Hedging Portfolios for European Feed Processors and Compounders Including Foreign Exchange Risk

by

Jack E. Houston, Glenn C. W. Ames, and Robert B. Burney

Suggested citation format:

Houston, J. E., G. C. W. Ames, and R. B. Burney. 1987. "Hedging Portfolios for European Feed Processors and Compounders Including Foreign Exchange Risk." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. [http://www.farmdoc.uiuc.edu/nccc134].

Hedging Portfolios for European Feed Processors and Compounders Including Foreign Exchange Risk

Jack E. Houston, Glenn C. W. Ames and Robert B. Burney

U.S. futures exchanges have become an important risk management and price discovery tool in international trade. Greater knowledge of futures risk management and incentives for participation by traders who are located outside of the United States could increase volume in commodities and related financial futures contracts on U.S. exchanges. Thompson and Bond (1985) reported that although precise measures of involvement of foreign traders on U.S. futures markets was limited, a review of the Commodity Futures Trading Commission's large trader reporting system indicated that foreign traders were involved in the grains and soybean complex and in the coffee, cocoa and sugar markets. CFTC data also indicated that a majority of foreign traders with open interests were identified with Europe and Canada (p. 981). Thompson and Bond concluded that foreign traders are playing an increasingly active role in futures markets.

Domestic and foreign hedgers face similar problems in deciding whether to participate in futures markets. "For both groups of hedgers, decisions must be made regarding the levels of commodity stocks and sales, the associated amount of timing of borrowing or lending commitments, and the prices at which spot and futures transactions take place" (Thompson and Bond, 1985, p. 981). However, foreign commercial hedgers must also consider fluctuating exchange rates as well as contract specifications in their decision framework. Therefore, the foreign and domestic hedger may have substantially different objectives and strategies in hedging.

The objectives of this study were to (1) examine the potential for both simple and multiple hedging of European imported soybean meal using CBOT futures contracts, (2) determine the potential for hedging the exchange rate risk using the British pound and the German mark IMM(CME) futures contracts, and (3) test the effectiveness of a commodity and currency hedging portfolio using monthly data from 1978 through 1986.

Hedging Strategies for European Feed Processors

Futures markets provide risk shifting opportunities for producers, processors, and handlers of agricultural commodities. European oilseed crushers, feed processors and compounders may hedge current or anticipated inventory levels or requirements in American futures markets. In the U.S., futures markets have been used to hedge and to cross-hedge feed ingredients, such as distillers dried grains, rice bran, and other

---

Jack E. Houston is assistant professor, Glenn C.W. Ames is associate professor, and Robert B. Burney is graduate research assistant in the Department of Agricultural Economics at the University of Georgia, Athens, Georgia.

products which do not have futures contracts (Miller; Elam et al.). However, hedging is not confined to domestic feed millers and processors but has application for world commodity markets (Kuhn).

During the 1978-1986 period, U.S. commodity prices and foreign exchange rates demonstrated significant volatility, as the dollar appreciated to record levels against some major currencies in the early 1980s and then again devalued against those currencies in the latter two years. Certainly, this situation exposed importers to considerable variation in net returns. Consequently, futures and options hedging and cross-hedging strategies may be used as risk management tools in international commodity markets. Thompson and Bond (1987) offer a more recent caveat that "utilization of U.S. commodity futures exchanges by offshore traders...is likely to vary according to the commodity and the currency under review" (p. 50).

Several hedging situations may arise in the European soybean meal and oil market. A European feed compounder may make a commitment at the beginning of the year to import soybean meal at a future date, perhaps four months later. In this case, the European compounder may desire protection against a large soybean meal price increase between commitment and delivery by using American futures markets. The compounder would buy soybean meal contracts at the beginning of the period and offset his futures position at delivery by selling back the contracts and buying the cash meal. The gains (losses) in the futures market would be added to the cost of the cash meal to determine the effective buying price.

In a more realistic and complex situation, the crusher would be interested in protecting his gross processing margin (GPM), which is the formula that reflects the difference between the cost of soybeans and the value of the processed oil and meal. The crusher is concerned with the value of all three commodities, beans, oil and meal in calculating his potential profit and loss in the European market. Hedging the cost of the raw beans for crushing would set the stage for the output market transactions alternatives--cash, futures, and/or options (options are not included in this analysis).

While cash and futures commodity prices change daily, a third important element influences the effective sales price of the final product, namely the exchange rate between the dollar and the European crusher's currency. A hypothetical transaction may be helpful in demonstrating the nature of the risk. Suppose the crusher had contracted to sell meal to a dairy producers' cooperative or farmers' association at a future date. The price of the raw beans may be "locked in" through the use of the CBOT futures market. If the exchange rate between the dollar and the European currency is not protected by either a forward contract or a futures position, the effective cost of the raw material may increase due to appreciation of the dollar and thereby reverse the anticipated profitability of the transactions. The crusher is then subject to considerable exchange rate risk, which may be too large to be ignored in its business decisions.

Exchange rate volatility causes the effective price of goods and services to fluctuate, introducing an element of uncertainty and risk into international transactions. Forward contracting through the interbank market may remove some of the risk, but forward contracting may not be available to smaller firms. The IMM futures contracts in foreign currency provide ready hedging and speculating opportunities. Recent literature has tended to focus on the effectiveness of export hedging, optimal hedging ratios for currencies and a comparison of hedging strategies. These and other issues will be discussed in the next section.

Related Studies

Carter and Loyns (1985) introduced exchange rate risks into their model for hedging western Canadian feedlot cattle using four general hedging strategies. Market simulations of 622 lots of cattle from 1972 to 1981 compared average returns for each strategy against a no-hedging alternative. Fourteen scenarios were tested, with and without including exchange rate risks. Simple naive hedges simulated the feedlot operator taking a short position on the U.S. live beef cattle futures market when the cattle were placed on feed and lifting it when the cattle were sold. Another scenario simulated a hedging strategy whereby the cattle were left unhedged if critical levels of expected profit ($.05 and $.10/lb) were not attainable, using U.S. futures, when the cattle were placed on feed. The third strategy was a selective hedge placed anywhere up to six weeks after feeding commenced if the same predetermined profit levels were attainable. The fourth strategy involved placing the cattle on feed only if the arbitrary levels of profit were attainable. The exchange rate was allowed to vary between the time the hedge was placed and subsequently lifted. The profit level with varying exchange rates was compared to calculated profits without allowing the Canadian-U.S. exchange rate to affect futures profits or losses during the feeding period.

In the Carter and Loyns analysis, the exchange rate impacted the hedger's futures account only. Net profits after commission costs were compared for each of the four general strategies versus calculated gains or losses on the futures market when the exchange rate was arbitrarily held fixed at the rate when the short position was taken. Results indicated that the simulated routine naive hedge would have reduced average profits for both heifers and steers while increasing price risk for heifers and reducing price risk for steers compared to no hedging. The other three general hedging strategies indicated positive profits for steers but mixed results for heifers.

> Also, the results indicate that exchange rate risk was a significant source of hedging loss. Comparing each hedging strategy with and without exchange risk, the results indicate average profits to be consistently higher for heifers when exchange risk is removed.
>
> For steers the exchange risk does not consistently add to hedging losses; but for some strategies, such as the routine hedge, it does. (Carter and Loyns, p.37)

The authors concluded that their simulation cast doubt on the usefulness of U.S. fed cattle futures as a marketing tool in Canada without a higher level of hedging sophistication. They further concluded that basis risk was a problem for Canadian users of U.S. futures, claiming "Chicago futures price changes do not explain enough of the variance in Canadian cash cattle price to allow feedlot operators to reduce price risk through hedging. In other words, the basis is too variable." (p. 38) The exchange rate impact on the hedger's basis and the relative Canadian-U.S. cash prices were not explicitly measured by Carter and Loyns, and it may be desirable to separate out the two effects in a hedging strategy.

Although European importers of U.S. protein meal feed ingredients are subject to considerable price and exchange rate risk, feed compounders may use American futures markets to hedge soybeans, meal and other feedstuffs contained in their processing and ration compounding. However, simple commodity hedging may not fully take exchange rate risks into consideration. During many periods, there may be more variability in the foreign exchange rate than in either the cash or futures price of the imported commodity. Therefore, importers of U.S. commodities should be aware of how they may utilize the futures markets to hedge both their commodity and currency requirements.

Investigation of the appropriateness of currency futures for inclusion in the commodity hedging portfolio is thus justified, given the premise of exchange rate risk as a major contributor to the riskiness of the international trader's portfolio (Dale; Grammatikos and Saunders; Chalupa; Thompson and Bond, 1987). Despite the increasing importance of the international marketplace for U.S. agriculture, past empirical work has had a heavily domestic bias (Miller 1982; Elam, Miller, and Holder, 1986). However, the literature on foreign currency hedging (Dale; Hill and Schneeweis; Thompson and Bond, 1987) indicates that there are opportunities to combine commodity and currency futures contracts into the same portfolio model. Indeed, the omission of exchange rate changes may overlook the most important aspect of international commodity trade.

Procedures

The procedures involved comparing the feasibility of simple and multiple hedging contracts as risk management tools for both the commodity and the foreign currency requirements of European processors and feed compounders. Portfolio analysis of cash and futures positions in commodities and currencies at alternative levels of risk averseness were analyzed using vector autoregression (VAR) and selective optimizing procedures suggested by Johnson, Stein, Peck, Kahl, Brown and others. Simulated simple and multiple commodity hedging portfolios on prices and bases of U.S. and European markets were compared, with and without hedging foreign exchange risks.

Nelson and Collins have addressed the purpose behind hedging, citing Gray and Ruthledge's four "distinct approaches" to hedging and the implications for the selection of an optimal portfolio. Although the dependence of the selection of the optimal portfolio on the assumed goals of hedgers and levels of risk aversion has been widely discussed (Kahl, Brown), the issue is largely unresolved empirically. This study synthesized and tested several recent approaches in hedging analyses of commodities and currencies.

A prevailing view of the industry is that most hedging has both speculative and risk reduction components (Anderson and Danthine). The traditional naive (equal and opposite) hedge is then likely to be suboptimal in that it neither maximizes a firm's utility nor minimizes risk unless the futures contract(s) held are almost perfectly and positively correlated. This study follows a mean-variance portfolio framework similar to the Anderson and Danthine or Kahl approaches, but with extensions to multiple assets and asset markets. This multiple-asset hedging, in portfolio theory, is a diversification strategy which eventually leads to the elimination of all risk other than the unavoidable levels of average covariance among the assets (Elton and Gruber). A portfolio which attains least risk, however, may not be feasible under contract indivisibilities and transactions costs, and thus the constrained optimum must deal with achieving goals with a rather sparse set of assets in the portfolio. This frugal set of assets is chosen with the prior knowledge of the type of risks considered most important in achieving goals, and may be assisted by computation of a matrix of Pearson's correlation coefficients of likely assets to be held in the portfolio. Anderson and Danthine suggested extending the multiple hedge portfolio through the use of the partial correlation coefficient (defined as the correlation of the regressor and the response while all other regressors are held constant).

The coefficient of the theoretical multiple regression of cash on futures prices would then give the proportion of cash that should be placed in each of the contracts (Anderson and Danthine). The utility- maximizing (through 'profits' or returns) hedge may be extended to the three asset case:

(1) $$\Omega = E(\Pi) - \Gamma Var(\Pi)$$

(2) $$\Omega = X_1R_1 + X_2R_2 + X_3R_3 - \Gamma(X^2{}_1\sigma^2{}_1 + X^2{}_2\sigma^2{}_2 + X^2{}_3\sigma^2{}_3 + 2X_1X_2\sigma_{12} + 2X_1X_3\sigma_{13} + 2X_2X_3\sigma_{23})$$

For a maximum, differentiate with respect to each variable asset. For example:

(3) $$d\Omega/dX_1 = R_1 - 2\Gamma X_1\sigma^2{}_1 - 2\Gamma X_2\sigma_{12} - 2\Gamma X_3\sigma_{13} = 0$$

Solving for X_1,

(4) $$X_1 = \frac{R_1}{2\Gamma\sigma^2{}_1} - \frac{\sigma_{12}X_2}{\sigma^2{}_1} - \frac{\sigma_{13}X_3}{\sigma^2{}_1}$$

In a similar manner:

(5) $$X_2 = \frac{R_2}{2\Gamma\sigma^2{}_2} - \frac{\sigma_{21}X_1}{\sigma^2{}_2} - \frac{\sigma_{23}X_3}{\sigma^2{}_2}$$

and

(6) $$X_3 = \frac{R_3}{2\Gamma\sigma^2{}_3} - \frac{\sigma_{31}X_1}{\sigma^2{}_3} - \frac{\sigma_{32}X_2}{\sigma^2{}_3}$$

This suggests the potential for an interesting approach: i.e., solving the first order conditions, and estimating asset holdings as a system of equations yielding the maximum expected-profit portfolio dependent on the assumed level of risk aversion, Γ. Such an estimation has technical difficulties which will be discussed later. An estimation procedure, such as Zellner's Seemingly Unrelated Regressions (SUR) will theoretically introduce more information into the solution for each asset by incorporating the contemporaneous correlation expected in related futures markets (the error terms associated with the time series equation estimation for each asset or contract). Since the equations are estimated simultaneously, each of the resulting equations would represent the optimal portfolio for its dependent variable asset. Whether, as theory suggests, the additional information yields an improved estimator relative to a single equation is of interest in terms of justifying more complex techniques for optimal portfolio selection.

Equations 4, 5, and 6 were used to estimate a frugal portfolio containing three assets, cash soybean meal, soybean meal futures contracts, and currency futures contracts. Returns R_1, R_2, and R_1 were represented as basis or basis change relationships for each of the assets, as suggested by Anderson and Danthine (1981), depending on whether the model was specified in terms of price levels or returns (first differences). Only equation 4 was used for the single equation estimators, ordinary least squares (OLS) and vector autoregression (VAR) with a one- or two-period lag, (1,0,0) or (2,0,0). All three equations were used in the systems approaches, Zellner's SUR and Parks' extension.

The extension to Parks' procedure was used to estimate the multiple-asset market system because autocorrelation was present in the SUR results, just as it was previously under OLS. This procedure was used to ameliorate first order serial correlation problems in a manner similar to that used by VAR to transform OLS estimates and is outlined in Judge et al. (1980, pp. 268-274). Cross-correlation between the meal and currency futures was assumed to be minimal in this procedure and portfolio situation. Results with and without currency futures and multiple-asset markets are presented, including implications for estimation procedures and goals.

Results and Discussion

Monthly averages of daily cash soybean meal (SBOMROTT) and futures contract settle prices (NEARMAX for soybean meal, ROLLDM and ROLLBP for Deutsche marks and British pounds) were used, covering the period of October, 1978, through October, 1986, and both the averages and the underlying daily settle prices were checked for normality of distribution generally assumed for time-series regression analysis. Neither prices nor returns (first differences in prices) deviated significantly from a normally distributed sample, and thus the data were not further adjusted.

Results of single-equation, multiple-contract estimates for the risk-minimizing objective (risk averseness practically infinite) are presented in Table 1. Note that the Rotterdam cash soybean meal, when hedged by a single futures contract, has a coverage ratio not significantly different from 1.0. However, the intercept term is also significant, suggesting that the cash position is not fully covered. The U.S. soybean meal futures contract in this instance is a composite of the contracts nearest delivery from among the July, September, and October delivery contracts, those most efficient in explaining price variation in prior estimations.

Both a rolling composite Deutsche mark and a similarly-specified British pound contract position may be used (their coefficients are significant and they do explain some variation of cash soybean meal in Rotterdam), but the reliability of the hedge (related to forecast accuracy) is questionable. However, even in this simplistic estimation of multiple assets, a portfolio of U.S. soybean meal futures and British pound futures appears superior for alleviating risk of price changes in the Rotterdam cash soybean meal market.

As the Deutsche mark futures contracts appeared to be inferior to the pound contracts for this particular application, they are not further reported in the specifications for optimal portfolios hedging cash (Rotterdam) soybean meal. Comparative results of a profit-maximizing specification using returns (first-period differences of prices) and representing the profit potential through the changes in basis (futures less cash, in this case), suggested by Anderson and Danthine, are presented in Table 2. Single equation estimates using OLS and VAR (one and two-period lags) are presented in the first three rows as OLS, AUTOREG1*, and AUTOREG2**, respectively. Two-tailed t-tests of the coefficients (hedge ratios) on the futures contracts are given in parentheses for B = 0 and in square brackets for B = 1.0. Only the first of the three systems equations (that for equation 4) is reported for the Zellner and Parks estimators, as the optimal hedge ratios for a fixed cash position use information contained in equations 5 and 6 to estimate asset holdings in the portfolio.

Of particular note in Table 2 is the discrepancy between single-equation (OLS and VAR) estimated ratios and those estimated by a systems extension (Zellner and Parks). In the former, the meal futures to cash ratios do not differ significantly from 1.0, while in the latter the ratio is significantly different from 1.0 (1.15). In neither case is the currency contract significant, although the coefficients and probabilities do change markedly.

If minimizing the risk of adverse price changes is the goal (i.e. the risk averseness coefficient approaches infinity), the results shown in Table 3 demonstrate that quite a different portfolio would be called for. Again, the single-equation estimates differ appreciably from those hedge ratios suggested in a systems approach. The former suggest that the cash position is fully covered (hedged) by a combination of U.S. soybean meal and British pound futures contracts, while the latter suggests that some cash may remain unhedged (though not significant at the .05 level in the Parks transformed system estimation). More importantly, hedging ratios implied for both the meal and currency contracts differ significantly under the use of alternative estimators. However, both assets were important to the optimal portfolio hedging a Rotterdam cash meal position.

Table 1. Comparison of European Soybean Meal Hedging Potential under Risk Minimization: Price Level Specification Estimation by Vector Autoregression with a One Period Lag.

No.	Reg R^2	Total R^2	MSE	DF	Equation Parameter Estimates				
					Cash Meal	Intercept	Meal Futures	Mark Futures	Pound Futures
1	.649	.843	250.21	89	SBOMROTT =	33.466664 (2.261)	+ .99474 NEARMAX (12.815) [-.068]		
2	.067	.796	324.54	89	SBOMROTT =	111.16989 (2.557)		+ 2.35721 ROLLDM (2.534) [1.459]	
3	.190	.803	308.64	86	SBOMROTT =	80.759 (2.587)			+ .78842 ROLLBP (4.540) [-1.218]
4	.904	.886	179.97	87	SBOMROTT =	.21994 (-.028)	+ .84573 NEARMAX (16.356) [-2.979]		+ .34960 ROLLBP (.035) [-14.948]
5	.878	.878	196.89	88	SBOMROTT =	-15.27885 (-1.569)	+ .94697 NEARMAX (18.670) [-1.046]	+ 1.28990 ROLLDM (6.497) [1.460]	
6	.212	.802	312.77	87	SBOMROTT =	82.03706 (2.468)		- .11987 ROLLDM (-.104) [-.973]	+ .81270 ROLLBP (3.053) [-.704]
7	.906	.887	181.26	86	SBOMROTT =	-3.23238 (-.340)	+ .85763 NEARMAX (15.735) [-2.612]	+ .22779 ROLLDM (.615) [-2.083]	+ .29839 ROLLBP (3.197) [-7.518]

a - parentheses indicate t-values at p =.05 when H^o: ß = 0

b - brackets indicate t-values at p =.05 when H^o: ß = 1

Table 2. Comparison of Profit-Maximizing Soybean Meal Portfolio Estimators: Returns Specification

		R^2				Equation Parameter Estimates					
Estimator	DF	Regular	Total	System	MSE	Cash Meal	Intercept	Expected Returns	Meal Futures	Currency Futures	DW
OLS	86	.923	.923		30.266	SBMRTR =	-.18476 (-.361)a	-.96736 BASNRMXR (-30.532)	+1.04169 NEARMAXR (19.220) [.769]b	-.00585 ROLLBPR (-.646) [-7.893]	2.244
AUTOREG1*	85	.920	.924		30.089	SBMRTR =	-.17997 (-.347)	-.95875 BASNRMXR (-28.888)	+1.04644 NEARMAXR (20.017) [.888]	-.00240 ROLLBPR (-.020) [-8.30]	NA
AUTOREG2**	84	.922	.925		30.099	SBMRTR =	-.16884 (-.359)	-.95918 BASNRMXR (-29.962)	+1.04357 NEARMAXR (20.325) [.849]	+.00003 ROLLBPR (.600) [-8.491]	NA
ZELLNER	249			.986	.699	SBMRTR =	-.21984 (-.372)	-.99438 BASNRMXR (-32.631)	+1.14381 NEARMAXR (28.907) [3.634]	-.02610 ROLLBPR (-.208) [-8.177]	2.261
PARKS*	249			.986	.698	SBMRTR =	-.27829 (-.473)	-.98713 BASNRMXR (-31.011)	1.14666 NEARMAXR (29.901) [3.824]	-.10468 ROLLBPR (-.889) [-9.382]	2.032
PARKS**	249			.986	.707	SBMRTR =	-.30457 (-.521)	-.98369 BASNRMXR (-31.204)	+1.14068 NEARMAXR (30.496) [3.761]	-.10259 ROLLBPR (-.907) [-9.752]	2.008

* - NLAG (Number of lagged periods) = 1

** - NLAG = 2

a - parentheses indicate H^o: $\beta = 0$ at $p = .05$

b - square brackets indicate H^o: $\beta = 1$ at $p = .05$

Table 3. Comparison of Risk-Minimizing Soybean Meal Portfolio Estimators: Returns Specifications

Estimator	DF	R^2			MSE	Equation Parameter Estimates				DW
		Regular	Total	System		Cash Meal	Intercept	Meal Futures	Currency Futures	
OLS	87	.087	.087		354.225	SBMRTR =	.07921 (.040)	+.40095 NEARMAXR (2.345)a [-3.504]b	+.49582 ROLLBPR (1.147) [-1.166]	2.923
AUTOREG1*	86	.234	.300		274.488	SBMRTR =	.09619 (.079)	+.58107 NEARMAXR (4.539) [-3.272]	.39905 ROLLBPR (1.320) [-1.987]	NA
AUTOREG2**	85	.310	.340		262.120	SBMRTR =	.07281 (.071)	+.66330 NEARMAXR (5.555) [-2.820]	+.35700 ROLLBPR (1.295) [-2.331]	NA
ZELLNER	261			.276	.937	SBMRTR =	.28628 (.143)	+.70993 NEARMAXR (4.277) [-1.747]	+.78864 ROLLBPR (1.840) [-.493]	2.972
PARKS*	261			.288	.953	SBMRTR =	.02257 (.013)	+.86035 NEARMAXR (7.058) [-1.146]	+.19100 ROLBPR1 (.652) [-2.706]	2.386
PARKS**	261			.340	.951	SBMRTR =	.03194 (.019)	+.91825 NEARMAXR (8.149) [-.726]	+.16891 ROLBPR1 (.627) [-3.084]	2.341

* - NLAG (Number of lagged periods) = 1

** - NLAG = 2

a - parentheses indicate H^{O}: $\beta = 0$ at $p = .05$

b - square brackets indicate H^{O}: $\beta = 1$ at $p = .05$

Finally, if the goal is to hedge total value of the cash meal position on a period-to-period basis, a comparison of risk-minimizing estimators is presented with that alternative specification in Table 4. Note that none of the intercept terms are significantly different from zero in this case, implying that returns are fully hedged by futures contracts. Furthermore, the implied ratios of futures to cash are different from those in Table 3, and the difference may be appreciable. In this case, currency contracts are again insignificant, but the probabilities of their usefulness differ among estimators. Removing these currency contracts from the portfolio, moreover, would almost certainly change the ratios implied for meal contracts and their removal from the system would deprive it of information that may be useful in particularly volatile exchange rate subperiods of this data sample. The forecast accuracy of the returns risk-minimizing specification is considerably lower than that using average settle price data.

Conclusions and Implications

Feedstuffs as a whole are the largest U.S.-EC trade sector, and soybean meal imports by the EC are a significant portion of U.S. agricultural exports. Since any hedging process which makes price risk management more effective should enhance trade, the results of this study should be beneficial to both American and European interests. Optimal portfolios for hedging European soybean meal with commodity and currency futures have been estimated under varying objectives, using single and multiple equation estimator procedures. Systems estimates of hedging ratios appear to be superior to those which are commonly derived from OLS or VAR procedures in terms of estimation efficiency and accuracy.

Both price level and returns specifications have been tested and compared, and the parameter estimates (hedge ratios) suggested by each were quite different. An interpretation of the importance of these differences is made only in the presence of a determination by the hedger as to the importance of relative risks faced from changes in price levels or in returns. The price level specification attempts to explain (and hedge) the total value of the cash position, while the returns specification attempts to explain (and therefore hedge) changes in the total value of the cash position. The results represent only averages over the specific time period studied, and relative risk (variances in levels compared to potential returns) is not likely constant through time in international markets, particularly when exchange rate risk is included. The autocorrelation-correcting procedures, VAR and Parks, demonstrated an unbiased set of efficient estimators under which one can evaluate both specifications and alternative portfolio goals.

Table 4. Comparison of Risk-Minimizing Soybean Meal Portfolio Estimators: Price Level Specifications

Estimator	DF	R^2 Regular	R^2 Total	R^2 System	MSE	Equation Parameter Estimates Cash Meal	Equation Parameter Estimates Intercept	Equation Parameter Estimates Meal Futures	Equation Parameter Estimates Currency Futures	DW
OLS	89	.886	.886		176.938	SBOMROTT =	1.25245 (.148)a	+ .83636 NEARMAX (15.041) [-2.943]b	+.35364 ROLLBP (7.478) [-13.668]	2.104
AUTOREG1*	88	.897	.886		178.258	SBOMROTT =	.60152 (.075)	+ .84202 NEARMAX (15.889) [-2.981]	+.35140 ROLLBP (7.829) [-14.452]	NA
AUTOREG2**	87	.904	.886		179.969	SBOMROTT =	.21994 (.028)	+.84573 NEARMAX (16.356) [-2.983]	+.34960 ROLLRP (8.035) [14.948]	NA
ZELLNER	267			.992	.623	SBOMROTT =	-28.72157 (-3.866)	+.91734 NEARMAX (21.933) [-1.977]	+.43861 ROLLBP (11.409) [-14.604]	1.909
PARKS*	267			.979	.817	SBOMROTT =	-10.75993 (-1.451)	+.93286 NEARMAX (23.008) [-1.714]	+.31563 ROLLBP (8.009) [-17.365]	2.007
PARKS**	267			.978	.823	SBOMROTT =	-9.73568 (-1.347)	+.93853 NEARMAX (24.939) [-1.634]	+.30199 ROLLBP (8.046) [-18.599]	2.005

* - NLAG (Number of lagged periods) = 1

** - NLAG = 2

a - parentheses indicate H^o: $\beta = 0$ at $p = .05$

b - square brackets indicate H^o: $\beta = 1$ at $p = .05$

References

Anderson, R. W. and J. P. Danthine. "Cross Hedging." Journal of Political Economy. 89 No. 1(1981):1182-1196.

Brown, Stewart L. "A Reformulation of the Portfolio Model for Hedging." Amer. J. Agri. Econ. 67(1985):508-12.

Carter, C. W., and R. M. A. Loyns. "Hedging Feedlot Cattle: A Canadian Perspective." Amer. J. Agri. Econ. 67(1985):32-39.

Chalupa, Karel V. "Foreign Currency Futures: Reducing Foreign Exchange Risk." Economic Perspectives. Federal Reserve Bank of Chicago (Winter 1982):3-11.

Dale, Charles. "The Hedging Effectiveness of Currency Futures Markets." J. Futures Markets. 1(1981):78-88.

Elam, Emmett W., Stephen E. Miller and Shelby H. Holder. "Simple and Multiple Cross-Hedging of Rice Bran." Southern J. of Agri. Econ. 18(July 1986):123-28.

Elton, E. J. and M. J. Gruber. Modern Portfolio Theory and Investment Analysis. New York: John Wiley and Sons, 1984.

Grammatikos, T. and A. Saunders. "Stability and the Hedging Performance of Foreign Currency Futures." J. of Futures Markets. 3(3)(1983): 295-305.

Hill, Joanne and Tom Schneeweis. "A Note on the Hedging Effectiveness of Foreign Currency Futures." J. Futures Markets. 1(1986):659-64.

Johnson, L. L. "The Theory of Hedging and Speculation in Commodity Futures." Rev. of Econ. Studies. Vol. 27, No. 73(1960):139-151.

Judge, G. G., R. C. Hill, W. Griffiths, and T. C. Lee. The Theory and Practice of Econometrics. New York: John Wiley and Sons, Inc., 1980.

Kahl, Kandice H. "Determination of Recommended Hedging Ratio." Amer. J. of Agri. Econ. 65(1983):603-5.

Kuhn, Betsy A. Hedging Effectiveness of Domestic Versus International Futures Markets for Developing Countries. Research Report CFTC working paper #86-1, Commodity Futures Trading Commission, Washington, D.C., July 1986.

Marmer, Harry S. "Portfolio Model Hedging with Canadian Dollar Futures: A Framework for Analysis." J. of Futures Markets. 6(1)(1986):83-92.

Miller, S. "Forward Pricing Distillers Dried Grains." Feedstuffs. 54(April 1982):26-27.

________. "Simple and Multiple Cross Hedging of Millfeeds." J. of Futures Markets. 5(1)(1985):21-28.

Nelson, R. D. and R. A. Collins. "A Measure of Hedging's Performance." J. of Futures Markets. 6(1)(1985):45-55.

Peck, A. E. "Hedging Income Stability: Concepts, Implications, and an Example." Amer. J. of Agri. Econ. 57(1975):410-419.

Stein, J. L. "The Dynamics of Spot and Forward Prices in an Efficient Foreign Exchange Market with Rational Expectations." Amer. Econ. Rev. 70(1980):565-583.

Thompson, Sarahelen. "Use of Futures Markets for Exports by Less Developed Countries." Amer. J. Agri. Econ. 67(1985):986-91.

Thompson, Stanley R. and Gary E. Bond. "Basis and Exchange Rate Risk in Offshore Futures Trading." Amer. J. Agri. Econ. 67(1985):980-85.

______________. "Offshore Commodity Hedging under Floating Exchange Rates." Amer. J. of Agri. Econ. 69(1987):46-55.