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Forecasting Corn Gluten Feed Prices Using Soybean Meal Futures: Opportunities For Cross Hedging

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Since no futures contract exists for corn gluten feed (CGF) or meal, traders, feed millers, and users of CGF are exposed to considerable price risk in international delivery contracts. As a by-product, CGF supply is relatively fixed by high fructose corn syrup (HFCS) production (or equivalently, fuel alcohol processing). In general, the price of CGF has tended to be much more variable than soybean meal price. Opportunities for increasing price forecast accuracy and reliability and/or hedging CGF in other commodity futures contracts would therefore be quite attractive to industry participants in importing and exporting countries alike.

The primary objectives of this paper are: (1) to determine the optimal contracts and months for hedging CGF using soybean meal and corn futures; (2) to determine the coverage ratio of CGF per futures contract using soybean meal futures; (3) to analyze the impact of EC policy changes in the livestock sector on the price of CGF; and (4) to compare econometric forecasts of expected futures prices with other approaches to determine a hedging strategy.

Cross Hedging Futures Portolios

Hedging in commodities futures seldom is confined to textbook descriptions of reducing price risk through taking positions in the futures market equal and opposite to positions perceived or actually held in the cash market. Attempting to resolve deficiencies recognized in prior hedging studies, Anderson and Danthine (1980) provided a descriptive theory of hedging to better account for industry behavior. Contract combinations, including "cross hedges", can be best determined by using available statistical information on a linear combination of expectations and relevant futures prices. Their theoretical framework was equivalent to expected utility maximization under assumptions of normally distributed net revenues and exponential agent utility functions.

Holt and Brandt (1985) introduced price forecasts into the hedging strategy decision making framework, allowing for a dynamic process whereby the hedger has the opportunity to place a hedge more than once over the production period. Several forecasting approaches, including seasonal indexes, an autoregressive integrated moving average process (ARIMA), Econometric, and ARIMA-Econometric, were incorporated into a hedging framework. ARIMA-Econometric price forecasts generated higher returns and lower risks than either of the single method forecasts. When Meyer's

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stochastic dominance procedures were used to rank the forecasting/hedging strategies, three selective hedging procedures, including ARIMA and ARIMA-Econometric decisions methods, were preferred to a cash only marketing plan. The authors also concluded that combining the information from a price forecasting approach with a selective hedging strategy was superior to a routine hedging plan. While the study did not indicate an optimal selective hedging strategy, the price forecasting/selective hedging approach indicated price enhancement potential and risk reduction using the futures markets.

Miller (1985) examined the potential for both simple and multiple cross hedging of millfeeds using corn, oats, wheat, and soybean meal futures. In evaluating the simple cross hedging potential of Kansas City millfeed using corn, oats, wheat and soybean meal, the corn futures contract was found most appropriate for cross hedging. Average forecast error (AFE) and the root-mean square forecast error (RMSFE) were lowest among the four single commodity contracts. Mean mill feed price using the cross hedging was higher than the mean net cash price, while the RMSFE was decidedly lower (p. 25). Multiple cross hedging was more effective than simple cross hedging using corn futures. Basis risk was reduced by a multiple cross hedging of millfeeds using corn and soybean meal contracts, yielding the lowest RMSFE and smallest AFE relative to other alternatives. However, determining an optimal selective hedge is a problem beyond the scope of both the Holt and Brandt and the Miller studies.

Multivariate regression was used in Miller's (1982) cross hedging study of distillers grains and solubles. Soybean meal and corn futures were found appropriate for single contract, near month cross hedges. Blake and Catlett (1984) used similar techniques to cross hedge New Mexico and U.S. hay prices with monthly corn futures contracts from 1955 to 1981. Neither study attempted to incorporate the partial correlation coefficients between cash and futures prices, however, settling for simple correlation coefficients over the series.

Kahl (1983) developed a profit maximizing model for two risky assets, cash commodity and corresponding futures contracts, and determined that while risk aversion may affect the size of holding of each asset, it does not affect their ratio. However, if the cash position is given (predetermined), the optimal hedge may be expressed as:

$$X_1 = \mu_1/2\lambda\sigma_1^2 - \sigma_{12}X_2/\sigma_1^2 \qquad (1)$$

where X_1 is the futures position, X_2 is the cash commodity, λ is the risk aversion parameter, μ_1 is expected profit per unit on futures, σ_{12} is the covariance between profits from holding the futures position and profits from holding the cash position, and σ_1^2 is the variance in profits on the futures position. When risk aversion is very large, equation (1) reduces to the risk minimizing hedge ratio:

$$X_1/X_2 = -(\sigma_{12}/\sigma_1^2) \qquad (2)$$

This is equivalent to expressions in Kolb, Seidel and Ginsberg, and others. Seidel and Ginsberg (1983) suggest using least squares techniques to discover the portfolio hedge under the minimum variance assumption. Constrained allocation of hedging funds (zero intercept term) would allow long and short contracts to be utilized in the portfolio (p. 426-427). Simple correlations over the time series remain a defect in this specification, as it does in a principal components comparison to regression analysis by Herbst (1984) for portfolio hedging price index inflation.

Using commodity futures prices as expected cash prices has provided comparatively accurate hedging estimates for many commodities, including cross hedged commodities. However, forecasting futures prices with Box-Jenkins time series models may provide additional information to the hedging strategy by incorporating partial autocorrelations with cash prices into the expected price observations. Spreen and Arnade (1984) compared the potential roles of five different forecasting models in decision making, evaluating each by the traditional mean square (RMSE) criterion and two alternatives. One model implemented a first-difference, first-order autoregressive model (ARIMA) to estimate backward through the time series. Although the ARIMA model had a higher MSE than least squares, other forecasting decision criteria differed little from least squares, Logit, and trend forecasting models.

Modeling Futures Contract Selections

Anderson and Danthine (1980) argued that "rarity of a perfect hedge may justify a portfolio approach to hedging, whereby risk reduction (and speculation) is achieved through dealing in multiple contracts" (p. 2). They continued their theoretical discussion to derive criteria for choosing the "best" contracts with which to hedge. The selection of a portfolio of futures contracts in soybean meal and corn with which to hedge corn gluten feed is a central issue in this analysis, which focuses on selective rather than the routine hedging. The optimal selective hedge is based on forecasts of futures and cash prices and utility maximization profit/risk aversion goals.

Contract selection in a two-step autoregression process, employing prehedging forecast analysis, is presented as an alternative to multivariate regression portfolio selection of suitable cross hedging strategies for corn gluten feed. The general model of futures contract selection, given a predetermined cash commodity position, follows equation (1), with the Rotterdam basis between soybean meal futures prices and corn gluten feed cash prices explaining the variation in expected profits.

The hedging contract selection model is thus expressed:

$$SBMFP_{it} = f(\lambda^{-1}BASR_{it}, CRNGLUTP_t, u_t) \qquad (3)$$

where $SBMFP_{it}$ is the monthly average soybean meal futures price for contract delivery month i in the tth month, $BASR_{it}$ is the Rotterdam basis -- soybean meal futures price (Chicago) less corn gluten feed cash price (Rotterdam) -- for contract delivery month i in the tth month, $CRNGLUTP_t$ is the monthly average corn gluten feed cash price (Decatur) in the tth month, λ is the degree of risk averseness and u_t is the error term. Quite apart from contract selection, Anderson and Danthine observed that "futures prices and basis expectations may substitute for cash price expectations in the output decisions" (p. 12).

The latter concept, futures prices and basis expectations, is developed as the first, forecasting stage of the two-stage process for selecting hedging positions. OLS and ARIMA models using first-difference, first-order estimation may be appropriate for forecasting the expected basis and futures prices to be substituted into equation (3).

The second stage of the model is estimated by the AUTOREG (S.A.S.) procedure, a two-step full transform method. AUTOREG employs OLS in the first step and an iterative full-transform method using Yule-Walker autoregression estimates in the second step, similar to generalized least squares or the EGLS of Judge, et al. (1980). Results from this procedure are then compared with the traditional OLS procedure.

Data consisted of average monthly settle prices of soybean meal futures contracts from October, 1978, through October, 1985, or 85 observations. Average monthly cash prices for corn gluten feed and meal in the U.S. and Rotterdam cover the same period. Data were taken from issues of the Wall Street Journal, Dunn and Hargitt and USDA, FAS sources.

Forecasting Corn Gluten Feed Prices Under Agricultural Policy Changes

The primary demand for corn gluten feed and meal is derived from the European Community's Common Agricultural Policy (CAP) and its support of the dairy products sector. Changes in the value of the final product, such as milk or cheese, will either increase or decrease the price for feedstuffs. The quota on the amount of milk that can receive dairy price supports in the European Community (EC) should reduce the demand for imported feed ingredients. Both the price of corn gluten feed and soybean meal were expected to fall as a result of the reduced feedstuff demand. To account for this, a one-time shift was incorporated into the forecasts of CGF in the following sections.

New EC production quotas for milk were agreed upon March 31, 1984. The quotas dropped milk production 3.7 percent in 1984 and another one percent in 1985. By September, 1984, the c.i.f. price of soybean meal had fallen by 31 percent and corn gluten feed by 42 percent compared to the first of the year. Although the quota on EC milk production was not implemented until April 1, 1984, expectations of the quota system and other price support changes may have influenced prices three or more months in advance of the policy implementation. Thus an intercept shifting variable, DVECA, was treated as a zero for months prior to April, 1984, and a one thereafter.

The severity of the EC dairy policy change may also have had structural effects on the derived demand for various feedstuffs. Thus, the variable DVECB was posited, multiplying DVECA times the December soybean meal contract price to account for a slope change in the relationship with corn gluten feed and meal prices.

Several different monthly CGF price forecasting models were constructed, including a single-equation model with dummy variables estimated step-wise

OLS and an autoregressive least squares model. In the first model, monthly CGF prices were expressed as a function of the December soybean meal futures prices (SBMFPDC), a set of dummy variables to account for seasonality, and slope and intercept shifters for the period following the implementation of the EC's new dairy quota price support system which began in April, 1984. Prices were expected to be higher in the first and fourth quarters of the year, as the demand for protein feeds increased during the winter months. Therefore, 0 and 1 dummy variables, DV1 and DV4, were expected to have positive signs, while DV2, the dummy variable for the second quarter, was expected to have a negative sign. Results of the first analysis are given in Table 1, which demonstrate the forecasting value of related futures prices, seasonality, and the structural change of the dairy quota policy shock.

The coefficient of the single futures contract variable for soybean meal, SBMFPDC, was statistically significant and indicated the expected positive sign. Coefficients for the seasonality variables, DV1 and DV4, were negative and statistically significant at the one and ten percent level, respectively. The coefficient of the policy intercept shift variable, DVECA was negative as expected and statistically significant, indicating that prices would be lower as a result of the EC's policy change in 1984. The coefficient of the slope shift variable, DVECB, was also statistically significant. Depending upon the model specification, the coefficient of determination ranged from 0.66 to 0.77.

The second forecasting approach included futures contract prices for eight soybean meal delivery months. The dummy variables for the EC policy changes, DVECA and DVECB, were added to the model consecutively and then concurrently. The coefficient of the DVECA was still negative as expected and statistically significant (see Table 2, Equation IIa). The coefficient of the slope shift variable, DVECB, was statistically significant and negative, deflecting prices downward, when it was modeled without the intercept shifter. The slope coefficient was again positive when both variables were included in the model.

Serial correlation, to be expected when using related futures contracts, appeared to be a problem with the OLS forecasting method, as evidenced by the Durbin-Watson values. Furthermore, the R^2 for models with the eight soybean meal contracts using OLS were not higher than results modeling a single contract chosen for its high correlation with cash CGF prices. Subsequently, an autoregressive, Yule-Walker procedure, was used to forecast CGF prices by taking advantage of autocorrelation information over time. Results were compared to the OLS forecast estimates, and there were several interesting differences between the findings of the two methods. Neither the January nor December soybean meal contract coefficients were statistically significant in the autoregressive models. However, the July contract, SBMFPJY, was statistically significant at the one percent level with a positive sign in all AR models. The sign of the intercept shift coefficient, DVECA, was negative and statistically significant. When the two policy variables were included in the same model, the intercept shifter remained negative, indicating that forecast prices would be lower as a result of the EC dairy program change.

Table 1. Factors Affecting Monthly Corn Gluten Feed Prices, 1975-1985.

Explanatory Variables	Estimated Values					
	I	II	III	IV	V	VI
Intercept	16.04	24.05	22.97	24.56	22.94	23.28
SBMFPDC	+0.49 (15.33)	+0.45 (15.80)	+0.45 (16.12)	+0.44 (15.74)	+0.44 (16.01)	+0.44 (15.94)
DV1	--	--	--	--	+4.43 (2.26)	+4.13 (1.83)
DV2	--	--	--	--	--	-0.63 (-0.27)
DV4	--	--	+4.78 (2.48)	+5.45 (2.82)	+7.13 (3.49)	+6.84 (2.95)
DVECA	--	-17.30 (-5.95)	-17.34 (-6.09)	-73.26 (-2.56)	-82.93 (-2.91)	-84.46 (-2.90)
DVECB	--	--	--	+0.34 (1.96)	+0.39 (2.32)	+0.40 (2.32)
R^2	0.66	0.74	0.75	0.76	0.77	0.77
RMSE	10.62	9.37	9.18	9.07	8.92	--
F Value	234.47	168.23	119.01	92.36	77.50	64.08

a/ t-values in parentheses.

Autoregressive forecasts had lower RMSE terms than the OLS models, and total R^2 (forecasting) values were higher. The autoregressive forecasts tended to be decided improvements of the OLS forecasts. Holt and Brandt (1985) agreed with Peck that the preferred measure of price forecast risk is the degree to which the unpredictable portion of variation in prices can be reduced. In this regard, the RMSE terms of the autoregressive models were approximately one-half those of the OLS models, and would indicate that forecast risk is reduced by this process compared with OLS.

Forecasting and Contract Portfolio Selection

Regressions consistent with profit maximizing and minimum variance contract selection motives were estimated by the traditional OLS forecasting treatment and using autoregressive, Yule-Walker, forecasts. These models may be used either for their price forecasting accuracy or for indications of key contracts to include in a hedging portfolio. Results presented here include only monthly delivery soybean meal contracts. Corn futures were also included in our analysis, but low correlation coefficients (0.52 and less) relative to soybean meal contracts led either to hedging coverage ratios less than two percent or insignificantly different from zero in all estimations. Since CGF is by its nature a by-product, it retains little influence from corn prices.

Table 2. Forecasting Monthly Corn Gluten Feed Prices Using Monthly Average Soybean Meal Contract Prices and Accounting for European Policy Shifts (OLS and AUTOREG), 1975-1985.

Variables	Estimated Values							
	Ia[a]	Ib	IIa	IIb	IIIa	IIIb	IVa	IVb
Intercept	4.986	52.794	40.629	49.291	35.431	46.701	43.433	54.359
SBMFPJA	-0.158 (-0.50)[b]	-0.152 (-1.23)	-0.056 (-0.21)	-0.109 (-0.82)	-0.089 (-0.33)	-0.114 (-0.85)	-0.036 (-0.13)	-0.100 (-0.76)
SOYMAR	-0.037 (-0.20)	-0.069 (-0.86)	0.085 (0.56)	-0.004 (-0.04)	0.076 (0.49)	-0.014 (-0.16)	0.089 (0.58)	0.005 (0.05)
SBMFPMY	-0.059 (-0.55)	0.019 (0.47)	-0.040 (-0.44)	0.010 (0.237)	-0.042 (-0.46)	0.011 (0.25)	-0.038 (-0.42)	0.011 (0.25)
SBMFPJY	0.129 (0.48)	0.260 (2.36)	0.258 (1.14)	0.260 (2.20)	0.231 (1.00)	0.253 (2.12)	0.275 (1.20)	0.285 (2.40)
SBMFPAU	0.053 (0.15)	0.050 (0.41)	0.005 (0.02)	0.050 (0.38)	0.015 (0.049)	0.053 (0.40)	-0.001 (0.01)	0.044 (0.34)
SBMFPST	0.365 (1.04)	0.123 (1.05)	0.266 (0.91)	0.139 (1.096)	0.324 (1.10)	0.143 (1.12)	0.225 (0.75)	0.121 (0.96)
SBMFPOC	-0.044 (-0.17)	0.073 (0.78)	0.039 (0.19)	0.095 (0.94)	-0.004 (-0.019)	0.092 (0.90)	0.068 (0.35)	0.100 (1.00)
SOYDEC	0.297 (0.92)	-0.013 (-0.10)	-0.176 (-0.63)	-0.120 (-0.80)	-0.1049 (-0.37)	-0.092 (-0.061)	-0.215 (-0.75)	-0.169 (-1.10)
DVECA	--	--	-22.65 (-5.93)	-8.375 (-2.12)	--	--	-38.851 (-1.55)	-38.807 (-1.67)
DVECB	--	--	--	--	-0.128 (-5.68)	-0.043 (-1.90)	0.096 (0.15)	0.179 (1.34)
R^2	0.66	0.93[c]	0.77	0.92	0.76	0.92	0.77	0.93
RMSE	12.44	5.74	10.33	5.97	10.47	6.03	10.37	5.92
D.W.	0.33	--	0.48	--	0.49	--	0.47	--

a/ Models with 'a' subscript are forecast OLS; models with 'b' are forecast AUTOREG.

b/ Student t-ratios are in parentheses; $t_{.025,74} = 1.96$, $t_{.05,74} = 1.65$, $t_{.10,74} = 1.28$.

c/ In the case of AUTOREG estimates, the total R^2 is reported.

The profit maximizing performance of each delivery month contract for soybean meal in cross hedging EC corn gluten feed in Chicago futures markets, allowing for less than full contract coverage (i.e. an intercept term), are compared in Table 3. Following the linear model of Kahl with the risk averseness parameter λ set equal to 0.5, the hedging ratio of CGF to soybean meal futures appears stable over all contracts, using OLS estimates. A coverage ratio of 0.72 to 0.75 soybean meal contracts per 100 short tons of CGF is implied, consistent with (but slightly higher than) price ratios over the period. Implications for profitability, using the variation in basis suggested by Anderson and Danthine, are more variable, however, as the coefficients on the Rotterdam basis variables indicate. Coefficients of basis ranged from 0.64 to 0.775 for the OLS estimates. March and May contracts appear to carry relatively greater profit opportunities, as indicated by their higher variability in basis estimates, than other contract delivery months. However, July and September contracts display slightly higher forecasting reliability (Table 3).

Autoregressive estimates, using a one period lag, indicate consistently higher hedging coverage ratios (the inverses of the parameter estimates for CGF prices, CRNGLUTP) and consistently lower profitability potential. Total (forecasting) R^2 and RMSE for autoregressive forecasts were superior to OLS for each contract.

ARIMA forecasts of Rotterdam basis were next employed in the same model construct. This approach tested the hypothesis that additional information from such forecasts could improve contract selection or forecast reliability. Results presented in Table 4, with $FB\hat{A}SR_{it}$ representing the ARIMA (1, 1, 0) forecast of the Rotterdam basis between Chicago soybean meal futures prices and Rotterdam cash CGF prices, show neither improvement. In fact, total R^2s were lower and RMSE values higher using this procedure. Implied contract coverage in these estimates were very similar to the previous specification, but profitability forecasts were consistently lower, as indicated by smaller variability in basis estimates. For example, estimated coefficients of forecast basis for March and May contracts were 0.596 and 0.547, respectively, lower than the estimated coefficients for the actual basis estimates using both the OLS and autoregressive approaches.

Contract month selection under the profit maximizing framework was next examined by comparing OLS and autoregression on the same monthly basis forecasts without intercept terms. Again, the coefficients on cash CGF prices were quite stable, indicating relatively small differences in coverage ratios among contracts in Table 5. Coverage ratios established by the autoregressive procedure were slightly lower than those estimated by OLS, ranging from 0.62 to 0.64 soybean meal contracts per 100 short tons of CGF compared to 0.64 to 0.65 under OLS.

Contract profitability was consistent between the two estimation procedures, but the RMSE was lower under the autoregressive technique. May delivery contracts again outperformed others when estimating profitability at a risk averseness level of 0.5. The May forecast basis coefficients were higher, at 0.82, using OLS estimates than for any other delivery month. Autocorrelation and partial autocorrelation information on the error terms

Table 3. Results of Regressing Monthly Average Soybean Meal Futures Contract Settling Prices on Rotterdam Basis[a] and Decatur Corn Gluten Feed Cash Price, Comparing OLS and AUTOREG Estimators, October 1978-1985.

	Futures		Basis		Cash		R^2	TRSQ	RMSE
OLS	SBMFPJA =	25.474 +	0.676 (14.38)[b]	BASRJA +	1.366 (23.82)	CRNGLUTP	0.89		10.39
AUTOREG	SBMFPJA =	50.489 +	0.557 (10.48)	BASRJA +	1.166 (12.97)	CRNGLUTP	0.75	0.93	8.18
OLS	SOYMAR =	28.891 +	0.711 (14.90)	BASMAR +	1.372 (22.87)	CRNGLUTP	0.88		10.85
AUTOREG	SOYMAR =	43.405 +	0.62 (10.99)	BASMAR +	1.21 (12.99)	CRNGLUTP	0.75	0.92	9.02
OLS	SBMFPMY =	19.616 +	0.775 (16.42)	BASRMY +	1.393 (21.91)	CRNGLUTP	0.88		11.54
AUTOREG	SBMFPMY =	33.952 +	0.751 (14.57)	BASRMY +	1.267 (12.75)	CRNGLUTP	0.81	0.92	9.84
OLS	SBMFPJY =	22.712 +	0.682 (14.38)	BASRJY +	1.390 (24.29)	CRNGLUTP	0.89		10.49
AUTOREG	SBMFPJY =	46.791 +	0.528 (10.06)	BASRJY +	1.207 (13.38)	CRNGLUTP	0.76	0.94	7.89
OLS	SBMFPAU =	24.098 +	0.668 (12.94)	BASRAU +	1.377 (23.56)	CRNGLUTP	0.88		10.63
AUTOREG	SBMFPAU =	48.504 +	0.522 (8.96)	BASRAU +	1.188 (12.91)	CRNGLUTP	0.73	0.93	8.24
OLS	SBMFPST =	26.503 +	0.640 (12.35)	BASRST +	1.357 (23.63)	CRNGLUTP	0.88		10.35
AUTOREG	SBMFPST =	52.479 +	0.493 (8.95)	BASRST +	1.152 (12.76)	CRNGLUTP	0.73	0.93	7.79
OLS	SBMFPOC =	29.234 +	0.643 (12.09)	BASROC +	1.328 (22.27)	CRNGLUTP	0.86		10.48
AUTOREG	SBMFPOC =	56.033 +	0.507 (9.23)	BASROC +	1.110 (11.96)	CRNGLUTP	0.71	0.92	7.90
OLS	SOYDEC =	24.160 +	0.669 (13.89)	BASRDEC +	1.375 (24.10)	CRNGLUTP	0.89		10.39
AUTOREG	SOYDEC =	47.136 +	0.550 (9.90)	BASRDEC +	1.193 (13.33)	CRNGLUTP	0.75	0.93	8.28

[a] Rotterdam basis ($BASR_{it}$) is the soybean meal futures price for contract delivery month i in the t^{th} month minus the Rotterdam corn gluten feed cash price.

[b] Student t-statistics are in parentheses.

Table 4. Results of Regressing Monthly Average Soybean Meal Futures Contract Settling Prices on Forecast Rotterdam Basis[a] and Decatur Corn Gluten Feed Cash Price, Comparing OLS and AUTOREG Estimators, October 1978-1985.

Regression Type	Futures			Basis			Cash	R^2	TRSQ	RMSE
OLS	SBMFPJA	28.06	+	0.586 (8.94)[b]	$\hat{\text{FBASRJA}}$	+	1.365 (17.54) CRNGLUTP	0.80		13.91
AUTOREG	SBMFPJA	50.27	+	0.388 (4.83)	$\hat{\text{FBASRJA}}$	+	1.209 (10.52) CRNGLUTP	0.59	0.85	11.83
OLS	SOYMAR	30.92	+	0.596 (8.67)	$\hat{\text{FBASRMR}}$	+	1.336 (15.92) CRNGLUTP	0.77		15.13
AUTOREG	SOYMAR	49.30	+	0.424 (4.92)	$\hat{\text{FBASRMR}}$	+	1.230 (10.18) CRNGLUTP	0.58	0.82	13.50
OLS	SBMFPMY	33.90	+	0.547 (6.31)	$\hat{\text{FBASRMY}}$	+	1.316 (12.10) CRNGLUTP	0.66		19.69
AUTOREG	SBMFPMY	43.76	+	0.415 (4.059)	$\hat{\text{FBASRMY}}$	+	1.257 (9.236) CRNGLUTP	0.52	0.69	18.97
OLS	SBMFPJY	21.72	+	0.637 (10.29)	$\hat{\text{FBASRJY}}$	+	1.410 (19.61) CRNGLUTP	0.84		13.04
AUTOREG	SBMFPJY	40.11	+	0.437 (5.50)	$\hat{\text{FBASRJY}}$	+	1.289 (11.79) CRNGLUTP	0.65	0.89	10.82
OLS	SBMFPAU	23.12	+	0.618 (9.25)	$\hat{\text{FBASRAU}}$	+	1.398 (19.22) CRNGLUTP	0.83		13.01
AUTOREG	SBMFPAU	44.09	+	0.412 (4.79)	$\hat{\text{FBASRAU}}$	+	1.254 (11.58) CRNGLUTP	0.63	0.88	10.99
OLS	SBMFPST	26.90	+	0.568 (8.28)	$\hat{\text{FBASRAU}}$	+	1.370 (18.65) CRNGLUTP	0.81		12.95
AUTOREG	SBMFPST	50.34	+	0.340 (4.13)	$\hat{\text{FBASRAU}}$	+	1.20 (10.85) CRNGLUTP	0.60	0.88	10.50
OLS	SBMFPOC	32.02	+	0.551 (7.51)	$\hat{\text{FBASROC}}$	+	1.322 (16.73) CRNGLUTP	0.78		13.50
AUTOREG	SBMFPOC	57.30	+	0.32 (3.61)	$\hat{\text{FBASROC}}$	+	1.139 (9.67) CRNGLUTP	0.54	0.85	11.01
OLS	SOYDEC	24.77	+	0.584 (8.77)	$\hat{\text{FBASRDEC}}$	+	1.398 (18.14) CRNGLUTP	0.81		13.71
AUTOREG	SOYDEC	46.36	+	0.37 (4.60)	$\hat{\text{FBASRDEC}}$	+	1.23 (11.01) CRNGLUTP	0.61	0.86	11.65

a/ The forecast Rotterdam basis ($FBASR_{it}$) is the soybean meal futures price for contract delivery month i in the t^{th} month minus the Rotterdam corn gluten feed cash price calculated by the ARIMA procedure.

b/ Student t-values are in parentheses.

Table 5. Profit Maximizing Results of Regressing Monthly Soybean Meal Futures Prices on ARIMA Forecasts of Rotterdam Basis[a] and Decatur Corn Gluten Cash Price, Comparing OLS with AUTOREG Estimators, No Intercept, 1978-1985.

Regression Type	Futures	Basis	Cash	RMSE	R^2
OLS	SBMFPJA =	+0.7497 (16.31) $\widehat{\text{FBASRJA}}$ +	1.5739 (103.81) CRNGLUTP	11.17	0.99
AUTOREG	SBMFPJA =	+0.6423 (11.32) $\widehat{\text{FBASRJA}}$ +	1.5918 (68.97) CRNGLUTP	9.27	0.99
OLS	SBMFPMR =	+0.7782 (16.92) $\widehat{\text{FBASRMR}}$ +	1.5674 (101.78) CRNGLUTP	11.50	0.99
AUTOREG	SBMFPMR =	+0.7005 (11.95) $\widehat{\text{FBASRMR}}$ +	1.5799 (57.35) CRNGLUTP	9.83	0.99
OLS	SBMFPMY =	+0.8232 (18.25) $\widehat{\text{FBASRMY}}$ +	1.5552 (101.79) CRNGLUTP	11.95	0.99
AUTOREG	SBMFPMY =	+0.7880 (15.04) $\widehat{\text{FBASRMY}}$ +	1.5583 (67.07) CRNGLUTP	10.31	0.99
OLS	SBMFPJY =	+0.7418 (15.87) $\widehat{\text{FBASRJY}}$ +	1.5762 (102.90) CRNGLUTP	11.12	0.99
AUTOREG	SBMFPJY =	0.5905 (10.39) $\widehat{\text{FBASRJY}}$ +	1.6048 (68.30) CRNGLUTP	8.85	0.99
OLS	SBMFPAU =	0.7408 (14.75) $\widehat{\text{FBASRAU}}$ +	1.5739 (100.51) CRNGLUTP	11.32	0.99
AUTOREG	SBMFPAU =	+0.6029 (9.69) $\widehat{\text{FBASRAU}}$ +	1.5980 (66.80) CRNGLUTP	9.23	0.98
OLS	SBMFPST =	+0.7266 (14.38) $\widehat{\text{FBASRST}}$ +	1.5732 (103.98) CRNGLUTP	11.18	0.99
AUTOREG	SBMFPST =	+0.5778 (9.57) $\widehat{\text{FBASRST}}$ +	1.5971 (68.24) CRNGLUTP	8.95	0.98
OLS	SBMFPOC =	+0.7486 (14.76) $\widehat{\text{FBASROC}}$ +	1.5651 (105.39) CRNGLUTP	11.43	0.99
AUTOREG	SBMFPOC =	+0.6036 (10.02) $\widehat{\text{FBASROC}}$ +	1.5857 (68.24) CRNGLUTP	9.15	0.98
OLS	SBMFPDC =	+0.7371 (15.56) $\widehat{\text{FBASRDC}}$ +	1.5739 (105.12) CRNGLUTP	11.11	0.99
AUTOREG	SBMFPDC =	+0.6280 (10.65) $\widehat{\text{FBASRDC}}$ +	1.5915 (69.65) CRNGLUTP	9.26	0.99

[a] Rotterdam basis ($BASR_{it}$) is the soybean meal futures price for contract delivery month i in the t^{th} month minus the Rotterdam corn gluten feed cash price.

[b] Student t-ratios are in parentheses.

of the OLS selection forecasts appears to improve the reliability of the hedging contract selection process in all autoregressive forecasts.

Blake and Catlett (1984) argued that "when multiple futures contract delivery dates are available for a commodity, the proportion of the commodity that should be hedged for each contract can be determined by a multiple regression of spot cash prices on each futures contract" (p. 130). To select a minimum variance (maximum risk averse) hedging portfolio, average monthly cash prices of CGF at Decatur were regressed on the actual dollar value of the eight soybean meal futures contracts and again on the forecasted (ARIMA) values. OLS and autoregression were again compared, and the results are presented in Table 6.

While other studies (Blake and Catlett) of cross hedging have selected a single optimal contract month, or considered only contract months near delivery, a selection of several contract months for a hedge portfolio may be desirable in the case of corn gluten feed. Results in Table 6 indicate that soybean meal futures contracts for January, July, September and December were most viable to comprise a hedging portfolio using the OLS procedure on actual contract prices. The autoregressive procedure selected January, July, September, and October contracts, replacing the December contract by the October contract.

Cash CGF prices were also regressed on ARIMA forecasts of each soybean meal monthly contract, with rather mixed indications of differences in reliability. Autoregression forecasts reflected superior reliability of estimates throughout, using time series feedback information in the error terms to weight price changes anticipated in one period ahead.

Conclusions

Substitutability of corn gluten feed and meal with soybean meal exports to the EC encourages prospects for cross hedging corn gluten feed in U.S. markets. Portfolios of futures contracts may not always offer an adequate hedge, but when the relationship between the commodity and another existing futures contract is strong, hedging may reduce price risk exposure considerably. This study has shown clear opportunities for cross hedging corn gluten feed on soybean meal futures contracts.

Preliminary results comparing the profit maximization approach with the minimum variance objective indicate that the hedging position will depend upon goals and/or risk averseness. While the multiple regression selected three or four contracts that minimize the variance in returns, profit maximization criteria selected contracts with greater volatility. Some of this volatility may be associated with responses to the EC dairy policy changes which are announced annually at the end of March. Autoregressive procedures on forecast variables, prices and bases, appeared to improve the reliability of portfolio contract selection.

A successful cross hedging strategy depends heavily on accurate forecasts of price relationships between soybean meal and CGF, which may be affected by future trade relationships. Regression analysis clearly indicated a decline in CGF prices as a result of the policy changes in the ble 6. Comparison of OLS and AUTOREG Regressions Selecting Soybean Meal Contract Months Under Minimum Variance, 1978-1985.

	Actual Prices for Contract Month		Prices for ARIMA Forecast Contract Month	
riables	OLS	AUTOREG	OLS	AUTOREG
NGLUTP	--	--	--	--
MFPJA	-0.139 (-0.45)a/	-0.100 (-0.73)	-0.201 (-0.70)	-0.244 (-1.89)
MFPMR	-0.032 (-0.18)	-0.070 (-0.78)	0.148 (0.83)	0.144 (1.67)
MFPMY	-0.057 (-0.54)	0.018 (0.40)	0.027 (0.21)	0.147 (2.49)
MFPJY	0.121 (0.45)	0.265 (2.14)	0.031 (0.14)	0.008 (0.08)
MFPAU	0.063 (0.18)	0.100 (0.73)	0.119 (0.42)	0.118 (1.10)
MFPST	0.358 (1.03)	0.180 (1.38)	0.200 (0.72)	0.071 (0.68)
MFPOC	-0.002 (-0.01)	0.147 (1.42)	0.095 (0.45)	0.135 (1.56)
MFPDC	0.261 (0.83)	0.007 (0.05)	0.151 (0.52)	0.137 (1.11)
SE	12.38	6.42	13.27	6.66
	0.989	0.977b/	0.987	0.997

Student t-ratios are in parentheses; $t_{.025,75} = 1.96$, $t_{.05,75} = 1.65$, $t_{.10,75} = 1.28$.

Redefined total R-squares, no intercept.

EC. Already, U.S. exports of CGF to the EC, which totaled $525 million in 1984, were down 12.9 percent from the previous year. Handlers of CGF would certainly desire protection against unfavorable price movements and cross hedging may be a useful tool for price protection. A knowledge of the Rotterdam basis may also signal opportunities for profit enhancement in cereal substitutes.

In the first quarter of 1986, CGF has become a bargaining issue in the U.S.-EC trade conflict over the accession of Spain and Portugal into the EC. The Accession Treaty states in part that Portugal must take 15.5 percent of its cereal imports from the rest of the EC and that variable levies be imposed on Spanish corn and sorghum imports from the U.S. EC Agricultural Commissioner Frans Andriessen threatened retaliation for the U.S. quotas on white wine, cheese and other imports from the EC, hinting quota reductions on cereal substitutes such as CGF (Agra Europe, April 4, 1986, p. 2). Consequently, CGF could lose its tariff binding, and thus its immunity from the variable import levy which the EC uses to equalize imported feedstuff prices with higher priced EC wheat and feed grains.

Other potential changes in derived demand also necessitate accurate price forecasts for CGF users in the U.S. and abroad. The U.S. livestock feeding sector is awakening to the potential of CGF as an economical protein substitute for higher-priced protein feeds and grains, as demonstrated in Iowa and Illinois beef feeding trials. Declining derived demand for CGF in Europe and increased awareness by U.S. livestock producers could indicate an even more important reason for cross hedging this valuable feed commodity.

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