FS 00-12 July 2000

CROSS-HEDGING COTTONSEED MEAL

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ABSTRACT

This study examines the feasibility of cross-hedging cottonseed meal with soybean meal futures. The Bayesian tests for market efficiency on the cash and futures price data soundly rejects the presence of nonstationary root. The 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 exhibit risk efficiency superior to cash pricing. The empirical analyses suggest that soybean meal futures can be used as a potential cross-hedging vehicle for cottonseed meal.

Key words: soybean meal, cottonseed meal, cross-hedging, bayesian.

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I. INTRODUCTION

With each hundred pounds of fiber, the cotton plant produces approximately 155 pounds of cottonseed. At present production levels the national average is around 990 pounds of cottonseed produced per acre of cotton grown (National Cottonseed Products Association, NCPA). In recent years, industry-wide 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 manufacturing loss of 80 pounds per ton (NCPA). Cottonseed products yield per ton of seed crushed is shown in fig.1.

Of the four primary products produced by cottonseed processing plants, meal is the second most valuable product. Cottonseed meal is used principally as feed for livestock and is usually sold at a 41 percent protein level (NCPA). 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, phosphorous, potash, and many minor plant food elements. However, cottonseed meal enters markets that are highly competitive. It encounters a large degree of competition from other protein concentrates like soybean, peanut, and sunflower meals.

Cottonseed crushers face a 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. 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. Additionally, it is hypothesized that the relationship between cash cottonseed meal prices and the soybean meal future prices is strong enough such that cross-hedging can be executed. The final hypothesis is that net realized prices from cross-hedging will exhibit risk efficiency superior to cash pricing.

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 the 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. Soybean meal is selected as a cross-hedging vehicle for this analysis because it is a close substitute and is thought to be influenced by many of the same supply and demand factors as cottonseed meal since both are primarily used as livestock feed.

The cross-hedging analys presented in this study is composed of four major procedures. First, an analytical framework is presented to justify the selected model. Second, the Bayesian tests for nonstationarity are performed on all cash and futures prices. Third, separate regressions are computed to estimate the relationship between cash cottonseed meal and soybean meal futures. Finally, the regression results are applied to evaluate a cross-hedging marketing strategy for cottonseed meal.

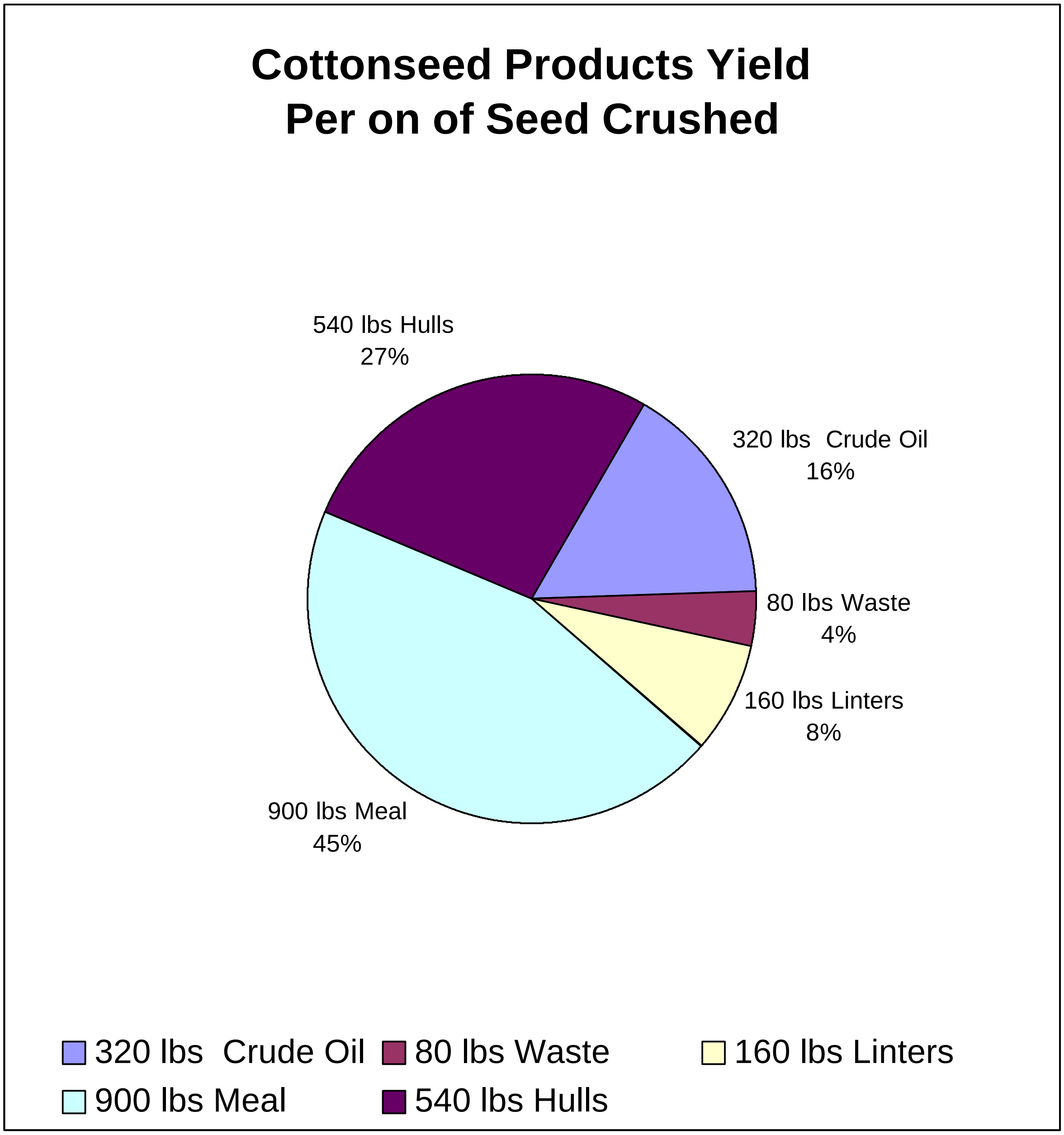

Figure 1. Cottonseed products yield per ton of seed crushed.
Source: National Cottonseed Products Association (NCPA).

II. **REVIEW OF SELECTED LITERATURE**

This section presents the theoretical considerations involved in each concept and illustrates the models to be used. A review of selected literature is divided into two major parts. To begin with, some valuable theoretical and empirical works on cross-hedging are summarized. The final part reviews literature related to test for market efficiency.

Previous Works on Cross-Hedging

An extensive theoretical description of cross-hedging for a commodity for which no futures exists is provided by Anderson and Danthine (1981). Assuming a non-stochastic production process (no yield risk), Anderson and Danthine consider the problem of hedging in a single futures market but with many possible trading dates. Their cross-hedging model uses a mean-variance framework to derive optimal hedging strategy assuming that the agent has knowledge of the relevant moments of the probability distribution of prices. Following Anderson and Danthine the net revenue associated with a single cross-hedge can be expressed as

$$ER = E(P_1^c)Y - [P_0^f - E(P_1^f)]X \qquad (2.1)$$

where, *ER* is expected revenue, $E(P_1^c)$ is expected cash price at the time of sale of commodity *A* (the commodity to be hedged), P_0^f is futures price of commodity *B* (potential cross-hedging vehicle) at the time of opening of futures position, $E(P_1^f)$ is expected futures price of *B* at the time of sale of commodity *A* (closing of future market position), *Y* is the amount of production for *A* and *X* is the futures position taken for *B*. In the mean-variance framework the following utility maximization problem is considered.

$$\max U(ER) = ER - 0.5a\ Var(R) \qquad (2.2)$$

Where, *Var(R)* is the variance of revenue, a is a parameter reflecting the agent's risk aversion. Differentiating the above equation with respect to *X* yields the optimal cross-hedging level *X**.

$$X^* = \left[P_0^f - E(P_1^f)\right] / \left[a \ Var(P_1^f)\right] - \left[YCov(P^c, P_1^f)\right] / \left[Var(P_1^f)\right] \qquad (2.3)$$

Where, $Var(P_1^f)$ is the variance of futures prices, $Cov(P^c, P_1^f)$ is the covariance between cash and futures prices. The first term of the above expression is viewed as a pure speculative component and the latter term is referred to as a pure hedge position.

Kahl (1983) illustrates the derivation of optimal hedging ratios under different assumptions about the cash position. She argues 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 those of Telser (1955, 1956) she shows that the optimal hedging ratio is not dependent on the risk parameter. Following Johnson (1960) she deduces that if the optimization criterion is to minimize the variance of revenue when there are only two risky assets, the cash commodity and the corresponding futures contract, the optimal cross-hedge position is found to be

$$X^* = -YCov(P^c, P_1^f) / Var(P_1^f) \qquad (2.4)$$

which is independent of a . The minus sign in the above equation comes from the fact that the futures position has to be opposite to the cash position.

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

$$\Delta P_1^c = g_o + b_1 \Delta P_1^f + e \qquad (2.5)$$

where, b_1 represents the optimal hedge ratio and g_0 represents the intercept term. He also provides an empirical measure of the effectiveness of a hedge using the variance of revenue in an unhedged position and that in an optimally hedged position.

$$HE = 1 - Var(R)^* / Var(R) \tag{2.6}$$

$$Var(R)^* = Var(R)[1 - r_{cf}^2] \tag{2.7}$$

Where, r_{cf}^2 is the correlation coefficient between price changes in the two markets. *HE* may be interpreted as the average proportional decrease in cash price risk that could be realized by hedging at *X**. A large value of *HE* indicates a more effective hedge in terms of risk aversion. As *HE* approaches zero, risk reduction from the prescribed hedge also goes to zero.

Myers and Thompson (1989) argue that the hedge-ratio obtained by means of traditional approaches (simple regression of spot price levels on futures price levels or spot price changes on futures price changes) are not appropriate as the estimated slope coefficients are the ratio of the unconditional covariance between cash prices and futures prices to the unconditional variance of futures prices. They suggest a generalized conditional approach that uses fundamental market information available at the time of placing the hedge to improve the performance of the estimated hedge-ratios.

Viswanath (1993) modifies Myers and Thompson’s model arguing that the basis at the time of placing the hedge should have power to predict changes in cash and future prices. When applying the basis-corrected method to grains, Viswanath finds that it produces significantly smaller hedged return variances in many instances and in some cases there is no significant variance reduction at all.

Hayenga et al. (1996) advocate that the fit of cross-hedging equations should improve if recent changes in market relationships persist during the period of the forward contract. They show that the conditional cross-hedge model formulation significantly improves the fit of the regressions for all meat cuts.

Dahlgran (2000) presents 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 has developed the desired hedge ratios for a variety of cross-hedging portfolios and for several hedge horizons. Risk minimizing hedge ratios are 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 futures contracts for the soybean complex; futures contracts for feed grains; US wheat futures contract; futures contract for cotton, the dollar index, and the Japanese yen; and Canadian futures contracts for flaxseed, rapeseed, oats, and wheat. Dahlgran reports that the effectiveness increases the longer the term of the hedge. His observations imply that the economics of hedge management might be as important as the underlying risk aversion in determining hedging behavior.

Tests for Nonstationarity

In general, the null hypothesis of an efficient market is equated to the statistical relationship that prices follow a unit root data generating process. A univariate time series is said to have a unit root when one of the roots of the determinental polynomial of the series has magnitude equal to one (lies on the unit circle). If one of the roots lies on or inside the circle (explosive roots) the data generating process is said to be nonstationary. When all the roots lie outside the circle the time series is said to be stationary. A stationary series has a defined expected value, or mean, and is mean-reverting, implying that it tends to return to its central value. Such mean reversion excludes market efficiency. On the other hand, nonstationary series, with unit or explosive roots, do not have an unconditional expected value. Nonstationary time series have an infinite variance which violates the assumptions of regression analysis. Ignoring this violation results in biased t and F statistics and inaccurate assessments of the probabilities associated with hypothesis tests.

The standard sampling theory test for a unit root is the Dickey-Fuller test, which tests the null hypothesis of a unit root versus the alternative hypothesis of a stationary root. Hayenga et al. (1996) perform a unit root test on each of the series of cash and future prices using the standard Dickey-Fuller test. The null hypothesis of a unit root is rejected for all cash price and nearby futures price series at the five percent level of significance and all series are treated as stationary for estimation purpose. Dahlgran (2000) also examines the data for nonstationarity using the standard Dicky-Fuller test. When one-week price differences are examined, the nonstationarity hypothesis is rejected for all series.

The sampling theory approach, however, does not treat the two competing hypothesis equally and does not even consider the posterior probability of the null hypothesis. As a result, the alternative hypothesis has to meet a large burden in order to force a rejection of the null hypothesis. This leads to very low power of such tests, the inability to reject the null hypothesis of unit roots when no unit root exists (DeJong et al., 1992).

Dorfman (1993) first presents a nonparametric Bayesian test for nonstationarity. Using hourly data from individual trades and assuming both flat priors and informative beta priors, the test is performed on corn and soybean futures prices in order to test the market efficiency of these markets. He uses informative and “ignorance” priors so that the sensitivity of results to prior assumptions is revealed. Results are derived under four sets of assumptions, representing the combinations of flat prior and beta (informative) prior on the dominant root and both normal and nonparametric kernel density for the sampling distribution of the time series. Using importance sampling on the marginal posterior distribution of the roots, four sets of posterior odd ratios are computed, pairing each of the two likelihoods with each of the two prior specifications. An odds ratio less than one indicates that the price series is stationary which implies an inefficient market, while an odd ratio grater than one implies an efficient market. Setting the number of Monte Carlo iterations equal to 5000, the Bayesian tests for market efficiency are performed. The test results soundly reject the presence of a nonstationary root, leading to the conclusion that the markets are not efficient. The results also show that the assumption of normality produces less posterior support for market efficiency than is found when a nonparametric approach is taken. The prior had an even smaller effect on results than did the distribution assumed. However, in no case did the outcome of the market efficiency test differ across the two priors. Dorfman also performs sample-theoretic augmented Dickey-Fuller tests for a unit root for all subsamples for comparison. Although sampling-theory results are not in complete opposition to Bayesian ones, the augmented Dickey-Fuller test fails to reject market efficiency at conventional significance levels (á =0.01 or 0.05) reflecting the test's low power.

III. THE BAYESIAN TESTS FOR MARKET EFFICIENCY

Following Dorfman (1993), the Bayesian tests for market efficiency are performed on all cash and futures prices. The data used in this analysis is constructed from two sources. The cash cottonseed meal price data for seven markets, i.e. Atlanta, Chicago, Fort Worth, Kansas City, Los Angeles, Memphis and San Francisco, are obtained from Feedstuffs. The observations are Wednesday closing prices since July 17, 1996 through September 15, 1999. The soybean meal futures prices data are obtained from the Chicago Board of Trade. The futures prices are also the

Wednesday closing prices for the same time period and are always for the contract nearest to maturity.

In order to test for nonstationarity, Bayesian Monte Carlo integration techniques are employed in four steps: specification of the two hypotheses, specification of the prior, specification of the likelihood, and computation of the posterior odd ratio. The two hypotheses are specified as

H_1 : $\text{Ö}_1 < 1.00$ (stationary), and

H_2 : $1.00 \leq \text{Ö}_1 \leq 1.03$ (nonstationarity)

a slightly explosive dominant root is allowed for as posterior support for a unit root which is slightly shifted due to sampling error. The following univariate AR(3) model with two additional exogenous variables, an intercept and a linear time trend is chosen to approximate the data generating process for both of the hypotheses,

$$y_t = m + b\,t + r_1 y_{t-1} + r_2 y_{t-2} + r_3 y_{t-3} + e_t \qquad (3.1)$$

where, y_t is the series of interest, e_t is an iid normally distributed error term, b is a parameter which controls the deterministic trend of the series, t is a time trend and m and r_i are unknown parameters. The dynamic properties of this model can be investigated by direct examination of the matrix

$$\mathbf{A} = \begin{bmatrix} r_1 & 1 & 0 \\ r_2 & 0 & 1 \\ r_3 & 0 & 0 \end{bmatrix} \qquad (3.2)$$

The largest eigenvalue of the matrix A in equation (3.2) is the dominant root for the model in equation (3.1) and the root suspect of nonstationarity. It is the maximum eigenvalue of A around which we should build a Bayesian unit root test.

Prior distributions for the two smaller roots are specified as Beta (1.1, 1.1) distributions that look like flat, rounded hills. The prior on the dominant root is specified as a Beta (30, 2), for the mean shifted variable (Ö$_1$ - 0.03), giving positive prior support over the range Ö$_1 \in$ [0.03, 1.03]. This prior distribution is sharply skewed to the right with a prior mean of 0.9675, and a prior mode of 0.9667. A standard Jeffrey's prior is taken for the variance which allows for easy analytical posterior distribution of the roots. A flat prior on the three dominant roots is also considered in order to examine the sensitivity of the empirical results to the prior specification. These priors mimic those used in Dorfman (1993).

The tests are performed under two different likelihood functions. First, a nonparametric density is chosen, using a Gaussian Kernel density which can be written for a single observation error term as

$$p(e_t) = f(e_t) = \frac{c}{Th}\sum_{i=1}^{T} \exp\left[\frac{-(e_t - e_i)^2}{2h^2}\right] \tag{3.3}$$

where, T is the number of observations, $c = (2p)^{-\frac{1}{2}}$, and $h = 1.6444 s\, T^{-\frac{1}{5}}$ is the bandwidth parameter, which is selected by the parametric expansion of a normal density. The alternative likelihood function specification is Gaussian, assuming that the errors of the AR(3) model are iid normal random variables with zero mean.

Four sets of posterior odds ratios are computed, pairing each of the two likelihoods (nonparametric and Gaussian) with each of the two prior specifications (beta and flat), using importance sampling on the marginal posterior distribution of the roots. Draws on the three autoregressive parameters are made from a trivariate normal distribution centered at the least squares estimates and with metric equal to the least squares covariance matrix scaled by 1.5. For each draw, the three roots are found by solving for the eigenvalues of the A matrix . An indicator function is defined as $I(\Phi^{(i)}) = 1$ when the dominant root satisfies H_1 and equals 0 when the dominant root satisfies H_2. The posterior probability in support of H_1 is given by

$$p(H_1|y) = \frac{\sum_{i=1}^{B} I(\Phi^{(i)})\, p(\Phi^{(i)})\, J^{(i)}\, p(y|\Phi^{(i)}) / g(y|\Phi^{(i)})}{\sum_{i=1}^{B} p(\Phi^{(i)})\, J^{(i)}\, p(y|\Phi^{(i)}) / g(y|\Phi^{(i)})} \qquad (3.4)$$

where, $\Phi^{(i)}$ represents the vector of three roots from the *i*th draw, *B* is the number of Monte Carlo draws (1000), $p(y|\Phi^{(i)})$ is the likelihood function of the data (either nonparametric or Gaussian), *J* is the Jacobian and $g(y|\Phi^{(i)})$ is the substitute importance sampling density. The posterior support for H_2 can be found by substituting $\left[1 - I(\Phi^{(i)})\right]$ in place of $J(\Phi^{(i)})$ in equation (3.4), or by simply taking $1 - p(H_1|y)$. The posterior odds ratio is then computed as

$$K_{21} = \frac{p(H_2|y)}{p(H_1|y)} \qquad (3.5)$$

The posterior odds ratio is computed according to (3.5) for all combinations of prior distribution and distributional assumption. Results are depicted in table 1. An odds ratio greater than one implies an efficient market while an odds ratio less than one implies an inefficient market. The test results soundly reject the presence of a nonstationary root. Of the 32 odds ratios, only two are greater than unity. The test on soybean meal futures contract favors an efficient market under nonparametric density. But when employing normal density the tests do not show even a little posterior support for a unit root and the corresponding market efficiency. The market inefficiency implies that soybean futures prices could be predicted accurately enough to earn risk adjusted economic profit. It also suggests that Ordinary Least Squares (OLS) method can be used on the cash and futures prices to estimate the parameters.

Table 1. Results of Bayesian Test for Nonstationarity

Sample	K_{nb}	K_{nf}	K_{gb}	K_{gf}
Cottonseed meal (Atlanta)	0.3414	0.3546	0.2790	0.2922
Cottonseed meal (Chicago)	0.3613	0.3787	0.2710	0.2730
Cottonseed meal (Fort Worth)	0.5815	0.6268	0.2550	0.2411
Cottonseed meal (Kansas City)	0.2602	0.2462	0.3267	0.3212
Cottonseed meal (Los Angeles)	0.3848	0.4029	0.3342	0.3512
Cottonseed meal (Memphis)	0.2309	0.2541	0.3323	0.3308
Cottonseed meal (San Francisco)	0.0003	0.0002	0.2178	0.2099
Soybean meal futures	1.0985*	1.0745*	0.3382	0.3434

K is the posterior odds ratio in favor of nonstationary dominant root, the subscripts representing innovation density and prior, respectively. Subscript *n* stands for the nonparametric density; *g*, for the Gaussian (normal) density; *b*, the beta-prior; and *f*, the flat prior. Odds ratios marked by asterisks imply efficient markets.

IV. ESTIMATION OF THE OPTIMAL CROSS-HEDGE RATIO

Linear Regression Model For Cross-Hedging

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

$$CSMP_w = b_0 + b_1 SMFP_w + u_w \qquad (4.1)$$

where, $CSMP_w$ is the Wednesday closing prices of cottonseed meal in the cash markets, $SMFP_w$ is the Wednesday closing prices of soybean meal contracts on the Chicago Board of Trade, b_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 b_0 reflects the mean difference between the soybean meal futures prices and cottonseed meal cash prices. It indicates any spatial and temporal market market dimensions or any qualitative variations. The slope coefficient b_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 indicates 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.

Empirical Results

Seven separate regressions of cash cottonseed meal prices are run on the soybean meal futures prices using the data and employing the OLS model defined above. Parameter estimates are presented in Table 2. It is found that the estimated slope coefficients are more than 0.60 being significantly different from zero in all the cases. This implies that the movements in soybean meal futures prices can explain movements in the cash cottonseed meal prices. R-squares are around 0.80 in each case, indicating that 80 percent of the variation in cottonseed meal cash prices 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. The obtained results suggest that soybean meal futures can be used as a cross-hedging vehicle for cottonseed meal.

Table 2. Estimated Parameters for Cross-hedging CSM Cash Prices with SBM Futures Prices.

Variables	Atlanta	Chicago	Fort Worth	Kansas City	Los Angeles	Memphis	San Francis.
b_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)
b_1	0.654 (0.024)	0.65 (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-Values	383.95	444.94	324.78	376.18	548.25	309.74	422.63
n	147	163	161	163	138	161	144

Standard Errors are in parenthesis. All estimates are significant at 1%.

V. AN APPLICATION OF CROSS-HEDGING COTTONSEED MEAL

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

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 $197.00 per ton in Atlanta. The producer expects that cottonseed meal prices would 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). He decides to place the cross hedge on May 28, 1997. To place the cross-hedge the producer 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 finds that he should sell seven contracts (1,000 / 100 x 0.65 = 6.5, i.e. approximately seven contracts) at the CBOT.

On October 29, cottonseed meal cash price has decreased to $ 175.00 per ton, i.e. a decrease of $22 per ton from the price of May 28 ($ 197.00 per ton). Assume that the producer sells all of his cottonseed meal in Atlanta at $175.00 per ton, receiving a total of $175,000.00 . 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 transaction is $ 40390.00 ($57.70 x100 x 7). The net return is then $215,390.00 ($175,000 + $40390) , 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 3 summarizes the cross-hedging presented in this example.

Table 3. Simple cross-hedging example of cottonseed meal using soybean futures (1997):

Date	Cash	Futures
May 28, 1997	$197.00/ton	Short 7 soybean meal futures contract @ $280.30/ton
October 29, 1997	Sell 1,000 tons of Cottonseed meal @ $175.00/ton	Long 7 soybean meal futures contract @ $222.60/ton
		Gain = $57.70/ton

Revenue from selling 1,000 tons of cash cottonseed meal = $175.00 x 1,000 = $175,000

Profits from futures transaction = $57.70 x 100 x 7 = $40390.00

Total revenue = $175000.00 + $40390.00 = $215390.00

Net realized price = $215390.00/1000 = $215.39

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 cross-hedge, selling seven soybean meal futures contract at $156.30 per ton. On October 28, he sells all of his cottonseed meal in Atlanta at $99.00 per ton. On the same day, he lifts the cross-hedge by buying seven soybean meal futures contract at $141.10 per ton. The futures transactions result in a profit of $15.20 per ton. The net realized price ($109.64) exceeds the cash price at the time of placing 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.

Table 4. Simple cross-hedging example of cottonseed meal using soybean futures(1998):

Date	Cash	Futures
May 20, 1998	$97.00/ton	Short 7 soybean meal futures contract @ $156.30/ton
October 28, 1998	Sell 1,000 tons of Cottonseed meal @ $99.00/ton	Long 7 soybean meal futures contract @ $141.10/ton
		Gain = $15.20/ton

Revenue from selling 1,000 tons of cash cottonseed meal = $99.00 x 1,000 = $99,000

Profits from futures transaction = $15.20 x 100 x 7 = $10640.00

Total revenue = $99000.00 + $10640.00 = $10964.00

Net realized price = $10964.00/1000 = $109.64

The same test procedure is carried out using the corresponding hedge-ratios for the seven selected cottonseed meal cash markets for both the years. The cash sale prices and the net realized prices from cross-hedging are presented in Table 5. In all the cases, the futures transactions result in profits. However, this is not always the case. If soybean meal futures prices rise before the cotton harvest period, cross-hedging may result in losses. For example, soybean meal futures prices have started rising from the beginning of August 1999 ($145.60 per ton) and are expected to be much higher than that of the time of placing cross-hedges (May 1999 soybean futures prices are around $130.00 per ton).

Table 5. Comparison of cash and net realized prices.

	Cash Prices	Net Realized Prices	Cash Prices	Net Realized Prices
City\Year	1997	1997	1998	1998
Atlanta	175.00	215.39	99.00	109.64
Chicago	230.00	270.39	135.00	145.64
Fort Worth	280.30	314.92	124.00	133.12
Kansas City	210.25	244.87	120.50	129.62
Los Angeles	239.00	273.62	140.00	149.12
Memphis	192.50	232.89	107.50	118.14
San Francisco	227.00	261.62	137.00	146.12

VI. SUMMARY AND CONCLUSION

The general objective of this study is to explore the feasibility of cross-hedging cash cottonseed meal with soybean meal futures. The cash-futures price relationships are 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 are presented. The net realized prices from cross-hedging exhibit risk efficiency superior to cash pricing. Thus simple cross-hedging using soybean meal futures is found to be effective as a potential pricing alternative for the cottonseed meal producers.

This analysis has shown that soybean meal futures can be effectively used as a cross-hedging vehicle for cottonseed meal. However, further studies on the distribution of prices and hedging efficiency are required for the justification of cross-hedging. Finally, since soybean meal futures provide accurate predictions on the movement in cash cottonseed meal prices, the formation of a cottonseed meal futures market will be reasonable.

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