Cross-Hedging Fishmeal: Exploring Corn and Soybean Meal Futures Contracts

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Fishmeal is an important feed ingredient in fresh water aquaculture feed and cattle and dairy (ruminant) diets. Levels of fishmeal added to diets has been found to enhance milk production in dairy cows and enhance growth and health of young calves. Fishmeal is used in fresh water fish diets, as fish like catfish are carnivores. Fishmeal is purchased in bulk, and buyers of fishmeal face much uncertainty about price risk management of their fishmeal purchases.

During 2006 the fishmeal price nearly doubled from $500MT to over $900MT (see Figure 1). The dramatic increase in fishmeal price is likely sustainable due to issues involving the over harvesting of the worlds oceans will eventually limit junk fish harvest supplies. The objective of this research is to determine the optimal cross-hedge ratio between fishmeal and soybean meal and corn, and corresponding hedging weight between corn and soybean, using Maddala's (1992) hedging selection model.

Vukina and Anderson (1993) estimated the cross-hedge relationship between soybean meal and fish meal. Their static model showed a cross-hedge ratio range between 1.08 for a risk loving individual to 2.71 for a risk averse individual. Their study is now 14 years old, and much structural change has occurred within both industries. Also, because corn can be refined to a much higher protein content now, e.g., Fishmeal, it may be that the corn futures contract offers an additional cross-hedging opportunity.

Empirical Model

The empirical model is based off of the Sanders and Manfredo research, except that cash and futures prices are not first differenced. For the current analysis, statistical tests conducted for the presence of non-stationarity indicated no need to take the first differences. In addition, scouring the data indicated many similar fishmeal prices in the sequence. Therefore, the analysis is done using levels as opposed to changes. Furthermore, Myers and Thompson find only a marginally improved hedge coefficient by employing first differences.

As stated by Leuthold, Junkus, and Cordier, ex post minimum variance hedge ratios are usually estimated with ordinary least squares regression as:

(1) $$\Delta CP_t = \alpha + \Delta\beta FP_t + e_t$$

where CP_t and FP_t are cash price and futures price, respectively. In this equation, α is the trend in cash prices, β is the ex post minimum variance hedge ratio, Δ represents changes in price, and e_t is the residual basis risk.

If there are two competing contracts that can be used to hedge a cash transaction, a standard minimum variance regression can be utilized to determine the hedging effectiveness of the two different contracts. Equation (1a) represents the original contract and equation (1b) represents the alternative contract.

(1a) $$CP_t = \alpha_0 + \beta_0 FP_t^0 + e_{0,t},$$

or

(1b) $$CP_t = \alpha_1 + \beta_1 FP_t^1 + e_{1,t}.$$

The fitted values for the competing hedging contracts are represented by y_0 and y_1 for equations (1a) and (1b) respectively. The dependent variable is represented y in place of CP_t. The fitted and actual dependent variables can be plugged into equation (2) (Maddala, p. 516):

(2) $$y - y_0 = \Phi + \lambda(y_1 - y_0) + v.$$

The $y - y_0$ represents the residual basis or spread risk of the first model while $y_1 - y_0$ represents the difference in fitted values of the two models. This study is not looking at a conventional basis but rather the spread in the case of a cross hedge. In this case, if λ is not found to be statistically different from zero, then the second model has no more explanatory power than the first. Therefore, if $\lambda = 0$, the new contract does not provide a reduced basis or spread risk above the original contract. According to Granger and Newbold, by adding λy to equation (2), it can be shown that:

(2a) $$y - y_0 = \Phi + \lambda[(y - y_0) - (y - y_1)] + v.$$

In this equation, $y - y_0$ is the residual basis risk for the original contract and $y - y_1$ is the residual basis risk for the new contract. Given the above, the error terms from equations (1a) and (1b) can be substituted for $y - y_0$ and $y - y_1$, in equation (2a), respectively, for basis risk giving.

(2b) $$e_{0,t} = \Phi + \lambda[(e_{0,t} - e_{1,t})] + v_t.$$

Equation (2b) is similar to the regression test for forecast encompassing by Harvey, Leybourne, and Newbold. In this equation, λ is the weight to be placed on the new model and (1- λ) is the weight to be placed on the original model's forecast which minimizes the mean squared forecast error. The null hypothesis that the preferred model "encompasses" the new model is tested and the following are the alternative results.

$\lambda = 0$: All hedging should be in the encompassing futures market.

$0 < \lambda < 1$: A combination of hedging should be done in each market with λ as the weight assigned to the new futures contract.

$\lambda = 1$: All hedging should be done in the competing futures market.

As shown by Maddala (p. 516), the λ that best reduces the error or risk can be illustrated as:

(3a)
$$\lambda = \frac{\sigma^2 e_0 - \rho e_0 e_1}{\sigma^2 e_0 + \sigma^2 e_1 - 2\rho e_0 e_1 \sigma e_0 \sigma e_1},$$

where, σ^2, σ, and ρ represent the variance, standard deviation, and correlation concerning basis risk for the original and new models. Maddala also shows:

(3b)
$$\lambda \geq 0 \text{ iff } \frac{\sigma e_0}{\sigma e_1} \geq \rho e_0 e_1, \qquad \text{and}$$

(3c)
$$\lambda < 0 \text{ iff } \frac{\sigma e_0}{\sigma e_1} < \rho e_0 e_1.$$

The λ in equations (3b) and (3c) show the ability of the new futures contract to reduce the residual basis risk associated with the original futures contract.

Previous studies, such as Sanders and Manfredo, compare two different markets to determine the hedging effectiveness of each. This study will determine the cross hedge ratio of corn and SBM futures contracts as an effective hedge for fishmeal in four markets in different parts of the U.S.

The conventional practice of hedging corn in the corn futures markets is to use one 5,000 bushel contract for each 5,000 bushels of corn to be hedged. However, since fishmeal is a substitute for corn or soybean meal the one-to-one ratio may be inappropriate, and a cross-hedge ratio is necessary to determine the size of the futures position to take. Following the work of Buhr and Schroeder and Mintert, the relationship between cash prices for fishmeal and corn or soybean meal futures prices is estimated using SHAZAM 9.0 to determine the cross-hedge ratio (β) in equation (1):

(4) Fishmeal Cash Price = $\beta_{0, Corn} + \beta_{1,Corn}$ (Corn Futures Price), and

(5) Fishmeal Cash Price = $\beta_{0,SBM} + \beta_{1,SBM}$ (Soybean Meal Futures Price),

where ($\beta_{0, Corn}$ and $\beta_{0, SBM}$) are the intercepts or expected basis and ($\beta_{1, Corn}$ and $\beta_{1, SBM}$) are the hedge ratios. The corn and soybean meals futures prices are for the nearby months. While not specified in equations (4) and (5), contract dummy variables were used to account for contract bias that might exist in the data. Unlike prior research, the estimated cross-hedge coefficients here are not time variant. That is, we do not evaluate alternative hedging horizons for each contract futures month offered. We justify non time varying hedge ratios because in practice, merchandiser and procurement managers prefer to have a seemingly simple rule-of-thumb cross-hedge relationship to use.

Historical weekly CBOT corn and soybean meal price data were pulled for the time period from 1999 to October 10, 2007 using Commodity Research Bureau information. Weekly fishmeal prices for two locations: Chicago, Illinois and Minneapolis, Minnesota were collected for the same time period from the Ingredient Market Report of *Feedstuffs* magazine. A total of

457 observations were used in estimation of each of the models. Corn futures price was converted to dollars/ton. The average $/ton corn futures over the period of investigation was $85.83/ton with a standard deviation of $18.71/ton. The average soybean meal price was $182.25/ton with a standard deviation of $37.32/ton. For the locations Chicago and Minneapolis the average fishmeal price was $595.36/ton and $574.71/ton, respectively. The standard deviation was $180.03/ton for Chicago and $172.18/ton for Minneapolis.

Equations (4) and (5) utilize the cross-hedge ratios ($\beta_{1,\,Corn}$ *and* $\beta_{1,\,SBM}$) to determine the approximate tons of fishmeal to hedge,

$$\text{(6)} \qquad \textit{Cash Fishmeal Quantity Hedged} = \frac{\textit{Futures Contract Quantity}}{\beta_1}.$$

The *Futures Contract Quantity* is the bushel (ton) amount per corn or soybean meal futures contract, and the *Cash Fishmeal Quantity Hedged* is tons of fishmeal hedged per futures contract. For example, a 5,000 bushel (140 ton) corn futures contract would appropriately cross-hedge 140 tons of fishmeal if the cross-hedge ratio ($\beta_{1,\,Corn}$) is determined to be 1.0. Similarly, if the cross-hedge ratio was estimated to be 0.8, the appropriate number of tons of fishmeal to cross-hedge against one corn futures contract is 175 tons (= 140 tons/0.8).

In practice, however, fishmeal merchandiser and procurement persons are more likely interested in how many futures contracts are needed per portion of fishmeal produced during a particular time period. Rearrange equation (6) to get,

$$\text{(7)} \qquad \textit{Futures Contracts Quantity} = \textit{Cash Fishmeal Quantity Hedged} \times \beta_1.$$

Suppose the cross-hedge ratio for corn futures is 0.80 and there is 140 tons of corn to a corn futures contacts, then for 525 tons of fishmeal seeking to be hedged, a merchandiser would take a position on three corn futures contracts (525*0.80/140). Equation (7) can easily be specified to account for hedging weights assigned across multiple futures contract for the cash price of one commodity.

Results

Table 2 and Table 3 show the results of the models (equations 4 and 5) for Chicago and Minneapolis cash fishmeal price. Panel A presents hedge ratios for corn and SBM to be used when hedging fishmeal with corn or SBM alone, along with statistical measures for the regression equations. To understand the interpretation of the results let us look at the results for fishmeal sold in Chicago. For Chicago fishmeal, the corn hedge ratio was 6.02 which is a ratio of Corn-to-Fishmeal. Similarly, the SBM hedge ratio for Chicago was estimated to be 0.55 of SBM-to-Fishmeal. These results state that 6.02 tons of corn, and 0.55 tons of SBM are hedged for each ton of fishmeal.

Panel B shows the estimated hedge weight to be placed on SBM with the standard error reported below. In the case of Chicago fishmeal price with the hedging weight of -0.06, none of the hedging weight would be placed on the SBM hedge ratio and all of the hedging weight would be placed on the corn hedge ratio (1- (-0.06)). In addition, this shows that basis risk is increased with the inclusion of SBM.

Panel C shows the number of CBOT contracts to hedge per given value of Fishmeal produced in a week. The 1000, 2000, 4000, and 6000 tons of Fishmeal weekly. The number of corn contracts to hedge against 1000 tons of Fishmeal is determined by taking the fishmeal quantity hedged (1000) multiplied by the corn hedge ratio (6.02). Because SBM does not add risk reduction to hedging fishmeal, no weight is placed on SBM. For Minneapolis fishmeal price, the results are similar.

Conclusions

The results presented here are interesting relative to research reported by Vukina and Anderson (1993) and Kristofersson and Anderson (2004). Previous research has only analyzed the SBM contract as a cross-hedging mechanism to manage fishmeal price risk. Consistent with previous research, the SBM cross-hedge coefficients estimated here are similar in magnitude with the previous research results. However, when including corn futures into the risk management decision, corn futures much more successfully reduces fishmeal cash price variability risk than does SBM futures. As a matter of fact, the encompassing model suggest all hedging weight be placed on a corn futures market contract and none on a soybean meal futures market contract.

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Table 1. Descriptive Statistics of Variables

	Mean	Standard Deviation	Coefficient of variations	Min	Max
Fishmeal price data ($/ton)					
Chicago	$595.36	$180.03	0.30	$340	$990
Minneapolis-St. Paul	$573.71	$172.18	0.30	$300	$950
Futures contract data ($/ton)					
Corn	$85.83	$18.71	0.22	$63	$152
Soybean meal	$182.25	$37.32	0.20	$124	$322

Note: The C.V. (coefficient of variation) is the standard deviation of each 10-year, weekly price series expressed as a percentage of the mean of that series.

Table 2. Chicago Market

Panel A. Hedging Regressions

Description	Corn	SBM
Estimated Hedge Ratio (β)	6.02	0.55
(Standard Error)	(0.06)	(0.01)
R^2	0.46	0.10
Standard Deviation (e_t)	\$126.5/ton	\$166.6/ton
Correlation ($\rho e_0 e_1$)	0.79	

Panel B. Encompassing Regression

Description	Corn	SBM
Estimated Hedging Weight		-0.06
(Standard Error)		(0.001)

Panel C. Contracts Required to Hedge

	Weekly Fishmeal Output (tons)			
	1000	2000	4000	6000
Contracts used to hedge quantity				
CBOT Corn	43	86	172	258
CBOT SBM	n/a	n/a	n/a	n/a

Table 3. Minneapolis Market

Panel A. Hedging Regressions

Description	Corn	SBM
Estimated Hedge Ratio (β)	7.33	.069
(Standard Error)	(0.02)	(0.03)
R^2	0.52	0.10
Standard Deviation (e_t)	\$22.67/ton	\$55.26/ton
Correlation ($\rho e_0 e_1$)	0.69	

Panel B. Encompassing Regression

Description	Corn	SBM
Estimated Hedging Weight		0.02
(Standard Error)		(0.01)

Panel C. Contracts Required to Hedge

	Weekly Fishmeal Output (tons)			
	1000	2000	4000	6000
Contracts used to hedge quantity				
CBOT Corn	52	105	209	314
CBOT SBM	n/a	n/a	n/a	n/a

Figure 1. Historic Chicago Menhaden fishmeal cash price, January 1999 through October, 10, 2007 (source: Feedstuffs)