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SIMPLE AND MULTIPLE CROSS-HEDGING OF MILLFEEDS

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Introduction

Millfeeds (bran, middlings) are important by-products of the flour milling industry. On average, a hundredweight of wheat yields approximately 73 pounds of flour and 26 to 27 pounds of millfeeds. For marketing years 1978 through 1981, millfeed sales contributed an average of 14.9 percent of the total gross returns from milling in the Kansas City area (USDA). Millfeed price variability is comparable to variability of other livestock feed prices. For example, coefficients of variation for mid-month Kansas City millfeed prices, and mid-month corn and soybean meal futures nearest maturity between January 1972 and December 1982 were 24, 24, and 27, respectively.

Millfeed price variability is a source of risk for flour millers. Flour milling is an intensely competitive industry, characterized by relatively narrow milling margins. It is common practice for millers to book sales of flour for deferred shipment; unexpected decreases in millfeed prices between booking and milling can seriously erode milling margins if the millfeeds are not forward priced. Allowing for this risk in pricing forward sales of flour may result in a loss of bookings if competitors are less conservative in their estimates of subsequent millfeed prices. Although millfeeds could once be directly hedged using millfeed futures at the Kansas City Board of Trade and the St. Louis Merchants Exchange, trading in these contracts ceased in the late 1950s and early 1960s.[1] In the absence of futures markets for millfeeds, flour millers are faced with a problem if they desire to forward price their millfeeds. One alternative is to forward contract with feed mixers who use millfeeds as ingredients or with other feed users. However, millers may find that their opportunities for forward contracting without making substantial price concessions are limited.

Another alternative for flour millers is to cross-hedge their millfeeds using futures markets for other commodities. Hieronymus (1977) has pointed out that millers may forward price their millfeed production by using either corn, oat, or soybean meal futures as cross-hedging vehicles. However, no empirical evidence as to the potential effectiveness of such cross-hedges has been offered. Contacts with trade sources indicate varying perceptions of cross-hedging effectiveness. Some millers are not aware of cross-hedging opportunities, while others employ sophisticated multiple cross-hedging strategies. The objective of this paper is to examine the potential for both simple and multiple cross-hedging of millfeeds. Subsequent sections provide a discussion of cross-hedging mechanics, an analysis of simulated cross-hedges of millfeeds, and conclusions.

Cross Hedging Mechanics

Cross-hedging may be used as a risk management tool when direct hedging is not feasible. By definition, cross-hedging is the hedging of cash commodity positions by using futures markets for different commodities (Hieronymus, 1977). Cross-hedging also may be thought of as the use of futures for hedging cash commodities not directly deliverable under the terms of the futures contracts used. Thus, cross-hedging also accounts for locational and quality differences between the cash and futures commodities. In its simple form, cross-hedging involves using the futures of only one commodity to offset a cash commodity position.

Multiple cross-hedging involves the offsetting of a cash commodity position by using the futures of two or more different commodities. While direct hedging involves speculation in cash and futures price relationships for the same commodity, cross-hedging involves speculation in the relationship between cash and futures prices for different commodities. Like direct hedging, cross-hedging replaces absolute price risks with relative, or basis, price risks.

Although a theoretical treatment of cross-hedging has been provided by Anderson and Danthine (1981), there is only limited empirical evidence regarding the feasibility of using cross hedging as a risk management tool. Previous studies have dealt with the simple cross-hedging of wholesale beef cuts with live cattle futures (Miller, 1980; Miller and Luke, 1982; Hayenga and DiPietre, 1982b), and wholesale pork cuts with live hog futures (Hayenga and DiPietre, 1981a). The feasibility of multiple cross-hedging has been considered for the case of distillers dried grains with corn and soybean meal futures (Miller, 1982a). Miller (1982b) found that cross-hedging of feeder pigs with both live hog and corn futures was more effective than the use of only live hog futures.

Cross-hedging is more complicated than direct hedging on several counts. First, the appropriate futures commodity or commodities to be used for cross-hedging must be selected. The cash and futures commodities may be substitutes, complements, or some combination thereof. Also, the cash and futures may be associated as inputs and/or outputs of a production or marketing process. Partial correlations of the cash commodity price and a particular futures commodity price given other futures commodity prices, may be used to evaluate the potential usefulness of particular futures commodities as cross-hedging media (Anderson and Danthine, 1981)

After selection of the appropriate futures for cross-hedging, the amount of futures required to offset a cash position must be estimated. This is accomplished by estimation of the historic relationship between cash and futures prices in a regression framework. Let the estimated regression be represented as follows

$$\widehat{CP}_t = b_o + \sum_{i=1}^{k} b_i \, FP_{i,t}^{t} \qquad (1)$$

where $\widehat{CP}_t$ equals the per unit predicted cash price at time t; $FP_{i,t}^{t}$ equals the per unit price at time t of the ith futures commodity contract nearest maturity at time t, with the second subscript indicating the time at which price is measured and the superscript indicating the time of maturity of the futures contract; and $b_0, b_1, \ldots b_k$ are estimated parameters. Seasonal differences in the price relationship may be accounted for by including seasonal intercept and/or slope shifters as additional regressors, as appropriate. The estimated regression coefficient for the ith per unit futures price, b_i, indicates the units of the ith futures required to offset one unit of the cash commodity. The estimated coefficients typically will be positive. With a positive estimated coefficient, a short cross-hedge would involve selling the associated futures, and a long cross-hedge would involve buying the associated futures. However, negative estimated coefficients may be encountered.[2] With a negative estimated coefficient, a short cross-hedge would involve buying the associated futures, and a long cross-hedge would involve selling the associated futures. The indivisible nature of futures contracts complicates multiple cross-hedging. If QF_i is the quantity contract specification of the ith futures, only by chance would $(QF_1/b_1) = (QF_2/b_2) = \ldots = (QF_k/b_k)$. Thus, different contract multiples of the k futures would likely be required to obtain an approximate "balance" with the quantity of the cash commodity to be cross-hedged.

Target prices for cross-hedges to be lifted at time t+j (the date of cash millfeed sales) are calculated at time t by inserting the current prices of the futures maturing nearest to, but not before, time t+j into the estimated regression and solving for the predicted cash price. The target price may then be adjusted to reflect estimated hedging costs (round turn commissions and interest on margin). The target price equation for a short cross-hedge may be represented as follows

$$TP_t^{t+j} = b_0 + \sum_{i=1}^{k} b_i \, FP_{i,t}^{t+j} - \sum_{i=1}^{k} |b_i| \widehat{HC}_i \qquad (2)$$

where TP_t^{t+j} equals the per unit target cash price for time t+j as calculated at time t; $FP_{i,t}^{t+j}$ equals the per unit price at time t of the ith futures maturing at time t+j; and $\widehat{HC}_i$ equals the estimated per unit hedging costs for the ith futures commodity.[3]

The net price from a short cross-hedge is given by the actual price of the cash commodity at time t+j when the cross-hedge is lifted plus the gain from futures, less actual hedging costs; i.e.

$$NP_{t+j} = CP_{t+j} + \sum_{i=1}^{k} b_i \, (FP_{i,t}^{t+j} - FP_{i,t+j}^{t+j}) - \sum_{i=1}^{k} |b_i| HC_i \qquad (3)$$

where NP_{t+j} equals the per unit net price of the cash commodity at time t+j; CP_{t+j} equals the per unit price of the cash commodity at time t+j; and HC_i equals the actual per unit hedging costs for the ith futures commodity. Conversely, the net price from a long cross-hedge is the actual price of the cash commodity at time t+j less futures gains plus actual hedging costs.

If the regression relationship between cash and futures prices holds exactly at time t+j, then

$$CP_{t+j} = b_o + \sum_{i=1}^{k} b_i \, FP_{i,t+j}^{t+j} \, . \tag{4}$$

If hedging costs are estimated correctly ($\widehat{HC}_i = HC_i$), and Equation (4) holds, the net price from cross-hedging will equal the cross-hedging target price.

If the regression relationship does not hold exactly, or the hedging cost estimate is incorrect, the target and net prices will differ. Since the relationship between the cash and futures prices is not deterministic, the target and net prices will only rarely be exactly equal. That is, a basis risk remains. This basis risk is analagous to that encountered in direct hedging since the basis when the direct hedge is lifted is not known with certainty at the time the direct hedge is placed. A means of evaluating cross-hedging as a risk management tool is to examine the basis risk, or the degree to which the target and net prices differ. If the target prices are not "good predictors" of subsequent net prices, cross-hedging may not be acceptable as a risk management tool.

Cross-Hedging Simulation

In this section, the results of simulated simple and multiple cross-hedges of millfeeds are compared. It was assumed that millfeed sales were made at mid-month. Kansas City millfeed prices ($/ton) at mid-month, as reported by the Agricultural Marketing Service, were used as the millfeed prices.[4] The futures for oats, corn, soybean meal, and wheat were considered as cross-hedging vehicles. As noted above, Hieronymus (1977) has suggested the use of oats, corn, and soybean meal for this purpose. Although wheat is mainly a food grain, it is also used as a livestock feed. The futures prices were those at closing on the trading day nearest the 15th of the month. January 1972 was chosen as the first observation in estimating cross-hedging levels, with the initial sampling interval for estimation containing 48 monthly observations. The regressions used to determine cross-hedging levels were reestimated each month in the simulation using data available at that month. Monthly intercept shifters (with January as the base period) were included as regressors to account for seasonal differences in the regression relationships between millfeed and futures prices.[5] Eighty-two cross-hedges were simulated for each futures used as a cross-hedging vehicle, with the final cross-hedges being lifted in December 1982. Although alternative cross-hedging horizons from one to twelve months were simulated, only the results of the cross-hedges of three month's duration ($j = 3$) are reported here. However, the results for other horizons were similar.

The results of the simulated cross-hedges are summarized in Table 1. Simulation number 1 indicates the results of only cash sales and serves as a base against which alternative cross-hedging strategies may be compared. The average forecast errors (AFE) may be used to determine whether target prices are biased forecasts of subsequent net prices. The root mean-squared forecast errors (RMSFE) may be used to measure the risks associated with the divergence of realized net and target prices. Root mean squared forecast errors which are smaller than the standard error of cash millfeed prices indicate less risks are associated with cross-hedging than without. Simple cross-hedging results are summarized in Table 1 as simulation numbers 2 through 5. The AFE's of target prices as forecasts of subsequent net prices ranged from 2.6 to 5.7 percent of mean net prices. Only the AFE for corn was not significantly different from zero.[6] While all of the simple cross-hedging simulations yielded RMSFE's which were smaller than the standard error of cash millfeed prices, the RMSFE was smallest when corn futures were used. Although there are no published data on the extent of simple millfeed cross-hedging, informal contacts with trade sources indicate that corn is the predominant futures used for that purpose. The results presented here support the conventional wisdom that corn futures are appropriate for the simple cross-hedging of millfeeds.

Examination of the multiple cross-hedging results (simulation numbers 6 through 16) indicates that multiple cross hedging can be more effective than simple cross-hedging using only corn futures.[7] The use of either corn and soybean meal futures (simulation number 8); corn, oat, and soybean meal futures (simulation number 13); corn, wheat, and soybean meal futures (simulation number 14); or corn, oat, wheat, and soybean meal futures (simulation number 16) produced lower absolute AFE's and RMSFE's than did use of only corn futures. In other words, basis risks can be reduced by using multiple rather than simple cross-hedging. Although the differences in AFE's and RMSFE's between simulation numbers 8, 13, 14, and 16 were minor, the use of corn and soybean meal futures (simulation number 8) yielded the lowest RMSFE and next to the smallest absolute AFE.

The use of only corn and soybean meal futures would also simplify the problem of "balancing" futures contract multiples. Corn futures quantities are 1000 and 5000 bushels on the Mid-American Commodity Exchange (MCE) and the Chicago Board of Trade (CBT), respectively; the soybean meal futures quantity is 100 tons on the CBT. Using the mean cross-hedging levels from simulation number 8, these contracts would be sufficient to cross-hedge millfeed quantities as follows: MCE corn--46 tons, CBT corn--231 tons, and CBT soybean meal--1000 tons. Four CBT corn contracts, two MCE contracts, and one CBT soybean meal contract would be sufficient to cross-hedge approximately 1000 tons of millfeed. This would represent the approximate eight-day output of a "typical" flour mill with capacity of 7000 cwt of flour per day. Regulatory approval of a 20-ton soybean meal contract proposed by the MCE would permit multiple cross-hedging of smaller millfeed quantities. One MCE soybean meal contract and four MCE corn contracts would allow the cross-hedging of approximately 200 tons of millfeeds.

Although there were no significant differences in the mean net prices across simulations, the mean net prices from cross-hedging were generally higher than the mean net price from cash sales only. This runs counter to expectations since the costs incurred in cross-hedging reduce mean net prices in simulation numbers 2 through 16. There were no significant differences in variances of net prices between simulations. This result is in agreement with Tomek and Gray (1970) who have shown that for grains, distant futures prices are just as variable as nearby futures.

The target price equations (estimated with data from January 1972 through December 1982) for the simple (corn) and multiple (corn and soybean meal) cross-hedging alternatives with the smallest RMSFE's are displayed in Table II.[8] To illustrate the use of this table, suppose that in May a miller contemplates sales of millfeeds in Kansas City the following mid-August. Further assume that in May, September corn futures are trading at $2.81/bushel and August soybean meal futures are trading at $192.00. The target price for a simple cross-hedge would be the August intercept (17.02) plus the product of the corn futures coefficient and corn futures price (24.10 x 2.81 = 67.72) less hedging costs (0.24) or $84.50/ton. The target price for a multiple cross-hedge would be the August intercept (5.65), plus the product of the corn futures coefficient and corn futures price (21.18 x 2.81 = 59.52) plus the product of the soybean meal futures coefficient and soybean meal futures price (0.11 x 192 = 21.12) less corn hedging costs (0.21) and soybean meal hedging costs (0.06) or $86.02/ton. In this example, the multiple cross hedge offers the highest target price; however, this need not always be the case. In cases in which the simple cross hedge offers a higher target price, the higher target price would have to be weighed against the higher basis risks associated with simple cross-hedging.[9]

Conclusions

The objective of this paper was to evaluate the feasibility of cross-hedging wheat millfeed sales. Results of simulated millfeed cross-hedges indicate that corn futures are appropriate for simple cross-hedges. Given an acceptable target price, millers would face less risks from divergent net and target prices with simple cross-hedging using corn futures than without. However, risks associated with cross-hedging are reduced by using both corn and soybean meal futures to forward price millfeeds. That is, the risks associated with not realizing target prices are smaller for multiple cross-hedging using corn and soybean meal futures than for simple cross-hedging using only corn futures.

Table I. Summary of Simulated Kansas City Millfeed Cross-Hedges

Simulation Number	Mean Cross Hedging Levels				Target Price Forecasts[a,b]		Net Price[a]	
	Corn	Oats	Wheat	Soybean Meal	AFE	RMSFE	Mean	Standard Error
	----------bushels--------			tons	--------------$/ton------------------			
1	--	--	--	--	--	--	87.36	16.82
2	23.46	--	--	--	2.24	12.22	89.34	16.49
3	--	40.45	--	--	-4.17	15.55	87.78	16.59
4	--	--	12.81	--	4.96	15.22	88.99	17.41
5	--	--	--	0.17	3.50	15.12	87.99	15.91
6	21.78	3.39	--	--	2.56	13.20	89.70	16.32
7	21.72	--	1.33	--	2.57	12.53	89.57	16.49
8	21.60	--	--	0.10	0.14	11.01	89.44	16.42
9	--	27.33	6.79	--	-1.22	13.85	88.80	16.51
10	--	37.19	--	0.12	-6.07	14.95	87.92	16.93
11	--	--	11.64	0.12	2.42	13.05	89.30	16.95
12	17.16	6.83	2.26	--	2.17	13.31	89.69	16.33
13	19.37	4.75	--	0.10	-0.04	11.27	89.70	16.38
14	20.01	--	1.21	0.10	0.31	11.11	89.59	16.39
15	--	25.91	6.02	0.11	-3.61	12.59	88.72	16.72
16	15.00	8.00	2.15	0.10	-0.36	11.35	89.68	16.39

a. Target and net prices for simulation numbers 2-16 are inclusive of assumed hedging costs (round turn commissions and interest on margin accounts) of $0.01/bu for corn, oats, and wheat, and $0.50/ton for soybean meal, as appropriate.

b. AFE = average forecast error, or the average difference between net and target prices; RMSFE = root mean-squared forecast error, or the root of the mean of the squared differences between net and target prices.

Table II. Kansas City Millfeed Target Prices Equations for Simple Cross-Hedging Using Corn Futures and Multiple Cross-Hedging Using Corn and Soybean Meal Futures[a]

	Equation	
	Simple Cross-Hedging	Multiple Cross-Hedging
Intercepts		
January	26.86	16.07
February	18.44	7.57
March	20.66	9.51
April	15.23	3.43
May	10.13	-2.21
June	16.29	3.47
July	9.72	-2.12
August	17.02	5.65
September	21.15	10.75
October	26.40	15.89
November	33.31	21.82
December	34.66	22.66
Futures		
Corn	24.10	21.18
	(1.57)[b]	(1.51)
Soybean Meal	--	0.11
	--	(0.02)
Hedging Costs		
Corn	0.24	0.21
Soybean Meal	--	0.06

a. Equations are estimated using mid-month data from January 1972 through December 1982.

b. Standard errors of futures coefficients are shown in parentheses.

Footnotes

1. Gray (1966) has attributed the demise of these markets to a lack of speculative interest.

2. For an example, see Miller (1982b).

3. The target price for a long cross-hedge is calculated as in Equation (2) except that estimated hedging costs are added rather than subtracted.

4. The Agricultural Marketing Service reports identical bran and middling prices for the Kansas City market.

5. The results of simulations in which monthly slope shifters (with January as the base period) were also included as regressors did not differ appreciably from those reported below.

6. Statements as to statistical significance here and below are based on appropriate F and t tests using 5% significance levels.

7. The only AFE's significantly different from zero among the multiple cross-hedging simulations were those for numbers 10 and 15.

8. There were no indications that the regression coefficients for either corn, or corn and soybean futures changed over time under these cross-hedging alternatives. Note the similarity between the futures coefficients for these cross-hedging alternatives in Tables I and II.

9. Readers are cautioned that the equations reported in Table II should only be used to calculate millfeed target prices for Kansas City sales made at mid-month. Other millfeed marketing patterns would require estimation of equations with data reflecting those patterns.

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