THE IMPACT OF A GRAIN SORGHUM FUTURES MARKET ON HEDGING RISK FOR TEXAS GRAIN SORGHUM

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ABSTRACT

During the 1970's, grain sorghum futures traded at the Chicago Mercantile Exchange and the Kansas City Board of Trade (KCBT). There was very little trading interest in either contract, however. In 1988, the KCBT revised its grain sorghum futures contract and initiated trading in the revised contract in May 1989.

Because a sorghum futures contract has not always been available in the past, corn futures have been widely used by elevators, feedlots, and farmers to hedge grain sorghum. However, basis risk in a cross hedge in corn futures is greater than in a direct sorghum futures hedge. This research estimates that hedging risk can be reduced 17-34 percent by hedging sorghum in the KCBT sorghum futures market compared to cross hedging sorghum in corn futures. This level of reduction in hedging risk should encourage the use of the KCBT sorghum futures market to hedge sorghum.

Key Words: Grain sorghum, futures, corn, hedge, cross hedge, hedging risk.

INTRODUCTION

Grain sorghum is the second largest U.S. feedgrain crop behind corn. From 1981-85, an average of 7,400 million bushels of corn was produced in the U.S. compared to 840 million bushels of sorghum (U.S. Dept. of Agriculture). The average dollar value of corn production over this period was $19.4 billion, compared to $2.0 billion for sorghum. From 1981-85, thirty-two percent of U.S. sorghum production was exported (U.S. Dept. of Agriculture). Grain sorghum is primarily used as a feed ingredient in livestock rations. Studies have shown that sorghum contains 95% of the nutritional value of corn (Kansas City Board of Trade, 1989a, Appendix 26).

During the 1970's, grain sorghum futures traded at the Chicago Mercantile Exchange for five years and the Kansas City Board of Trade (KCBT) for three years. There was very little trading interest in either contract, however. In 1988, the KCBT revised its grain sorghum futures contract, and resubmitted it to the Commodity Futures Trading Commission. The KCBT's revised contract was approved in February 1989, and trading began on May 5, 1989. The KCBT believes the revised sorghum futures contract will succeed as a pricing and risk-management tool because of the change in agricultural policy toward more market orientation. "As market factors become ascendent, inherent [price] risk increases, stimulating a greater need for a viable hedging mechanism" (Kansas City Board of Trade, 1989a, p. 21). A second reason the sorghum contract is expected to succeed is because changes have been made to correct problems that existed in the earlier contract. These include (1) adding three delivery points in addition to Kansas City; (2) restricting the standards for delivering No. 3 sorghum; and (3) allowing flat transit billing, as opposed to freight paid to another destination.

This research estimates the impact of a sorghum futures contract on hedging risk for Texas grain sorghum. In the past, corn futures have been widely used by elevators, feedlots, and farmers to hedge grain sorghum (Kansas City Board of Trade, 1989a, p. 18). Corn is a close substitute for sorghum in livestock rations, and thus factors that affect corn prices also affect sorghum prices. The link between corn and sorghum prices makes it possible to use corn futures as a cross hedge for sorghum. "To cross hedge is to assume a futures position opposite an existing cash position, but in a different commodity" (Leuthold, Junkus, and Cordier, 1989, p. 146). A cross hedge is called for when a futures market does not exist for a commodity.

The problem a sorghum trader faces when hedging sorghum in corn futures is greater basis risk (where basis=sorghum cash price-corn futures price). This results because the relationship between cash sorghum prices and Chicago corn futures prices is not as close as the relationship between cash sorghum prices and Kansas City sorghum futures prices. Thus, a sorghum futures market is expected to provide a more effective hedge for sorghum than a cross hedge in corn futures (Stalcup, 1989).

When comparing sorghum futures and corn futures as hedges for cash sorghum, an objective measure of hedging risk is needed. This is developed in the second section of the paper from a simple regression of cash on futures prices. The standard deviation of the regression residuals serves as a measure of hedging risk. In the third section, hedging risk is calculated for cash sorghum hedged in sorghum futures versus corn futures for three locations in Texas. The last section provides a summary of the results and the conclusions.

HEDGING RISK

Hedging can be used to reduce price risk associated with an existing (or anticipated) cash position. For example, a cattle feeder can "lock in" a price for corn (an energy ingredient in cattle rations) by buying corn futures. If the price of cash corn should rise after the hedge is placed, the long position in corn futures will provide a return which can be used to offset the higher price paid in the cash market. In this sense, hedging shifts price level risk to futures speculators (Hieronymus, 1977, pp. 148-51).

Hedging does not completely eliminate price risk because the relationship between cash and futures prices (or basis) is always changing. Consider the situation of a cattle feeder who is making a decision in April about pricing corn he will be feeding in September. He decides to purchase September corn futures to lock in a price for corn in September. The feeder anticipates that the price of corn at his local market will be $0.10/bu. under the September futures price when the hedge is lifted in September. If September corn futures is trading at $2.80/bu., the price the hedger expects to achieve by hedging is $2.70/bu (Table 1). The expected price from hedging is called the target price.

The actual price achieved by hedging, called the net price, depends on the relationship between cash and futures prices in September. If the cash price at the feeder's local elevator is $0.10/bu. under the September futures price when the hedge is lifted in September, the net price from hedging will be equal to the target price of $2.70/bu. (Table 1). However, if the cash price is more than $0.10/bu. under the September futures price when the hedge is lifted, the net price will be under the target price (and vice versa). For

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Table 1. Example of Sorghum Hedge.

Date	Cash	September Futures	Basis = Cash-Futures
April	Target Price = $2.70	Buys at $2.80	-$0.10 (expected Sept. basis)
September	Buys at $3.00	Sells at $3.10 Gain $0.30	-$0.10 (actual basis)

Effective net buying price:
$3.00 cash purchase price in September
0.30 gain on futures
$2.70 net price

example, if the cash price in September is $0.25/bu. under the September futures price, then the net price from hedging will be $2.55/bu., which is $0.15/bu. under the target price (Table 2).

Table 2. Example of Sorghum Hedge with Basis Risk (i.e., Net Price Is Not Equal to Target Price).

Date	Cash	September Futures	Basis = Cash-Futures
April	Target Price = $2.70	Buys at $2.80	-$0.10 (expected Sept. basis)
September	Buys at $2.85	Sells at $3.10 Gain $0.30	-$0.25 (actual basis)

Effective net buying price:
$2.85 cash purchase price in September
0.30 gain on futures
$2.55 net price

The above example illustrates that hedging involves risk (or uncertainty) because the net price achieved by hedging can be different from the target price. Risk for a hedge can be measured by calculating the variation of the net price about the target price. This concept of hedging risk has been used in practical applications (Hieronymus, 1977, p. 208; Chicago Board of Trade, 1978), and academic studies of hedging (Miller, 1985; Elam, Miller and Holder, 1986; Elam, 1988; and Schroeder and Mintert, 1988). Equations for the target and net prices are required to develop a mathematical definition of hedging risk.

The target price is derived at the time a hedge is placed, and represents the price a hedger expects to achieve by hedging. The first step in deriving the target price is to estimate the relationship between the cash price at the hedger's local market and the nearby futures price:

$$(1) \qquad C_t = b_0 + b_1F^t_t + v_t$$

where C_t is the actual per bushel price of cash sorghum at time t; and F is the per bushel futures price at time t for the futures contract maturing nearest to, but not before, time t; b_0 and b_1 are estimated intercept and slope parameters, respectively; and v_t is the regression residual with expected mean of zero and variance of $E[(v_t)^2]=\sigma_v^2$.

To reduce basis risk, a hedge is typically placed in the futures contract that is at, or nearest to, maturity. For example, if a hedge will be lifted in September, then it should be placed in the September sorghum futures contract. By comparison, if the hedge is to be lifted in October, it should be placed in the nearby futures contract which is December. Sorghum futures contracts trade (or mature) only five times per year—March, May, July, September, and December.

The estimated slope parameter from eq. (1), b_1, indicates the number of bushels of the nearby futures required to hedge one bushel of cash sorghum. For example, if b_1=0.9, then 0.9 bushel of futures is required to hedge 1.0 bushel of cash sorghum. If the cash position is 10,000 bushels, a hedge would require the sale of 9,000 bu. (10,000 x 0.9) of futures. The KCBT sorghum futures contract is for 5,000 bushels, so a hedge for a 9,000 bushel cash position would call for the sale of two KCBT contracts (which is closest to 10,000 bushels).

The target price for a hedge to be lifted at time t is calculated at time t-j by substituting the futures price for the contract maturing nearest to, but not before, time t into eq. (1) and solving for the predicted cash price:

$$(2) \quad T^t_{t-j} = b_0 + b_1F^t_{t-j},$$

where T^t_{t-j} is the target price as calculated at time t-j for a hedge to be lifted at time t. The target price is the per bushel cash price the hedger expects to receive/pay for cash sorghum at the hedger's local market at time t. In the example in Table 2, the target price is $2.70/bu. Note that the target price in the example is derived in April at the time the hedge is placed.

After a hedge is lifted, the net price for the hedge is calculated. The net price represents the actual price achieved from hedging. In the example in Table 2, the hedge is lifted in September and the net price ($2.55/bu.) is calculated. The net price for a hedge is the sum of the cash price at the time the hedge is lifted plus the return on the futures position:

$$(3) \qquad N_t = C_t + b_1(F^t_{t-j} - F^t_t),$$

where N_t is the per bushel net price for a j-period hedge that is lifted at time t.

The target price from eq. (2) reflects the price a hedger <u>expects</u> to achieve by hedging, whereas the net price from eq. (3) represents the <u>actual</u> price achieved by hedging. The difference between the net and target prices is obtained by subtracting eq. (2) from (3):

$$(4) \quad N_t - T^t_{t-j} = C_t - b_0 - b_1F^t_t.$$

Eq. (4) shows that the difference between net and target prices is equal to the difference between the cash price at the time a hedge is lifted

(C_t) and the predicted cash price, $\hat{C}_t=b_0+b_1F^t_t$. This difference is equal to v_t, which is the regression residual from the regression of cash on nearby futures prices (eq. (1)):

$$(5) \quad N_t - T^t_{t-j} = v_t.$$

A measure of the risk involved in hedging is the standard deviation of the difference between the net and target prices:

$$(6) \quad \text{Std. Dev. } (N_t - T_{t-j}) = \sigma_v.$$

where σ_v is the standard deviation of the regression residuals from a price level regression (eq. (1)). The standard deviation is preferred over the variance as a measure of hedging risk because it is in dollars per bushel, rather than in dollars per bushel squared. Equations (5) and (6) show that hedging risk is directly related to the uncertainty in the relationship between a hedger's local cash price and the nearby futures price at the time a hedge is lifted. This risk is quantified in the regression residual, v_t.

In the following section, the measure of hedging risk from eq. (6) is used to compare hedging risk for grain sorghum hedged in the Chicago Board of Trade corn futures market versus grain sorghum hedged in the KCBT grain sorghum futures contract.

HEDGING RISK FOR SORGHUM HEDGED IN SORGHUM FUTURES VS. CORN FUTURES

Hedging risk was estimated for cash sorghum hedges using Thursday cash prices for No. 2 Yellow Sorghum for three locations in Texas—High Plains (represented by the Triangle Area from Plainview to Canyon to Farwell), Houston, and Corpus Christi (Texas Dept. of Agriculture, 1977-88). Thursday prices were used because Kansas City sorghum prices are reported for Thursday in the Grain and Feed Market News (U.S. Department of Agriculture). Corn futures prices were collected for the same day of the week as the cash sorghum prices (U.S. Dept. of Agriculture, and Wall Street Journal). Because sorghum futures prices were not available on a historical basis, Kansas City No. 2 Yellow Sorghum prices were used as a proxy for sorghum futures prices (U.S. Dept. of Agriculture). Cash prices have been used as proxies for futures prices in feeder cattle hedging studies where a historical series of cash settlement futures prices was not available (Elam, 1988; Schroeder and Mintert, 1988). The justification is that cash and futures prices will be approximately equal at the time a contract matures (Hieronymus, 1977, p. 152). Cash sorghum prices from Kansas City should approximate sorghum futures prices at contract maturity because Kansas City is the primary delivery point on the KCBT sorghum futures contract.

Hedging risk was estimated for a direct sorghum hedge versus a cross hedge in corn futures using the standard deviation of the difference between net and target prices. The standard deviation (O_v from eq. (6)) was calculated from the residuals from regressions of (1) cash sorghum price on sorghum futures price, and (2) cash sorghum price on corn futures price. Separate regressions were run for each of the three markets, and for each of the months of March, May, July, September, and December (the five months that sorghum and corn futures trade).[1] The standard deviations for a direct sorghum hedge compared to a cross hedge in corn futures are shown in columns 2-3 of Table 3. The percentage changes in hedging risk are shown in column 4.

The average reduction in hedging risk for a direct hedge over a cross hedge ranges from 4-29 percent. The average reduction is greatest for the Texas High Plains (29 percent) and smallest for Corpus Christi (4 percent).

Table 3. Hedging Risk for a Direct Sorghum Hedge Compared to a Cross Hedge in Corn Futures, by markets, 1977-88.

Market	Estimated Hedge Ratio[a]			Bushel-for-Bushel Hedge[b]		
	Sorghum Futures	Corn Futures	Change in Hedging Risk	Sorghum Futures	Corn Futures	Change in Hedging Risk
	dollars per cwt.		percent	dollars per cwt.		percent
Texas High Plains						
March	0.189	0.282	-33.0	0.191	0.327	-41.6
May	0.138	0.266	-48.2	0.136	0.281	-51.7
July	0.233	0.309	-24.6	0.261	0.418	-37.5
September	0.203	0.268	-24.3	0.248	0.406	-39.0
December	0.202	0.242	-16.6	0.199	0.285	-30.0
Average			-29.4			-34.0
Houston						
March	0.193	0.257	-25.0	0.205	0.269	-23.8
May	0.338	0.298	13.4	0.333	0.294	13.3
July	0.218	0.339	-35.5	0.216	0.390	-44.5
September	0.222	0.259	-14.4	0.230	0.267	-13.7
December	0.224	0.261	-14.2	0.233	0.272	-14.4
Average			-15.2			-16.6
Corpus Christi						
March	0.209	0.228	- 8.5	0.222	0.337	-34.1
May	0.280	0.254	10.6	0.297	0.304	2.1
July	0.234	0.330	-29.0	0.234	0.386	-39.4
September	0.221	0.227	- 2.6	0.217	0.257	-15.5
December	0.264	0.247	7.1	0.260	0.286	- 9.3
Average			- 4.5			-20.1

[a]The estimated hedge ratio is b_1 from eq. (1) in the text

[b]In a bushel-for-bushel hedge, one bushel of futures is used to hedge one bushel of cash sorghum. The hedge ratio for a bushel-to-bushel hedge is b1-1.00.

Hedging risk is reduced with a direct hedge in the High Plains for all five months that sorghum futures trade, with the smallest reduction being 17 percent for December. By contrast, for the Corpus Christi market, July is the only month in which hedging risk is reduced more than 10 percent. For the other four months for Corpus Christi, hedging risk is reduced for two months with a direct hedge, but for the other two months, hedging risk increases. The only other situation in which hedging risk increases with a direct hedge over a cross hedge is for May at Houston. May is at the end of the marketing season for sorghum, and relatively small amounts of sorghum are traded/exported during May. Prices at times during May are not reported; and prices that are reported are typically based on small lots of sorghum. Because of the above reasons, relatively little weight should be given to the figures for Corpus Christi and Houston for May.

The results for hedging risk presented in columns 2-4 of Table 3 assume that an estimated hedge ratio is used to determine the size of the futures position.[2,3] However, most sorghum is currently hedged on a bushel-to-bushel basis using corn futures (Kansas City Board of Trade, 1989a, p. 19). A bushel-to-bushel hedge involves using one bushel of futures to hedge one bushel of cash sorghum. The hedge ratio for a bushel-to-bushel hedge is b_1=1.0. Textbook examples of hedging typically use bushel-to-bushel hedges (Hieronymus, 1977, pp. 175-78; and Chicago Board of Trade, 1978).

Because of the widespread use of bushel-to-bushel cross hedges in the sorghum trade, it seemed appropriate to measure the change in hedging risk for direct hedges versus cross hedges on a bushel-to-bushel basis. This should provide a more accurate indication of the actual reduction in hedging risk that would be achieved in practice when a direct sorghum hedge is used compared to a cross hedge in corn futures. Hedging risk for a bushel-to-bushel hedge can be calculated as described in the previous section, with the exception that the hedge ratio is assumed to be b_1=1.0. Hedging risks for bushel-to-bushel hedges are shown in columns 5-6 of Table 3, and the percentage changes in hedging risks for direct over cross hedges on a bushel-to-bushel basis are shown in column 7.

The results for bushel-to-bushel hedges are similar to those in columns 2-4 for the situation where a hedge ratio was estimated. However, one difference is that bushel-to-bushel hedges typically show a greater reduction (or smaller increase) in hedging risk. This is most noticeably true for the Corpus market where bushel-to-bushel hedges show on average a 16

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[1]Separate regressions are typically run for each season of the year to allow for seasonal differences in hedging risk (Elam, 1988; Schroeder and Mintert, 1988; Schroeder, 1988).

[2]The hedge ratio is the slope coefficient (b_1) from a regression of cash sorghum prices on sorghum or corn futures prices. Hedge ratios were estimated for the three locations and five months sorghum futures trade (March, May, July, September, and December). To save space, average hedge ratios are reported below (and specific monthly hedge ratio estimates are available from the authors).

Market	Direct Hedge Ratio	Cross Hedge Ratio
High Plains	0.97	0.81
Houston	1.06	0.92
Corpus Christi	0.94	0.82

The average cross hedge ratio is less than the average direct hedge ratio for each of the three markets. Also note that the direct hedge ratios are closer to 1.0 than the cross hedge ratios. A direct hedge ratio of 1.0 indicates that one bushel of sorghum futures is required to hedge one bushel of cash sorghum.

[3] The purpose in using an estimated hedge ratio is to reduce hedging risk (Elam and Davis, 1990). In the case of a cross hedge, the cash commodity is different from the futures commodity, and thus the change in cash and futures prices can be different. For example, the cash price of sorghum may decline on average by $0.45 per bushel when the corn futures price declines by $0.50 per bushel. When using corn futures to cross hedge sorghum, this situation calls for a position of 0.9 bushel of corn futures for each bushel of cash sorghum. The 0.9 is the cross hedge ratio, which is the estimated slope coefficient (b_1) from a regression of cash sorghum price on corn futures price (equation (1)). The hedge ratio represents the relative change in cash sorghum and corn future prices. A cross hedge for 50,000 bushels of cash sorghum will require the sale of 45,000 (50,000 x 0.9) bushels of corn futures. Then if the cash sorghum price declines by $0.45 per bushel and corn futgures price by $0.50 per bushel, the decline in the value of the sorghum position ($22,500=$0.45x50,000 bushels) will be exactly offset by the gain in value of the short corn futures position ($22,500-$0.50x45,000 bushels).

percentage point greater reduction in hedging risk for direct over cross hedges than that for the situation where a hedge ratio was estimated (columns 2-4).

CONCLUSIONS

Hedging risk for Texas cash sorghum positions is estimated to be reduced 17-34 percent with a direct sorghum hedge compared to a cross hedge in corn futures (based on the results for bushel-to-bushel hedges). This level of reduction in hedging risk should encourage the use of the KCBT sorghum futures market to hedge cash sorghum.

An advantage of a sorghum futures contract for the U.S./Texas sorghum industry is that it will improve the image of sorghum as a desirable feedgrain. In the past, a sorghum futures contract has not always been available; and therefore the corn futures market has been used for discovering the equilibrium price that equates the demand for and supply of sorghum. Cash sorghum traders look to corn futures prices as a benchmark, and adjust sorghum prices according to the particular demand-supply situation in the sorghum market. The need to interpret sorghum's market value relative to its corn-futures reference complicates sorghum pricing ..." (Kansas City Board of Trade, 1989a, p. 17). It is particularly difficult for foreign buyers to determine fair value for sorghum because they do not have timely access to information needed to interpret sorghum-corn price relationships. This puts them at a competitive disadvantage in their dealings with more knowledgeable parties. Foreign buyers are important to the domestic sorghum industry because approximately one third of U.S. sorghum production is exported. Importers have been wary about buying sorghum because there was no futures market on which to base pricing decisions (Kansas City Board of Trade, 1989b, p. 7).

If a sorghum futures market can develop, it should benefit the Texas sorghum industry in that (1) it will provide a more effective hedge for cash sorghum, and (2) it should improve the image of sorghum as a desirable feedgrain, which will encourage foreign purchases of U.S. and Texas grain sorghum.

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