The Feasibility of Cross Hedging Various Feeds in the Corn Futures Market

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Introduction

Risk management has become increasingly important in the management activities of feedlot operations, feed companies, and feed grain producers during the last several years. This situation arose for two reasons. First, feed represents a large portion of the total cost of many feed users. For example, approximately one-third of the total variable cost of beef farmer-feedlot operations is feed expenses (USDA). The second factor is the increasing volatility of commodity prices in the past decade. Weather aberrations and government policy changes here and abroad can cause feed prices to flucuate widely. Taken together these two factors provide an opportunity for greater profits for firms that are able to manage their purchasing and sales wisely .

One risk management tool is the commodity futures market. By hedging, a firm can establish approximate purchase or sale prices and minimize the risk of advance price movements. Futures markets can also extend the time period when prices can be established; this is especially helpful for firms with limited storage capacity.

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Futures markets for such feeds as corn, wheat, and soybean meal have existed for sometime. However, the opportunity to shift the risks of unfavorable price change for other feeds (e.g. sorghum and barley) is limited due to the lack of a futures market for them. The question then arises whether these feeds can be successfully cross hedged with established contracts for other feed grains.

The purpose of this paper is to evaluate the possibility of using the corn futures market for hedging barley, molasses, sorghum, wheat middlings, and hay. These five were selected because they are used in large quantities by feedlots and feed mixers, and some, such as barley, are major ingredients in foods. Regression analysis is used to determine the potential usefulness of corn futures as a cross hedging instrument.

Using wheat futures as a cross hedging instrument was not considered since wheat in the Midwest is priced primarily for its value as food and none of these feeds, including wheat middlings, are considered a substitute for wheat for food purposes. The possibility of cross hedging these feeds with oats futures was also dismissed since oat futures contracts are thinly traded.

Cross Hedging Mechanics

Futures contracts are the instruments by which risk is transferred by hedging. Contract specifications indicate the quantity and the other product characteristics which are standardized, along with appropriate discounts or premiums for any differences allowed in grade, alternate delivery locations, etc.

Cross hedging is the hedging of a commodity in a different commodity futures contract. While direct hedging involves the relationship between cash and futures prices for the same commodity, cross hedging involves the relationship between prices of different commodities.

Since cross hedging involves two or more different commodities, it is more complicated than direct hedging. The trader has a number of decisions to make prior to hedging. First, the trader must determine if the cash product price is related to a comparable futures. Then the variation in this relationship must be analyzed to see if it is sufficiently smaller than the variation in the cash price to make hedging a potentially useful risk management tool.

Once the appropriate futures market is selected, the amount of futures contracts required to offset value changes in a cash position must be estimated. That relationship will reflect any differences in the physical units of the futures contract and the commodity to be hedged (e.g. bushels vs. tons, or 56 lb. bushels vs. 48 lb. bushels). Moreover, even if the two commodity units of measurement are the same, prices may not fluctuate on a one-to-one basis if the products are not close to perfect substitutes.

Past Cross Hedging Studies

Anderson and Danthine (1981) have done a theoretical description of cross hedging. They derived optimal decision rules and used these rules to evaluate how optimal cash and futures positions are related to price expectations and the availability of futures markets. They also state that partial correlations of a cash price and a specific futures price may be used to evaluate the feasibility of cross hedging in that specific futures market.

Most of the work regarding cross hedging has been in the area of financial futures. Spot financial instruments and futures often have differing maturity dates so cross hedging is the predominant form of hedging in this area.

Starleaf and Langley (1983) estimated hedge ratios that minimized risk and then analyzed their effectiveness when the cash instrument was mortgage loans and the hedging instrument was either Treasury bond or Government National Mortgage Association Collateralized Depository Receipts (GNMA CDR) futures contracts. T-bond futures contracts were found to be more effective hedging instruments than GNMA CDR futures contracts.

Ederington (1979) estimated the effectiveness of the GNMA CDR and Treasury bills futures markets in reducing the risk of holding cash positions in these instruments. He found that the risk minimizing hedge ratio and the efficiency of the hedge depended on the length of the hedge and the maturity of the futures contract used. Also, the longer hedges were more efficient than short-term hedges.

The number of studies regarding the feasibility of cross hedging agricultural commodities is limited. Hayenga and DiPietre (1982), in a study of the cross hedging of wholesale beef cuts with live cattle futures, concluded wholesale product prices and live cattle futures prices moved in a proportional manner. Depending upon expected cash prices, prevailing futures prices, and firms' risk aversion, cross hedging could be a useful tool for firms in the wholesale beef market. Hayenga and DiPietre (1982) also found a similar relationship between wholesale pork product prices and live hog futures. In both studies, the relationships were estimated using ordinary least squares, the procedure employed in this analysis.

Miller has studied cross hedging among several commodities including possibility of cross hedging beef cuts with fed cattle futures using regression analysis. He concluded cross hedging would reduce the variability of wholesale prices without increasing the net price. In 1982, Miller argued that distillers dried grains can be effectively cross hedged with corn and soybean meal futures. Also in 1982, he found that cross hedging feeder pigs with both live hog and corn futures was more effective than just hedging with live hog futures.

Blake and Catlett (1984) examined the use of corn futures contracts to cross hedge hay. Simple cash-futures correlation estimates were used to determine the optimal corn futures contract, which was found to be May in each case, to cross hedge spot monthly hay prices. Regressions using May corn futures prices as the independent variable were then used to determine the optimal hedging ratio.

Model and Data Description

The relationship between spot feed prices and appropriate corn futures prices is estimated for each selected time period using ordinary least squares. The estimated regression can be represented by:

$$CP_{ij} = a_{ij} + b_{ij}FP_i + u_{ij}$$

where CP_{ij} is the cash price of the j^{th} feed during the i^{th} time period, FP_i is the corn futures price during the i^{th} time period, and u_{ij} is the error term.

The spot feed price is the dependent variable and the corn futures price the independent variable since the initial futures market price would be the instrumental or predetermined variable when a hedge is placed one to 12 months in advance of a cash market transaction. The corresponding spot feed price in the delivery period has to be estimated based on typical futures price-feed price relationships when pricing of the cash commodity would occur.

The slope coefficient, b_{ij}, indicates the position a hedger must take in the futures market to have the gains or losses from the cash market and futures market balance out. In other words, the slope indicates the number of bushels of corn futures needed to protect against changes in the estimated cost of feed per bushel, hundredweight, or ton. For example, if the slope is 50, the price of one unit of the feed is locked in by obtaining 50 bushels of corn futures. In terms of corn futures contracts, a slope coefficient of 50 means one contract, which is 5000 bushels on the Chicago Board of Trade, can establish the price of 100 tons, bushels, etc., of the feed (5000/50=100).

The slope coefficient also reflects the typical change in the feed price associated with a one dollar change in the corn futures price during each contract period. In the example above, a dollar increase in the corn futures price would translate into a 50 dollar increase per unit in the estimated feed price.

The regression equation can be used to calculate the feed price equivalent of a corn futures maturing nearest to the date when the cash product will be purchased. Once the cash price is predicted, the potential hedger can then choose to take a position in corn futures to establish that price in advance of the actual cash transaction.

The data was classified in two categories depending upon when the prices were quoted (see Table 1). The prices of Minneapolis barley (no. 3) and Kansas City sorghum (no. 2) are Thursday closing prices reported by the U.S Department of Agriculture, Agricultural Marketing Service, provided to us by Sparks Commodities, Inc. Barley prices are quoted in dollars per bushel while

Table 1
Variable Definitions

CP_1	=	Kansas City sorghum (no. 2) Thursday closing prices from the USDA Agricultural Marketing Service, provided by Sparks Commodities, Inc.
CP_2	=	Minneapolis barley (no. 3) feed Thursday closing prices from the USDA Agricultural Marketing Service, provided by Sparks Commodities, Inc.
CP_3	=	Platte Valley of Nebraska average weekly hay prices from the USDA Agricultural Marketing Service.
CP_4	=	Southwest Kansas average weekly hay prices from the USDA Agricultural Marketing Service.
CP_5	=	New Orleans molasses average weekly prices from the USDA Agricultural Marketing Service.
CP_6	=	Kansas City wheat middlings average weekly prices from the USDA Agricultural Marketing Serice.
FP	=	Chicago Board of Trade corn futures prices (Thursday closing prices or average weekly prices).

Table 2
Contracting Periods

March
Dec. 1 to Feb. 29
May
Mar. 1 to Apr. 30
July
May 1 to June 30
September
July 1 to Aug. 31
December
Sept. 1 to Nov. 30

sorghum prices are in dollars per hundredweight. The data encompassed the period 1975 to 1984.

New Orleans molasses, Kansas City wheat middlings, Platte Valley of Nebraska hay, and Southwest Kansas hay prices are weekly average prices at those locations compiled by the USDA Agriculture Marketing Service. Two series of hay prices were included in the analysis since the price of hay may vary significantly in various local markets. The data for molasses covered the period 1975 to 1984, wheat middlings 1975 to 1984, and hay 1978 to 1984. Each price is quoted in dollars per ton.

The corn futures prices used with the first data set are Thursday closing prices of the nearby futures contract. For the second data set, the corn futures prices used are weekly averages of closing prices of the nearby futures contract. The corn futures prices are quoted in dollars per bushel and are from the Chicago Board of Trade.

In defining the five contract periods, cross hedges were assumed to be terminated before threat of making or taking delivery occurred. Thus, the typical cash price-futures price relationship was estimated for the period beginning when the prior contract became the delivery month and ending just prior to the beginning of the nearby contract month. The contracting periods used in this analysis are listed in Table 2.

Empirical Results

The estimated equations are summarized in Table 3. All F-ratios, except for three, are significantly different from zero at the .0001 level of confidence. The three exceptions, the May and July equations for molasses and the September equation for Kansas hay, are significant at the .05 level.

Table 3
Empirical Results

	March	May	July	September	December
Sorghum (cwt)					
Intercept	.54	.40	-.27	-.12	.13
	(5.19)	(3.04)	(-1.22)	(-.79)	(.97)
Slope	1.40	1.43	1.65	1.65	1.54
	(37.39)	(30.40)	(21.13)	(30.79)	(34.34)
R^2	.91	.90	.83	.91	.89
SEF*	.23	.23	.28	.25	.29
Barley (bu)					
Intercept	-0.06	.31	.54	.28	.15
	(-.71)	(2.44)	(2.98)	(2.13)	(1.38)
Slope	.80	.64	.54	.65	.75
	(26.21)	(13.91)	(8.28)	(14.14)	(19.55)
R^2	.82	.66	.42	.68	.73
SEF*	.18	.23	.23	.22	.25
Nebraska Hay (tons)					
Intercept	5.28	-.81	-31.33	7.79	5.07
	(1.39)	(-.13)	(-3.71)	(1.46)	(2.02)
Slope	16.75	17.00	26.22	14.26	16.34
	(12.58)	(7.54)	(9.17)	(7.92)	(18.96)
R^2	.74	.58	.72	.60	.86
SEF*	5.39	5.99	5.65	5.48	3.64
Kansas Hay (tons)					
Intercept	18.14	-7.87	-17.21	34.06	19.73
	(3.16)	(-.87)	(-1.34)	(5.05)	(3.71)
Slope	15.96	23.48	24.78	7.16	14.77
	(7.94)	(7.49)	(5.70)	(3.15)	(8.13)
R^2	.52	.58	.50	.19	.53
SEF*	8.15	8.32	8.59	6.93	7.69
Molasses (tons)					
Intercept	-37.69	-30.44	-1.97	-1.34	-1.86
	(-2.94)	(-1.21)	(-.07)	(-.10)	(-.18)
Slope	39.23	35.21	25.49	23.48	25.94
	(8.72)	(4.07)	(2.72)	(5.46)	(7.42)
R^2	.57	.29	.18	.41	.49
SEF*	18.23	22.96	18.53	13.09	14.77
Wheat Middlings (tons)					
Intercept	23.43	15.54	15.47	3.02	29.09
	(2.99)	(1.18)	(1.25)	(.28)	(4.64)
Slope	25.25	24.21	22.13	26.89	24.69
	(9.17)	(5.33)	(5.31)	(7.42)	(11.49)
R^2	.60	.41	.46	.57	.69
SEF*	11.15	12.05	8.24	11.03	9.08

t--statistics are in parentheses

The correspondence between feed prices and corn futures prices vary widely, with R^2 statistics ranging from .18 to .91. The results for sorghum show the best fits. The equations exhibit R^2 statistics above .80. The R^2 statistics for the barley and Nebraska hay equation are also relatively large.

Within each feed type, the R^2 statistics vary seasonally. For example, the R^2 for the July sorghum equation is the lowest of the five. Perhaps one contributing reason for the low figure is that sorghum is less susceptible to drought than is corn. If a drought occurs, corn futures prices fluctuate in response to the possibility of a reduced corn crop. Sorghum, being less affected by the weather, may not vary as much in price. Since corn futures prices may be relatively more volatile in that time period, the R^2 is lower.

However, because sorghum is a direct substitute for corn in many uses, its price is based on its total nutritional value, usually estimated to be 85 percent of the nutrition value of corn (Church 1977). This figure is consistent with the regression equations. Therefore, it can be argued prices should be proportionately as variable as corn prices. However, the corn futures prices are based on Chicago delivery points while sorghum prices are for Kansas City. Weather patterns could differ significantly in the upper Midwest and the sorghum growing region, which is further west. This would cause the basis between the two locales to be erratic, lowering the R^2.

The R^2 also drops for the July barley equation. The probable cause of this is the fact that corn and barley are planted at different times. Wet weather would help the barley yield, but delay corn planting, possibly reducing corn acreage. Conversely, dry weather could hurt barley yields, but could increase corn acreage. A second factor could be that barley is harvested in the West and Southwest during this period. The basis may vary as the barley price falls, in relative terms, during harvest. Therefore, volatile cash and futures patterns during this period should not be surprising.

The R^2 statistics for both hay equations are low in July and August (September contract). This is the harvest time of the third crop of hay in the Midwest. Supply for the following year is known so hay prices are relatively stable, but corn futures prices are volatile during this critical growth period due to weather patterns. Taken together, these factors may contribute to the lower R^2 statistics observed.

The May, July, and September equations for molasses and wheat middlings have low R^2 statistics compared to the two other contract periods. Both molasses and wheat middlings exhibit stable cash price patterns for long periods, but corn futures prices can vary greatly especially during the summer. Therefore, R^2 statistics for these equations are at their lowest during this season.

The size and frequency of variations around the estimated relationships provide a better index of the potential risks of using these estimates. The standard error of the forecast (SEF)[1] reflects the basis risk borne by the hedger for the particular feed and contract period. Assuming a normal distribution, approximately two-thirds of the variations from the expected cash price would be within ±1 SEF. If the market structure remains unchanged, one-third of the hedges would result in favorable basis results and one-third in unfavorable results within the estimated standard error if market relationships continue. Similarly, one-sixth of the hedges would result in cash prices that were unfavorable by more than the estimated standard error

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[1] $SEF = [(\text{Standard Deviation})^2(1+1/n) + X_o-\bar{x})^2(\text{Standard Error of bij})^2]^{1/2}$ In large samples, the SEF is approximately the root mean square error.

and one-sixth of the hedge results would have favorable "basis" results larger than the estimated standard error. The errors should balance out in the long run.

The equations for sorghum, barley, and Nebraska hay exhibit relatively small SEF while the ones for Kansas hay, molasses, and wheat middlings have higher SEF's. Each SEF is expressed in dollars per ton, hundredweight, or bushel as specified in Table 1.

Cross Hedging Examples

The following two examples will provide a clearer picture of how the results of this study can be used.

Example One

A feedlot has limited storage space and can only receive a maximum of 300 tons (6000 cwt.) of sorghum with each purchase. This amount will fulfill two months' requirements. In February, the feedlot manager grows concerned that sorghum prices may rise so he decides to lock in favorable prices for the next six months. To establish the price of the first purchase, which will fulfill March and April requirements, May corn futures contracts are used. Using the May sorghum equation, the manager can take the current May corn futures price, e.g. $3.00 per bushel, and calculate an expected sorghum price of $4.69 per hundredweight [.40+1.43(3.00)=4.69]. The manager should expect the actual price to be within 23 cents (SEF) per hundredweight of this price approximately two-thirds of the time. The number of contracts required for the hedge is calculated by multiplying the amount of sorghum, expressed in hundredweights, by the slope coefficient and then dividing by 5000 (bushels). In this case, the result is 1.716 contracts. By buying one contract (5,000 bushels) of May corn futures at $3.00 per bushel, the manager establishes the approximate price of $4.69 per hundredweight for 175 tons (3500 cwt.) of sorghum. This would leave 125 tons unhedged. Since the manager thinks that the likely price direction is upward, he probably will buy two corn futures contracts (in essence speculating on 30 percent of one contract) or use the Mid-America Exchange's mini-contracts to hedge the remaining 125 tons. As the purchase date approaches, the futures contract(s) should be sold and the sorghum bought when the basis is favorable. Table 4 summarizes this hedging example.

Table 4
Price Quotation and Hedging Worksheet

Dates	Contract	Quantity (cwt.)	Hedge Ratio	Equivalent Quantity (bushels)	Number of Contracts	Futures Price ($/bu.)	Cash Price Equiv. ($/cwt.)
Mar 1-Apr 30	May	6000	1.43	8580	1.716	3.00	4.69
May 1-Jun 30	July	6000	1.65	9900	1.98	2.80	4.35
Jul 1-Aug 31	Sept	6000	1.65	9900	1.98	2.75	4.42

Example Two

In January, a Nebraska farmer wishes to cross hedge his first cutting of hay since he will borrow funds in early March and wants to prove to the bank he will have a reliable cash flow. He will hedge two-thirds, 200 tons, of the expected crop since it is highly unlikely that the actual harvest will be below that level based on historical records. The first cutting of hay usually takes place in early June so a July contract should be used to hedge. Assuming the current July corn futures price is $3.00 per bushel, the expected Platte Valley of Nebraska hay price is $47.33 per ton [-31.33+26.22(3.00)=47.33]. Since the SEF is 5.65, the farmer's actual cash price can be expected to be within the price range of $41.68 to $52.98 per ton approximately two-thirds of the time. The hay can be hedged by selling one corn futures contract [26.22(200)/5000=1.05].

Summary

The objective of this analysis was to evaluate the possibility of cross hedging several feeds with corn futures. The relationships between cash and futures prices were estimated using simple econometric methods. The results show all these cross hedges meet the theoretical criteria set forth by Anderson and Danthine; that is, the correlation between cash and futures is a constant different from zero. However, the results also indicate that cross hedging sorghum would be by far the most promising. Persons cross hedging barley with corn futures also have some surety of success while cross hedging molasses, hay and wheat middlings is more risky.

The equations indicate that the futures position required to hedge each feed varies within the year. Therefore, using the same hedging ratio is not appropriate.

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