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Cross-Hedging Cottonseed Meal

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This study examines the feasibility of cross-hedging cottonseed meal with soybean meal futures. A simple linear regression of cottonseed meal cash prices on soybean meal futures provides a direct price movement relationship. Using the estimated hedge ratios, the net realized prices are calculated for seven different cash markets. The net realized prices are higher than cash prices in three of the four years evaluated. The empirical analyses suggest soybean meal futures can be used as a potential cross-hedging vehicle for cash cottonseed meal.

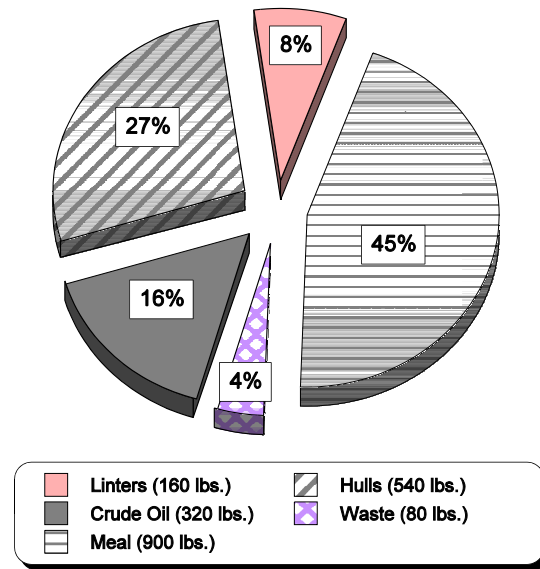
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Cotton produces approximately 155 pounds of cottonseed with each 100 pounds of fiber. At present production levels, the national average is around 990 pounds of cottonseed produced per acre of cotton grown [National Cottonseed Products Association (NCPA), 1999]. According to NCPA data, in recent years, industrywide yields of products per ton of cottonseed have averaged about 320 pounds of oil, 900 pounds of meal, 540 pounds of hulls, and 160 pounds of linters, with a manufacturing loss of 80 pounds waste per ton. A piechart illustrating cottonseed products' yield per ton of seed crushed is presented in figure 1.

Of the four primary products produced by cottonseed processing plants, meal is the second most valuable, after oil. Used principally as feed for livestock, cottonseed meal usually is sold at a 41% protein level (NCPA, 1999). Its major value is as a protein concentrate. In addition to its high protein content and high energy value, cottonseed meal is higher in phosphorous than any of the other vegetable proteins. It is also an excellent organic source of nitrogen, potash, and many minor plant food elements. However, cottonseed meal enters highly competitive markets, encountering a large degree of competition from other protein concentrates such as soybean, peanut, and sunflower meals.

Cottonseed crushers face substantial risk similar to other feed ingredients processors in terms of input and commodity price variability. They are limited in their planning because no viable futures market currently exists for cottonseed products.

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Source: National Cottonseed Products Association (1999)

Figure 1. Cottonseed products' yield per ton of seed crushed

The central hypothesis of this study is that even though there is no active futures market for cottonseed meal, processors can reduce price risk through cross-hedging cash cottonseed meal with soybean meal, a commodity having an established futures market. It is hypothesized that the relationship between cash cottonseed meal prices and soybean meal futures prices is strong enough for cross-hedging to be executed. Finally, we hypothesize net realized prices from cross-hedging will be higher than cash prices.

By definition, cross-hedging is the pricing of a cash commodity position by using futures for different commodities. Simple cross-hedging uses futures of one commodity to offset a cash position, and multiple cross-hedging uses two or more different commodities. However, cross-hedging is more complicated than direct hedging. Difficulties arise in selecting the appropriate futures contracts as cross-hedging vehicles and determining the size of the futures position to be established. Potential cross-hedging vehicles must be commodities that are likely to demonstrate a strong direct or inverse price relationship to the cash commodity.

This analysis is concerned only with simple cross-hedging. We selected soybean meal as a cross-hedging vehicle because it is a close substitute and is thought to be influenced by many of the same demand factors as cottonseed meal since both are used primarily as livestock feed.

The cross-hedging analysis developed in this study is composed of three sections. First, an analytical framework using previous approaches is presented to justify the selected model. Second, separate regressions are computed to estimate the relation-

ship between cash cottonseed meal and soybean meal futures. Finally, the regression results are applied to evaluate a cross-hedging marketing strategy for cottonseed meal.

Review of Selected Literature

Through a review of selected literature on cross-hedging, some valuable theoretical and empirical considerations are examined in this section.

An extensive theoretical description of cross-hedging for a commodity for which no futures contract exists is provided by Anderson and Danthine (1981). Assuming a nonstochastic production process (no yield risk), Anderson and Danthine considered the problem of hedging in a single futures market but with many possible trading dates. Their cross-hedging model employed a mean-variance framework to derive an optimal hedging strategy assuming the agent has knowledge of the relevant moments of the probability distribution of prices.

Kahl (1983) illustrated the derivation of optimal hedging ratios under different assumptions about the cash position. She argued that when the futures and cash positions are endogenous, the optimal hedging ratio is independent of risk aversion. Comparing the studies of Heifner (1972, 1973) to that of Telser (1955–56), Kahl concluded the optimal hedging ratio is not dependent on the risk parameter.

Hayenga and DiPietre (1982) employed the following basic model to cross-hedge a variety of wholesale pork products using live hog futures contracts:

$$(1) \quad CP_{ij} = a_{ij} + b_{ij}FP_{ij} + u_{ij},$$

where CP_{ij} is the average cash price of the j th wholesale pork product during contract period i each year, FP_{ij} is the average closing price of the nearby live hog futures contract during contract period i each year, and u_{ij} is the error term.

Wilson (1987) found the optimal hedge ratios obtained from minimizing the variance of revenue were equivalent to parameters estimated from ordinary least squares (OLS) regression of cash price changes on future price changes. In the single market case, the equation was specified as:

$$(2) \quad \Delta P_1^c = \gamma_0 + \beta_1 \Delta P_1^f + \varepsilon,$$

where β_1 represents the optimal hedge ratio and γ_0 represents the intercept term.

Dahlgran (2000) presented a cross-hedging consulting study performed for a cottonseed crusher. Applying a soybean crushing spread in a cross-hedging context with a portfolio risk-minimization objective, he developed the desired hedge ratios for a variety of cross-hedging portfolios and for several hedge horizons. Risk-minimizing hedge ratios were derived by regressing changes in prices for cottonseed, cottonseed hulls, cottonseed meal, and cottonseed oil against changes in prices of potential hedge vehicles, such as the following: futures contracts for the soybean complex; futures contracts for feed grains; U.S. wheat futures contracts; futures contracts for cotton, the dollar index, and the Japanese yen; and Canadian futures

contracts for flaxseed, rapeseed, oats, and wheat. Dahlgran reported effectiveness increased the longer the term of the hedge. Based on his observations, the economics of hedge management may be as important as the underlying risk aversion in determining hedging behavior.¹

Linear Regression Model for Cross-Hedging

The basic linear regression model to be estimated is adapted from the model developed by Hayenga and DiPietro (1982) in their analysis of cross-hedging wholesale pork products using live hog futures. The OLS model for cottonseed meal cash prices and soybean meal futures prices is written as:

$$(3) \quad CMCP_w = \beta_0 + \beta_1 SMFP_w + u_w,$$

where $CMCP_w$ is the Wednesday price of cottonseed meal in the cash markets, $SMFP_w$ is the Wednesday price of soybean meal contracts on the Chicago Board of Trade (CBOT), β_0 is the intercept term, and u_w is the stochastic disturbance.

The above regression equation is used to identify the relationship between cottonseed meal cash price and soybean meal futures. $SMFP_w$ is the independent variable, since the initial futures market price is predetermined in hedging and the corresponding cash cottonseed meal price is to be estimated. The intercept term β_0 reflects the mean difference between the soybean meal futures prices and cottonseed meal cash prices. It identifies any spatial and temporal market dimensions or any qualitative variations. The slope coefficient β_1 indicates the typical cash price change associated with a one dollar change in the futures. It provides the hedge ratio to determine the size of the futures position to be taken for a given amount of cash position held. A positive slope denotes a direct price relationship and calls for the usual inventory selling hedge. A negative slope would indicate an inverse price relationship and call for a buying hedge.

Following Dorfman (1993), Bayesian tests for stationarity were performed on all cash and futures prices. Nonstationarity was soundly rejected. For further details of the Bayesian test procedure, refer to Rahman (2000).

The data used in this analysis were constructed from two sources. The cash cottonseed meal price data for seven markets—Atlanta, Chicago, Fort Worth, Kansas City, Los Angeles, Memphis, and San Francisco—were obtained from various weekly issues of *Feedstuffs*. The weekly observations were Wednesday prices from July 17, 1996 through November 1, 2000. The soybean meal futures price data were obtained from the CBOT. The weekly futures prices were also the Wednesday closing prices for the same time period and were always for the contract nearest to maturity. Observations from September 22, 1999 through November 1, 2000 were separated for out-of-sample evaluation.

¹ Important differences should be noted between the Dahlgran (2000) study and our study: (a) our approach considers a single purpose whereas Dahlgran focuses on multiple purposes, and (b) the simplicity of the approach here contrasts with Dahlgran's more complex analysis.

Table 1. Estimated Parameters for Cross-Hedging Cottonseed Meal Cash Prices with Soybean Meal Futures Prices

Variable	Market City						
	Atlanta	Chicago	Fort Worth	Kansas City	Los Angeles	Memphis	San Francisco
β_0	23.34 (4.76)	54.22 (4.42)	47.16 (4.88)	47.75 (4.65)	63.59 (3.99)	25.07 (5.35)	54.99 (4.51)
β_1	0.654 (0.024)	0.650 (0.022)	0.602 (0.024)	0.624 (0.023)	0.645 (0.019)	0.649 (0.026)	0.636 (0.022)
R^2	0.8421	0.8457	0.8043	0.8246	0.8904	0.7968	0.8570
F -Value	383.95	444.94	324.78	376.18	548.25	309.74	422.63
n	147	163	161	163	138	161	144

Notes: Numbers in parentheses are standard errors. All estimates are significant at 1%.

Empirical Results

Seven separate regressions of cash cottonseed meal prices were run on the soybean meal futures prices using the data and employing the OLS model defined above. Parameter estimates are presented in table 1. All estimated slope coefficients have values greater than 0.60 (with t -values significantly different from zero in all equations). These findings suggest that the movements in soybean meal futures prices can explain movements in the cash cottonseed meal prices. R^2 s are around 0.80 in each case, indicating 80% of the variation in cottonseed meal cash price about its mean is explained by soybean meal futures. Calculated F -values are found to be greater than the corresponding critical values. Therefore, it can be concluded that the variation in cash prices accounted for by the estimated regression is significant. Based on these empirical results, soybean meal futures can be used as a cross-hedging vehicle for cottonseed meal.

An Application of Cross-Hedging Cottonseed Meal

Since cottonseed production depends on cotton production, cottonseed meal crushers must base their marketing decisions on expected yields. In the planting period for cotton, cottonseed meal producers would know the acreage committed and have an expectation of total cottonseed production. Cotton is typically planted throughout March and early April, and harvested in October–November. Thus, by the end of May, an estimated amount of production would be known to the cottonseed meal producer. To protect from fluctuation of cottonseed meal prices, the producer would like to place cross-hedges around May–June. As the cotton growing season progresses, yields may be estimated with greater accuracy.

In the scenario used here, we assume it is the end of May 1997. A cottonseed meal producer in Georgia would have the information about the acreage committed to cotton, and his expected production of cottonseed meal is 1,000 tons. On May 28, 1997, cottonseed meal is trading at the price of \$197 per ton in Atlanta. The producer expects cottonseed meal prices to be much lower by the end of October 1997. To protect himself against the falling price, the cottonseed meal crusher decides to cross-hedge using soybean meal futures. The May 28 soybean meal futures closing price is \$280.30 per ton (CBOT; 1 contract = 100 tons of soybean meal). The producer decides to place the cross-hedge on May 28, 1997. To place the cross-hedge, he needs to determine the number of soybean meal futures contracts necessary to offset 1,000 tons of cottonseed meal. Using the hedge ratio for Atlanta, the producer calculates he should sell seven contracts ($1,000/100 \times 0.65 = 6.5$, i.e., approximately seven contracts) at the CBOT.

On October 29, cottonseed meal cash price has dropped to \$175 per ton—a decrease of \$22 per ton from the \$197/ton price on May 28. Assume the producer sells all of his cottonseed meal in Atlanta at \$175 per ton, receiving a total of \$175,000. At the same time, he lifts the cross-hedge by buying seven contracts of soybean meal futures at the CBOT. The October 29 soybean meal closing price is \$222.60 per ton. Thus, the futures transactions result in a gain of \$57.70 per ton of soybean meal. The total gain from the futures transactions is \$40,390 ($\$57.70 \times 100 \times 7$). The net return is then \$215,390 ($\$175,000 + \$40,390$), which is \$215.39 per ton of cottonseed meal. The net realized price has exceeded the May 21, 1997 cash price by \$18.39 per ton. Table 2 summarizes the cross-hedging presented in this example.

A similar example of cross-hedging is presented in table 3 for the same producer in Georgia using 1998 May and October cash cottonseed meal and soybean meal futures prices. On May 20, 1998, the producer places the cross-hedge, selling seven soybean meal futures contracts at \$156.30 per ton. On October 28, he sells all of his cottonseed meal in Atlanta at \$99 per ton. On the same day, he lifts the cross-hedge by buying seven soybean meal futures contracts at \$141.10 per ton. The futures transactions result in a profit of \$15.20 per ton. The net realized price (\$109.64/ton) exceeds the cash price at the time of placing the cross-hedge by \$12.64 per ton. Notice that the cash price has also increased against the expectation of the producer. However, in routine hedging, potential gains in the cash market are given up as a tradeoff for protection from declining price levels.

The same test procedure is carried out using the corresponding hedge ratios for the seven selected cottonseed meal cash markets for 1997 and 1998 (in-sample analysis) and for 1999 and 2000 (out-of-sample analysis). Cash sale prices and the net realized prices from cross-hedging are reported in table 4. In three of the four years (1997, 1998, and 2000), the futures transactions result in profits. However, this is not always the case. If soybean meal futures prices rise prior to the cotton harvest period, as illustrated in 1999, cross-hedging may result in losses. Soybean meal futures prices started rising from the beginning of August 1999 (\$145.60 per ton) and were much higher than the price at the time of placing cross-hedges (May 1999 soybean futures prices were around \$130 per ton). The result for 1999 in all

Table 2. Simple Cross-Hedging Example of Cottonseed Meal Using Soybean Futures (1997)

Date	Cash	Futures
May 28, 1997	\$197/ton	Short 7 soybean meal futures contracts @ \$280.30/ton
October 29, 1997	Sell 1,000 tons of cottonseed meal @ \$175/ton	Long 7 soybean meal futures contracts @ \$222.60/ton
Gain = \$57.70/ton		
Revenue from selling 1,000 tons of cash cottonseed meal = $175 \times 1,000 = \$175,000$		
Profits from futures transactions = $57.70 \times 100 \times 7 = \$40,390$		
Total revenue = $\$175,000 + \$40,390 = \$215,390$		
Net realized price = $\$215,390/1,000 = \$215.39/\text{ton}$		

Table 3. Simple Cross-Hedging Example of Cottonseed Meal Using Soybean Futures (1998)

Date	Cash	Futures
May 20, 1998	\$97/ton	Short 7 soybean meal futures contracts @ \$156.30/ton
October 28, 1998	Sell 1,000 tons of cottonseed meal @ \$99/ton	Long 7 soybean meal futures contracts @ \$141.10/ton
Gain = \$15.20/ton		
Revenue from selling 1,000 tons of cash cottonseed meal = $99 \times 1,000 = \$99,000$		
Profits from futures transactions = $15.20 \times 100 \times 7 = \$10,640$		
Total revenue = $\$99,000 + \$10,640 = \$109,640$		
Net realized price = $\$109,640/1,000 = \$109.64/\text{ton}$		

Table 4. Comparison of Cash Prices (CP) and Net Realized Prices (NRP), by Seven Market Cities, 1997–2000 (\$)

Market City	1997		1998		1999		2000	
	CP	NRP	CP	NRP	CP	NRP	CP	NRP
Atlanta	175.00	215.39	99.00	109.64	120.00	111.11	145.00	151.86
Chicago	230.00	270.39	135.00	145.64	145.00	136.11	180.00	186.86
Fort Worth	280.30	314.92	124.00	133.12	130.00	121.11	170.00	176.86
Kansas City	210.25	244.87	120.50	129.62	130.75	121.86	167.25	174.11
Los Angeles	239.00	273.62	140.00	149.12	133.00	124.11	142.00	148.86
Memphis	192.50	232.89	107.50	118.14	110.00	101.11	142.50	149.36
San Francisco	227.00	261.62	137.00	146.12	125.00	116.11	142.00	148.86

cottonseed markets was lower net realized prices than cash. In 2000, net realized prices were again higher than cash prices. Thus, for the four years observed, cross-hedging cash cottonseed meal with soybean meal futures was profitable 75% of the time.

Summary and Conclusions

The general objective of this study was to explore the feasibility of cross-hedging cash cottonseed meal with soybean meal futures. The cash-futures price relationships were determined to be statistically significant by regressing cottonseed meal cash prices on soybean meal futures. The cash cottonseed meal prices and soybean meal futures demonstrate a direct price movement relationship. Examples of cross-hedging using the estimated hedge ratios were presented. Findings show the net realized prices from cross-hedging are generally higher than cash prices. Thus, the results confirm our central hypothesis that simple cross-hedging using soybean meal futures is effective as a potential pricing alternative for cottonseed meal producers.

Finally, this study provides an alternative marketing strategy for cottonseed meal which improves profitability of cottonseed crushing. In the absence of a futures market for cottonseed meal, our empirical findings indicate soybean meal futures can be used effectively as a cross-hedging to lower the price risk. Nevertheless, further studies on the distribution of prices and hedging efficiency are required for the justification of cross-hedging.

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