural Commodity Prices and Real Interest Rates." Journal of Futures Markets. 3(1983): 47-54.

Tewels, Richard J., Charles V. Harlow, and Herbert L. Stone. The Commodity Futures Game: Who Wins? Who Loses? Why? New York, New York: McGraw-Hill Book Co., 1974.

Thiessen, G. Willard. "Spread Trading in the Grains." Review of Research in Futures Markets. Vol. 1, No. 3, (1982): 188-194.

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

U. S. Department of Agriculture. History of Agricultural Price-Support and Adjustment Programs, 1933-84, Washington: ERS, Agricultural Information Bulletin, No. 485, 1985.

Updaw, Nelson J. "Key Factors Associated with Basis Relationships." Oklahoma State University, Agricultural Extension Facts No. 461.

Ward, Ronald W. and Frank A. Dasse. "Empirical Contributions to Basis Theory: The Case of Citrus Futures." American Journal of Agricultural Economics. 59(1977): 71-80.

Weymar, F. Helmut. "The Supply of Storage Revisited." American Economic Review. 56(1966): 1226-1234.

Wickwire, Trent A. "Explaining Variations in the Gulf-Kansas City Hard-red Winter Wheat Basis" (Unpub. M.S. thesis, Oklahoma State University, 1985.)

Working, Holbrook. "Price Relations Between May and New-Crop Wheat Futures at Chicago Since 1885." Food Research Institute Studies, 10(1934), 183-228.

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

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

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

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

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

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

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