Price Discovery and Risk Management in the Sunflower Market

by

William W. Wilson

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Introduction

One of the major sources of risk for participants in the sunflower market is that related to volatility in prices. The sunflower market reflects price movements in the world oilseed complex, as well as price movements in response to its own fundamentals. Price risk appears to be somewhat greater in the sunflower market than the world oilseeds market and other markets. This is due to many factors including the following: variability in weather in concentrated growing regions, as opposed to more dispersed areas planted to other crops; relatively inelastic demands in some markets; and the lack of government programs in major producing countries. For these reasons evaluation of the efficiency of alternatives for reducing price risk for participants in the sunflower market is particularly important.

Sunflower production has increased significantly since 1970 and is produced largely in the upper Midwest. In 1984 major producing states included the following with the figure in parentheses indicating percentage of U.S. production: North Dakota (75.6), South Dakota (14.8), Minnesota (8.4), and Texas (1.2). In the recent three years there has been a gradual reduction in production largely in response to the increasing relative attractiveness of wheat and barley which are the major alternative crops and which have economics that are highly dependent upon government programs. In the past several years, however, increased sunflower production has occurred in Kansas, Nebraska, and Texas.

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There are several distinguishing characteristics of sunflower which are important to its pricing. First, no government programs exist for sunflower, although there has been debate in recent years to establish a program. The sunflower market is, however, significantly influenced by the markets of wheat and barley, which are major competitors in production. In the major producing region, producers are highly participative in farm programs, and thus, increasing attractiveness of these programs have an adverse influence on nonprogram commodities, such as sunflower. Sunflower is used to produce a high-valued oil and a lower-valued meal, relative to soybeans. Sunflower is very oil intensive with extraction rates of about 39 percent as opposed to 18 percent for soybeans. Traditionally, meal has been of greater value and was the driving force behind the oilseed complex. However, in recent years the proportion of oil value to the total value of oilseeds has increased and thereby changed the relationship between oilseeds of different oil intensities. Export demand plays a significant role in the sunflower market because roughly 90 percent of the production is exported either as the raw product or oil. Major consuming countries include Mexico, Portugal, and the EEC; the major direct competitor is Argentina.

For major commodities, such as wheat, corn, and soybeans, active futures markets exist and provide effective hedging opportunities and means of price discovery. However, there is not an active futures market for sunflower, although one temporarily existed at the Minneapolis Grain Exchange. In addition, a futures market exists for sunflower at the Buenos Aires Grain Exchange, but its use is largely limited to domestic Argentine processing and speculation. Alternative hedging markets for sunflower merchants include use of cash forward markets and/or cross-hedging into one or more futures markets, primarily those of the soybean complex. The most active cash forward market for sunflower is the FOB Duluth market which has been active since 1974. Major terms of the contract are as follows: quantity = 1,000 metric tons, quality is basis 40 percent oil with standardized premiums and discounts for other quality parameters; delivery exspout at a safe Duluth/Superior berth; and delivery months exist throughout the shipping season but November and May dominate. Trading in the FOB Duluth market is marginless and is facilitated by commercial brokers who receive and disseminate bids and offers. The FOB Duluth market can be used not only for traditional hedging (i.e., as a temporary substitute for a cash position), but also as a means to procure sunflower seeds by exporting or importing firms. Other cash forward markets exist for sunflower and sun oil at C&F positions. The most prominent of these markets are FOB New Orleans and ex-tank Rotterdam; however, these are not analyzed in this study.

Producers cannot make extensive use of these forward markets for contracting because of the delivery terms, particularly quantity. In fact, many country elevators would have insufficient volume to use these markets. However, by accumulating purchases from many producers, country merchants can use these markets. Nevertheless, forward contract prices are related to those of the Duluth FOB market.

The other major alternative for risk reduction in the sunflower market is that of cross-hedging into one or more futures markets. In cross-hedges, futures positions need to be lifted at the time the cash transaction is made, as opposed to the alternative in the cash forward market which is conducive to making or receiving delivery. Although cross-hedges could conceivably be placed in a multitude of futures markets, those with the greatest potential are likely soybeans or soybean oil which have a high degree of interdependence and substitutability. The effectiveness of cross-hedging depends on the correlation between price changes in the spot market and futures markets (e.g., between spot Duluth and Chicago soybean oil). If highly correlated, the cross-hedge would be effective.

This paper has two purposes. One is to analyze the performance of the Duluth FOB market. Tests for bias and forecasting ability are presented. The second purpose is to analyze the effectiveness of the hedging alternatives available to participants in the sunflower market. Specific comparisons are made between hedging in the Duluth FOB market, in the soybean complex, as well as multiple-market hedges.[1]

Performance of the Duluth FOB Sunflower Market

The Duluth FOB market has dominated pricing of sunflower in the past ten years. In fact, some industry participants have indicated that the demise of the sunflower futures market was because the paper markets (e.g., Duluth FOB) already provided very efficient pricing discovery and hedging mechanisms.[2] Nevertheless, because the Duluth FOB market is nontraditional in the futures market sense and because of its dominance, it is imperative to analyze its performance. In this section its performance is analyzed from a price discovery perspective. Tests are conducted for forecasting accuracy and bias.

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[1]This paper is a brief summary of a more detailed report which discusses methodology and results more thoroughly, as well as presents more extensive analysis (see Wilson forthcoming).

[2]The sunflower futures market existed for a brief period in the early 1980s and has been the subject of a previous analysis (Gordon). There were three major conclusions from that study. First, the basis did not have a significant trend, contrary to anticipation. Second, the hypothesis of randomness could not be rejected in most contract months, despite the thinness in trading. Third, the hypothesis of no bias could not be rejected. However, these conclusions were tentative due to data limitations. Since this study was completed the sunflower futures has been inactive and most functions of a futures market are assumed by the FOB markets.

The FOB market provides a price discovery mechanism which is important in and of itself even if participants do not use these markets for hedging. The price discovery function of the FOB market requires a test of forecasting ability. Stein has demonstrated that economic welfare is dependent on forecasting accuracy. Producers and other participants make allocative decisions based on prices generated from this market. Prices which are poor forecasts would result in resource misallocation throughout the system. The forecasting ability of the FOB sunflower market, therefore, was tested by using the mean squared production error (MSE) and by comparing the results to test results of the soybean oil futures market, a highly liquid market comprised of a large number of hedgers and speculators. The comparison is relevant because sunflower is very oil intensive and a competitive commodity in consumption.

Preplanting prices were compared to postharvest prices for each crop year from 1975-1984. The November FOB price was used for sunflower, and the December contract was used for soybean oil. Results are shown in Table 1. Comparison of the MSE indicates the FOB sunflower market does a superior job compared to soybean oil in predicting postharvest prices.[3] Given these results there is no reason to fault the FOB market on the basis of forecastii inaccuracy. Preplanting bids derived from the FOB market would not distort resource allocation due to forecasting inaccuracy.

The FOB sunflower market could potentially be characterized as a "thii market" being dominated by large hedgers and few, if any, speculators. Smal hedgers are discouraged because of contract size, and speculators would be discouraged because of potential illiquidity and delivery as well as the

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[3]The calculated MSE for the FOB sunflower market is also significantl less than those calculated for Winnipeg barley and Chicago corn when correct for measurement units (see Carter).

requirements to assure financial performance. Thin markets tend to favor buyers on the assumption that hedgers are predominately short. Long positions would be taken only if deferred prices are sufficiently depressed. Consequently, prices are biased downwards due to the excessive short hedging. This logic corresponds to the general theory of normal backwardation first discussed by Keynes and subsequently tested in many studies.

TABLE 1. PLANTING TIME AND POSTHARVEST FOB SUNFLOWER AND DECEMBER SOY OIL PRICES, 1975-84

Year	Planting Time FOB Sunflower Price[a]	Postharvest FOB Sunflower Price[b]	Planting Time December Soy Oil Futures Price[c]	Postharvest December Soy Oil Futures Price[d]
	$/cwt.			
1975	12.26	11.94	23.20	20.00
1976	10.99	14.08	17.15	22.45
1977	13.67	9.22	26.70	18.30
1978	N/A	N/A	21.75	25.65
1979	11.44	9.85	25.15	26.05
1980	10.26	12.22	22.50	24.70
1981	13.40	10.99	27.45	21.16
1982	11.53	9.40	20.45	17.40
1983	10.22	14.40	20.30	29.90
1984	12.26	N/A	26.65	28.07
Mean Square Error	7.9550		27.2793	

[a]Price of November FOB sunflower on or about April 1.
[b]Price of November FOB sunflower on or about November 1.
[c]Price of December soy oil futures on or about April 1.
[d]Price of December soy oil futures on or about November 1.

The FOB sunflower market was tested for market bias using a hypothetical trading routine similar to Gray, and recently used by Carter. It involves purchasing each futures contract on the first trading day in the delivery month of the preceding futures contract and then selling it on the first trading day of its own delivery month. This routine hedging was initiated on November 1, 1974, and was terminated on November 1, 1984. There were 17 trades, and the average profit per trade was $-.033 which was not significantly different from zero at the 5 percent level. These results are similar to an active futures market where the Keynes risk premium is bid close to zero. The market is not biased in favor of long hedgers and speculators. One possible reason for the lack of market bias in the traditional sense may be due to excessive long hedging. The underlying logic to test for market bias is due to excessive short hedging; however, in the case of the FOB sunflower market which is used extensively by importers, processors, and exporters, excessive long hedging may be more prominent.

Hedging and Cross-Hedging of Sunflower

Larger participants in the sunflower market have long been aware of and have used the FOB sunflower market for pricing and hedging purposes. Smaller hedgers have traditionally used forward contracts derived from FOB prices. Since the rise and fall of the sunflower futures market there has been a plethora of interest by producers and other smaller hedgers in cross-hedging sunflower positions in the Chicago Board of Trade soybean complex. This interest was brought on primarily by the promotion from various brokerage houses and by the apparent demand for risk management alternatives. There are two basic issues involved in the subject of cross-hedging. One is, how effective is the hedge and how does that compare to the alternatives? Second is, how much should be hedged, especially for commodities with uncommon units of measurement and value? The purpose of this section is to (1) compare the effectiveness of hedging sunflower positions in the FOB Duluth sunflower market, versus cross-hedging in the soybean complex; (2) analyze the stability of the hedge ratios; and (3) analyze the effectiveness of multimarket hedges for cash sunflower positions.

Theoretical and Empirical Models

Johnson and Stein in two independent papers have developed a theory of hedging which can be used to compare hedging effectiveness across markets and to determine optimal hedge ratios. Risk of price changes is introduced into the hedging model in a variance function, and a frontier is traced showing a relationship between variance (risk) and expected returns. Hedgers select the proportion of their cash position which is hedged according to their indifference between risk and expected returns. Spot and futures prices are treated as separate assets in a portfolio. The size of the position in the spot market can be viewed as fixed and the hedger's decision is to determine the proportion of the spot position that should be hedged. The theory has been generalized in the case of cross-hedging by Anderson and Danthine.

Two equations are presented throughout development of the theoretical model. One is an equation of expected revenue from holding a commodity, E(R). The other is the price risk of handling that commodity. In the two-market case, (i.e., one spot market and one hedging market [futures or forward delivery such as the FOB sunflower]) the equations are

$$E(R) = X_1 E(P_{1t+n} - P_{1t}) + X_2 E(P_{2t+n} - P_2) \quad (1)$$

$$V(R) = X_1^2 \sigma_1^2 + X_2^2 \sigma_2^2 + 2X_1 X_2 \sigma_{12} \quad (2)$$

where X_i = quantity of commodity held in market i (i = 1,2)

P_{it+n} and P_{it} = expected prices in time t+n and t respectively in market i

σ_i^2 = variance of price changes in market i

σ_{12} = covariance of price changes between markets 1 and 2.

The variance of price risk is the variance of a subjective probability distribution of price changes from t to t+n that is held by the trader at t when actual price change from t to t+n is random. X_1 and X_2 indicate the size of the positions held in market 1 and market 2, respectively. In a long cash/short future position, $X_1 \geq 0$ and $X_2 \leq 0$.

To derive the optimal hedged position, V(R) is minimized with respect to X_2. If $X_1 = 1$, the optimal hedge ratio is

$$X_2^* = - \frac{\sigma_{12}}{\sigma_2^2} \qquad (3)$$

which indicates the proportion of the cash position which should be hedged in order to minimize risk. So long as $\sigma_{12} > 0$, X_2^* will be opposite in sign from X_1.

A measure of the effectiveness of hedging can be derived from the relationships developed above. The variance of return in an unhedged position is given by $V_1(R) = \sigma_i^2$, and that in an optimal hedged position is $V(R)^* = \sigma_i^2 (1 - \rho ij^2)$. The effectiveness of the hedge is the extent to which risk is reduced in the optimal hedge case, relative to an unhedged position. An empirical measure of the effectiveness of a hedge is

$$E = 1 - \frac{V(R)^*}{V_1(R)} \qquad (4)$$

which in the two market cases can be reduced to

$$E = \rho ij2 \qquad (5)$$

where ρ_{ij} is the correlation coefficient between price changes in the two markets. E is a measure of hedging effectiveness and can be interpreted as the average proportional decrease in spot price risk that could be realized by hedging at X_j^*. A large value of E indicates a more effective hedge in terms of risk reduction. As E approaches 0, less risk reduction is obtained from the hedge.

Hill and Schneeweis (1981) and Ederington, as well as others, have shown that parameters estimated from ordinary least square regression of spot price changes on future price changes are equivalent to the results from the minimization problem above. In particular, the slope coefficient and coefficient of determination from the following equation are equivalent to the optimal hedge ratio and measure of hedging effectiveness, respectively:

$$\Delta CP = \gamma_0 + \beta_1 \Delta FP \qquad (6)$$

where CP and FP are cash and futures price respectively, and γ_0 and β_1 are parameter estimates. The change in prices is over some time horizon relevant to the particular hedging analysis. Others have regressed cash and futures price levels (not changes), but it has been demonstrated that use of price changes is more appropriate. Parameters derived from price level regressions are biased upwards, suffer from potential autoregression problems, and should be interpreted differently (Hill and Schneeweis 1981). These procedures have been used extensively in the analysis of hedging and spreading wheat (Wilson 1983), foreign exchange (Hill and Schneeweis 1982; Grammatikos and Saunders), financial instruments (Hill, Liro, and Schneeweis), barley (Carter), and potatoes (Kahl and Tomek). It is also particularly attractive and been used extensively in the analysis of cross-hedging (Miller; Miller and Luke; Elam, Miller and Holder; Hayenga and DiPietre 1982a, 1982b) because the hedge ratio is unknown and can be derived from the analysis.

The empirical equation could also be interpreted as the relationship between price changes in two markets where β indicates the corresponding changes and γ accounts for price changes not related to those in the other market. In practice it is unrealistic to assume that either the intercept or slope are constant through time. Studies on other commodities have demonstrated that hedge ratios (i.e., β) vary through time and with respect to other variables (Grammatikos and Saunders; Miller and Luke; Hill, Liro, and Schneeweis). The intercept term should also be allowed to vary, reflecting a change in the normal basis relationship, particularly in carrying charge markets where it appreciates in the postharvest period. In cross-hedging, the intercept term could also vary with inclusion of other fundamental variables. In this study the stability of the hedge ratios, and the intercept term are tested for seasonality and other fundamental variables.

In cross-hedging cash sunflower positions, it is possible and potentially desirable to simultaneously use more than one market for hedging. Sunflower, being composed of both oil and meal, may justify opposite positions in at least these two markets. However, in general, it is conceivable that hedges could be spread across an infinite number of hedging markets. A four-market portfolio, for example, would be comprised of one cash and three markets for hedging. The E(R) and V(R) are derived from expanded versions of (1) and (2) above.[4] Minimizing the V(R) in a four market model and setting

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[4]In the general case of n positions or assets in a portfolio, the variance of return is as follows:

$$V(R)1 = \sum_{i=1}^{n} X_i^2 \sigma_i + 2 \sum_{i=1}^{n} \sum_{j>1}^{n} X_i X_j \sigma_{ij}$$

$X_1 = 1$ gives a system of three equations and three unknowns that can be stated in matrix form as follows:

$$\begin{bmatrix} \sigma_2^2 & \sigma_{23} & \sigma_{24} \\ \sigma_{23} & \sigma_3^2 & \sigma_{34} \\ \sigma_{24} & \sigma_{34} & \sigma_4^2 \end{bmatrix} \begin{bmatrix} X_2 \\ X_3 \\ X_4 \end{bmatrix} = \begin{bmatrix} -\sigma_{12} \\ -\sigma_{13} \\ -\sigma_{14} \end{bmatrix}$$

and solved for X_2, X_3, and X_4 which represent positions in the hedging markets. The second-order conditions are satisfied as long as $\sigma_i > 0$. The solution to the equation system yields values for X_2^*, X_3^*, and X_4^* which can be interpreted as the size of the optimum positions held in each of the respective futures markets.

The spot price used in the analysis is the track-Duluth price for sunflower (results would vary of course, if different cash prices were used), and weekly prices were taken from the annual report of the Minneapolis Grain Exchange. Futures prices were taken from the annual report of the Chicago Board of Trade. FOB Duluth sunflower prices are not published but were obtained from industry participants. Weekly data (every Thursday) were used throughout the analysis. Data for analysis of cross-hedging covered the crop years (September-August) from 1977 to 1984. Analysis of hedging in the FOB market commenced in the 1979 crop year due to noncontinuous data prior to 1979. The results reported here show the analysis of 12-week price changes. Analysis of hedges of different durations were conducted; the results are similar but are not reported here. The Chow test was used to test hypotheses about stability of the regression coefficients. Inclusion of other commodities in the multimarket hedge was tested by sequentially including their price changes in the regression and evaluating the t-statistic.

Autoregressive correction procedures were used to adjust the data series and re-estimate the parameters where appropriate.

Empirical Results

The success of hedging and cross-hedging depends on the correlation between changes in spot prices and those in the futures or forward markets. The price behavior of relevant commodities is shown in Figure 1 (average by month) since 1979. Table 2 shows the correlation matrix for 12-week price changes in the Duluth spot market and the other markets. The coefficients indicate that soybeans, soybean oil, and the FOB market have correlations to the spot sunflower price similar in magnitude. The correlation of spot Duluth sunflower with soybean oil is the highest at 0.59. Also, the soybean oil market is correlated the highest with the FOB Duluth sunflower market.

TABLE 2. CORRELATION MATRIX OF PRICE CHANGES IN THE U.S. SUNFLOWER AND SOYBEAN MARKETS

	Duluth Sunflower Spot	Chicago Futures			Duluth Sunflower FOB
		Soybeans	Soybean Oil	Soybeans Meal	
Spot Sunflower	1.0	.55	.59	.41	.49
Chicago Futures					
Soybeans		1.0	.89	.87	.66
Soybean Oil			1.0	.71	.68
Soybean Meal			1.0		.58
FOB Duluth					1.0

Note: Correlations are of 12-week price changes at each of the markets. Analysis included 1977-84 with the exception of the FOB Duluth market which was from 1979-84. Nearby futures options were used throughout.

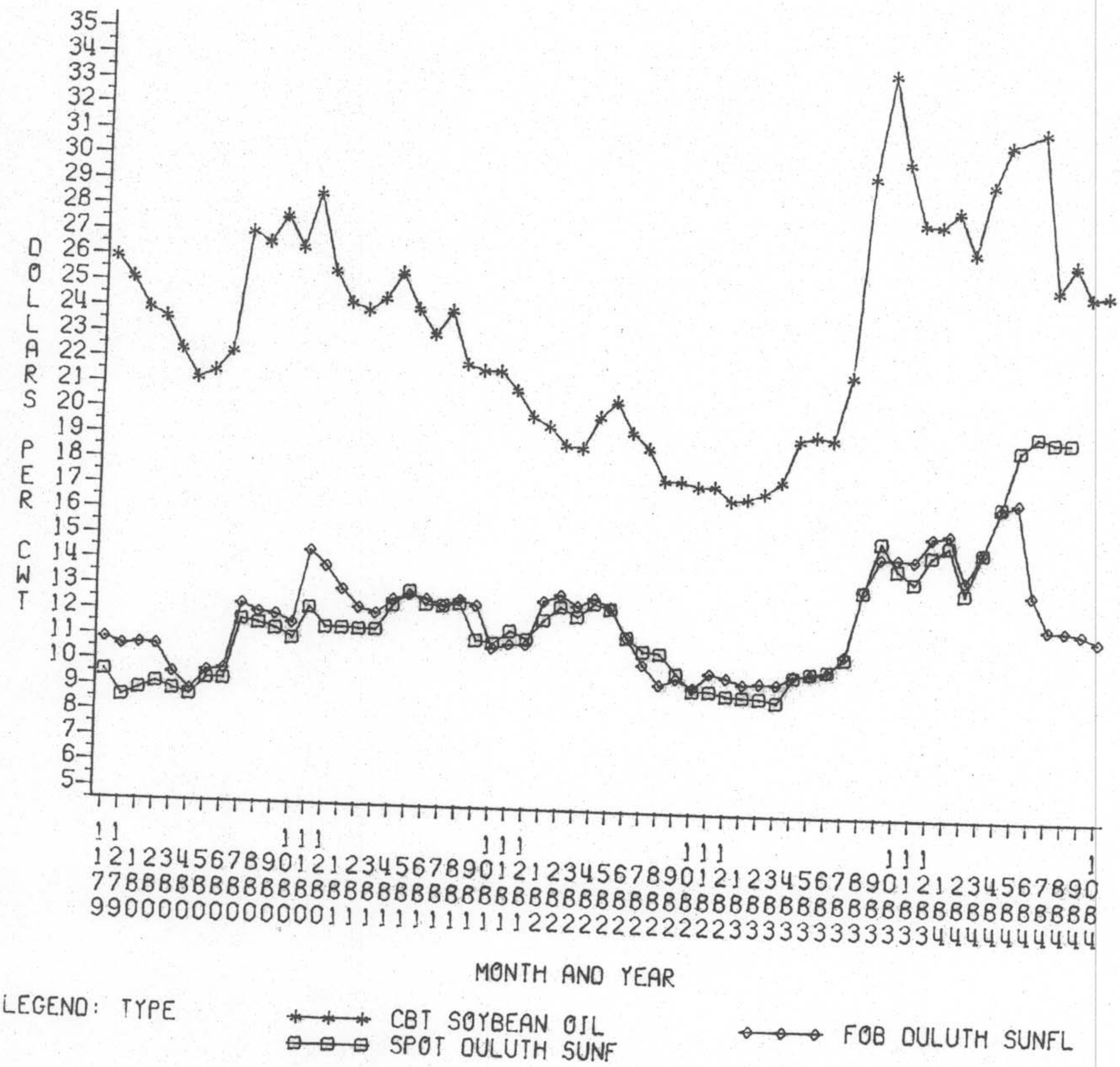

Figure 1. Sunflower and Soybean Oil Prices, 1979-1984

The optimal hedge ratios (HR*) and measures of hedging effectiveness (E) for each of the markets are shown in Table 3. In the top part of that table the parameters were estimated for more aggregate time periods, whereas in the lower part they were estimated for each crop year individually. E indicates the percentage that price risk is reduced by the hedged position. The results indicate that the hedging effectiveness of soybean oil and the FOB market are comparable, but the others are less. The optimal hedge ratios indicate the number of bushels or pounds required in the soybean oil futures market to minimize risk; the optimal hedge requires .34 pounds of oil for every pound of sunflower in the cash position (i.e., a long cash position of 500,000 lbs. requires a sale of 170,000 lbs. of oil which due to contract size would be two or three contracts, resulting in a net portion either over- or underhedged). Similarly, .0086 bushels of soybeans would be required to hedge 100 lbs. of sunseeds.[5]

The lower portion of Table 3 indicates the HR and E for each crop year individually. The results indicate that in each market these parameters are quite unstable, deviating from the more aggregated analysis substantially. The optimal hedge ratios for soybean oil range from .06 to .52;[6] and those for FOB Duluth range from .39 in 1981-82 to .83 in 1983-84. Similar variations exist in the measure of hedging effectiveness. For example, the effectiveness of the soybean oil for hedging spot sunflower at Duluth ranges from .03 to .72, which is the proportion that risk is reduced. These results are particularly important for merchants' cross-hedging of sunflower into soybeans or soybean oil. Use of an overall hedge ratio (i.e., .34) derived from

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[5]Using price levels instead of price changes results in significantly different coefficients. For example, price level regression on the FOB market yields a hedge ratio of .67 versus .52 using price changes.

[6]However, in four of the past five years they ranged from .30 to .33.

TABLE 3. OPTIMAL HEDGE RATIOS AND MEASURES OF HEDGING EFFECTIVENESS FOR HEDGING SUNFLOWER SPOT DULUTH, 1977-84, 1979-84 AND FOR INDIVIDUAL CROP YEARS

	Hedging Market							
	Chicago Futures						Duluth Sunflower FOB	
	Soybeans		Soybean Oil		Soybean Meal			
	HR	E	HR	E	HR	E	HR	E
1977-84	.0086	.16	.27	.31	.027	.16	---	
1979-84	.0086	.26	.29	.34	.028	.18	.52	.31
Crop Year								
1977-78	.0138	.41	.52	.72	.03	.14	---	
1978-79	.0123	.36	.17	.12	.02	.10	---	
1979-80	.0117	.21	.33	.20	.02	.06	.40	.14
1980-81	.0080	.42	.31	.53	.02	.36	.52	.44
1981-82	.0055	.12	.06[2]	.03	.02	.13	.39	.35
1982-83	.0095	.40	.30	.61	.03	.36	.57	.34
1983-84	.0099	.36	.33	.59	.04	.29	.83	.56

[1]Derived assuming 12-week hedges in each market. t-ratios are not shown but all are significantly different from zero at the 10 percent level except as indicated in 2 below. All regressions were adjusted for first order autoregression.
[2]Not significantly different than zero at the 10 percent level (N15).

aggregate data may not be very effective in reducing risk in particular years. Using the aggregate ratio for soybean oil would have resulted in being overhedged in some years and underhedged in others. The likely cause of this instability in hedge ratios is the fundamentals of the oilseeds markets. Of particular importance is (1) supply/demand conditions in sunflower; and (2) whether the oilseed market is being driven by the oil value or meal value (see Wilson 1985 for a more thorough discussion and analysis of this problem).

Consequently, merchants cannot divorce hedging decisions from fundamental market analysis, especially in the case of cross-hedging.

In addition to fundamental factors influencing price relationships, potential exists for the hedge ratios and intercepts to vary seasonally. This is especially important in the case of sunflower where the seasonal fundamentals differ slightly from soybeans, and the export of which is constrained by opening and closing of the Great Lakes. Consequently, it is very logical that hedge ratios and intercepts vary seasonally and with respect to other variables.

Several hypotheses were posed and tested regarding the stability of the hedging parameters. First, the intercept and slopes of the basic model were hypothesized to vary seasonally. Second, an attempt was made to capture the effect of two basic fundamental variables on the intercept and/or slopes. The total supply of sunflower (TS in 000 metric tons) was included as well as the ratio, R, of soybean oil to meal prices. The former was included to allow for the effects of variable supply conditions and its influence on price relationships. A larger total supply should reduce the sunflower price relative to soybeans and soybean oil. Another important phenomena in the price relationship is whether the market is being dominated by oil or meal. Traditionally, soybean meal dominated and oil was of lesser significance. However, recently oil has tended to give the market strength, and has been favorable to sunflower due to the oil intensiveness. To capture this phenomena, R was included as both a slope and intercept shifter. Covariance analysis was used to test each of these hypotheses either by themselves or jointly.

The results of selected equations are shown in Table 4. In all cases the hypothesis that the slope coefficients (i.e., hedge ratios) varied

TABLE 4. HEDGE RATIOS AND EFFECTIVENESS AND THE EFFECTS OF OTHER VARIABLES

	Hedging Market					
	Chicago				Duluth	
	Soybeans		Soybean Oil		Sunflower FOB	
Int.	-3.31	(3.51)[1]	-.23	(.67)	-1.67	(1.98)
ΔP_j	.007	(9.45)	.23	(10.66)	.53	(12.48)
TS	x[2]		x		-.0006	(3.55)
$\Delta P_j \cdot TS$	x		x		x	
R	24.80	(3.48)	x		20.03	(3.67)
$\Delta P_j \cdot R$	x		x		x	
S_{12}	.28	(1.25)	.17	(.78)	.18	(.70)
S_1	.54	(1.82)	.52	(1.77)	.63	(1.99)
S_2	.26	(.79)	.15	(.46)	.76	(2.28)
S_3	.57	(1.63)	.50	(1.43)	1.31	(3.92)
S_4	.79	(2.16)	.68	(1.87)	1.58	(4.72)
S_5	.82	(2.22)	.77	(2.11)	1.78	(5.31)
S_6	.99	(2.71)	.97	(2.68)	1.59	(4.73)
S_7	.94	(2.65)	1.01	(2.88)	1.35	(4.08)
S_8	.61	(1.82)	.73	(2.21)	1.41	(4.27)
S_9	.30	(1.02)	.34	(1.15)	.83	(2.62)
S_{10}	.16	(.72)	.16	(.69)	.35	(1.29)
R^2	.27		.29		.53	
MSE	.32		.31		.42	
ρ	-.88		-.88		-.59	

[1] t-ratios are shown in parentheses.
[2] x indicates variable not included.

seasonally could not be accepted and those variables were deleted. The effect of TS and R did not have a significant impact on either the slope or intercept coefficients in the soybean oil equation. The intercept however does have a significant seasonal variation. The seasonal coefficients should be interpreted relative to the intercept which reflects November, the first postharvest month. They are all positive and significant in January and April through August. The latter period corresponds with the beginning of the shipping season (April) through the last month prior to the beginning of harvest. During this period sunflower prices normally appreciate relative to soybean oil, and the value of the coefficient indicates the extent of the increase. The slope coefficient of the soybean equation is not significantly affected by either TS or R; however, the effect of R does have a positive and significant influence on the intercept. As oil prices increase relative to meal, the intercept term increases, reflecting the increase in sunflower prices relative to soybeans. Seasonal variation in the intercept is similar to that of soybean oil. Neither TS nor R has a significant influence on the slope; but both have a significant effect on the intercept in the FOB Duluth equation. Increases in TS shift the FOB price downward relative to the spot but the slope is unchanged; increases in R increase the spot value Duluth sunflower relative to the FOB. This likely indicates the effect of domestic processors bidding sunflower away from the export market. Seasonal shifts in the intercept are similar though the peak is reached earlier than in the cross-hedge alternatives. There was a significant increase in the hedging effectiveness in the FOB.

In traditional hedging opposite positions are placed in one market directly or indirectly related to the spot market. It is also possible to spread hedges across more than one futures/forward market. For example, in the case of spot sunflower it is conceivable that a multimarket hedge would include soybean oil and meal, or corn. The latter two are included to capture the meal portion of the sunflower price. Indeed crushing margins commonly used in soybeans are hedges spread across more than one market.

Portfolio analysis was used to determine the extent that risk could be further reduced by placing hedging in more than one market. The FOB and soybean oil markets were used as base models. Variables representing price changes in other markets were successively added into the analysis individually. Other markets include soybeans, soybean meal, and corn. Multimarket portfolios across more than two hedge markets did not significantly improve the risk reduction potential in all cases, and are not reported here. Seasonal intercepts and slopes were included, but only the intercepts were significant and included in the results presented here. The period of analysis for multimarket hedging was limited to 1979-84 for data reasons.

The results are reported in Table 5. When the FOB market is used as the base model, the t-ratios for each additional market were significant. The largest risk reduction potential is obtained from spot positions hedged in both the FOB and soybean oil futures markets. The optimum portfolio is comprised of 32.8 and 23.5 percent allocated to each market, respectively. Hedging effectiveness (E) increased from .48 to .57 by including soybean oil as part of a multimarket hedge. The seasonal intercepts represent monthly change in spot prices not related to either of the two included markets. Those for December through August are all significant with the coefficient value, increasing to a peak in May (of $1.51/cwt. from November) and declining thereafter.

TABLE 5. MULTIMARKET HEDGING OF SUNFLOWER IN THE SOYBEAN COMPLEX, CORN AND FOB DULUTH, 1979-84[1]

	Hedging Markets								
	Duluth FOB With:					CBT Soybean Oil With:			
		Soy-beans	Meal	Corn	Soy-bean Oil		Soy-beans	Meal	Corn
Int.	-.87 (3.46)	-.85 (3.55)	-1.00 (3.98)	-.86 (3.47)	-.73	-.54 (1.66)	-.54	-.56 (1.71)	-.55 (1.71)
Hedging Market(s)									
Duluth FOB	.60 (12.62)	.41 (7.94)	.49 (9.12)	.52 (10.24)	.328 (6.80)	X	X	X	X
CBT Soybean Oil	X	X	X	X	.235 (9.10)	.29 (11.42)	.25 (5.89)	.28 (7.92)	.27 (9.23)
CBT Soybean Meal	X	X	.15 (3.94)	X	X	X	X	.002 (.40)	X
CBT Soybeans	X	.006 (6.45)	X	X	X	X	.0016 (1.01)	X	X
CBT Corn	X	X	X	.011 (3.77)	X	X	X	X	.005 (1.43)
Seasonal Int. S17	.15 (.56)	.46 (1.82)	.38 (1.39)	.16 (.59)	.47 (2.00)	.41 (1.72)	.45 (1.83)	.43 (1.77)	.40 (1.67)
S1	.55 (1.67)	.83 (2.69)	.95 (3.14)	.58 (1.82)	.96 (3.10)	.79 (2.51)	.81 (2.54)	.83 (2.56)	.80 (2.53)
S2	.74 (2.12)	.86 (2.62)	1.11 (2.83)	.76 (2.24)	.75 (2.44)	.39 (1.09)	.42 (1.16)	.43 (1.18)	.43 (1.21)
S3	1.33 (3.79)	1.24 (3.75)	1.54 (4.41)	1.18 (3.42)	1.13 (3.57)	.78 (2.05)	.78 (2.06)	.81 (2.11)	.77 (2.01)
S4	1.64 (4.63)	1.52 (4.52)	1.75 (5.02)	1.48 (4.25)	1.28 (3.97)	.97 (2.45)	.98 (2.48)	1.00 (2.50)	.96 (2.42)
S5	1.95 (5.40)	1.78 (5.19)	2.06 (5.81)	1.83 (5.16)	1.51 (4.60)	1.30 (3.21)	1.30 (3.21)	1.32 (3.25)	1.29 (3.20)
S6	1.52 (4.07)	1.51 (4.26)	1.68 (4.57)	1.48 (4.04)	1.25 (3.69)	1.17 (2.85)	1.18 (2.89)	1.18 (2.88)	1.17 (2.87)
S7	1.34 (3.64)	1.25 (3.61)	1.46 (4.03)	1.37 (3.80)	1.02 (3.04)	1.05 (2.63)	1.06 (2.65)	1.06 (2.65)	1.08 (2.72)
S8	1.34 (3.66)	1.13 (3.27)	1.33 (3.74)	1.28 (3.59)	.87 (2.65)	.86 (2.33)	.87 (2.34)	.87 (2.33)	.87 (2.34)
S9	.73 (2.22)	.61 (2.00)	.75 (2.34)	.74 (2.32)	.32 (1.12)	.39 (1.25)	.41 (1.29)	.40 (1.26)	.40 (1.28)
S10	.36 (1.31)	.35 (1.38)	.34 (1.31)	.39 (1.47)	.19 (.82)	.15 (.64)	.18 (.72)	.15 (.64)	.16 (.68)
R^2	.48	.53	.50	.50	.57	.40	.40	.41	.41
ρ	-.64	-.67	-.65	-.65	.52	-.85	-.85	-.85	-.85

[1] t-ratios are in parentheses.

Also shown in Table 5 are multimarket hedges using soybean oil as the base model. None of the additional markets in the portfolio significantly improved upon the risk reduction potential of the single-market hedge (with the exception of inclusion of the FOB market). The seasonal intercepts are similar to prior results.

Summary and Conclusion

"Paper markets" provide important alternatives for price discovery and risk management for many commodities. In the case of sunflower, the Duluth FOB market provides similar functions to a futures market. Thus, alternatives for price risk management in the sunflower market include using the FOB market (or equivalently, a forward market) or cross-hedging into the soybean complex. The performance of the FOB market was evaluated with respect to forecasting ability and market bias. The MSE test indicated that the FOB market established price forecasts which were superior to those from the soybean oil futures. The results also indicated that prices were not biased in favor of long hedges and speculators.

The effectiveness of using the FOB market as a hedge was compared to cross-hedging. Optimal hedge ratios and measures of hedging effectiveness were calculated for each. The results indicated that, in general, hedges placed in the FOB market and cross-hedges in soybean oil were comparable, although the hedge ratios and effectiveness varied from year to year. Additional tests revealed that the intercept had significant seasonal variability. This is a reflection of the basis behavior which increases relative to November in January, and in April through August. The latter period corresponds with the beginning of the shipping season through to the last month prior to new crop harvest. During this period spot sunflower prices normally appreciate relative to other markets. The relative price of oil to meal also had a significant impact on the intercept in the soybean cross-hedges. As oil increases in value relative to meal the intercept increases, reflecting the increase in sunflower price relative to soybeans. Multimarket hedging is potentially attractive for cash sunflower positions, allowing a hedge against changes in both the value of meal and oil. When the FOB market was used as the base model, adding positions in other markets (soybeans, soybean meal and oil, and corn) increased the risk reduction potential of the hedge. The optimal hedge required the cash position to be spread across both the FOB market and soybean oil.

References

Anderson, R.W. and J.P. Danthine. "Cross Hedging." Journal of Political Economy, Vol. 89, No. 6 (1981): 1182-1196.

Carter, C. "An Evaluation of Pricing Performance and Hedging Effectiveness of the Barley Futures Market." Western Journal of Agricultural Economics, Vol. 9, No. 1 (July 1984): 1-13.

Ederington, L.H. "The Hedging Performance of the New Futures Market." Journal of Finance, Vol. XXXIV, No. 1 (March 1979): 157-170.

Elam, E.; S. Miller; and S. Holder. "Cross-Hedging Rice, Bran, and Mill Feed." Rice Situation, USDA (March 1984): 14-19.

Gordon, D. "Performance of Thin Futures Markets: Rice and Sunflower Seed Futures." Agricultural Economics Research, Vol. 36, No. 4 (Fall 1984): 1-16.

Grammatikos, T. and A. Saunders. "Stability and the Hedging Performance of Foreign Currency Futures." Journal of Futures Markets, Vol. 3, No. 3 (1983): 295-305.

Gray, R.W. "Price Effects of a Lack of Speculation." Food Research Institute Studies, supplement to Vol. VII (1967): 177-194.

Gray, R.W. "The Search for a Risk Premium." Journal of Political Economy, Vol. 69, No. 3 (1961): 250-260.

Hayenga, M. and D. DiPietre. "Cross-Hedging Wholesale Pork Products Using Live Hog Futures." American Journal of Agricultural Economics, Vol. 64, No. 4 (1982a): 747-751.

Hayenga, M. and D. DiPietre. "Hedging Wholesale Meat Prices: Analysis of Basis Risk." Journal of Futures Markets, Vol. 2, No. 2 (1982b): 131-140.

Hedge, S. "The Impact of Interest Rate Level and Volatility on the Performance of Interest Rate Hedges." Journal of Futures Markets, Vol. 2, No. 4 (1982): 341-356.

Hill, J. and T. Schneeweis. "A Note on the Hedging Effectiveness of Foreign Currency Futures." Journal of Futures Markets, Vol. 1, No. 4 (Winter 1981): 659-664.

____________. "The Hedging Effectiveness of Foreign Currency Futures." Journal of Financial Research, Vol. V, No. 1 (Spring 1982): 95-104.

Hill, J.; J. Liro; and T. Schneeweis. "Hedging Performance of GNMA Futures Under Rising and Falling Interest Rates." Journal of Futures Markets, Vol. 3, No. 4 (1983): 403-414.

Johnson, L.L. "The Theory of Hedging and Speculation in Commodity Futures." Review of Economic Studies, Vol. 27, No. 3: 139-151.

Kahl, K. "Determination of Recommended Hedging Ratio." American Journal of Agricultural Economics, Vol. 65, No. 3 (August 1983): 603-605.

Kahl, K. and W. Tomek. "Effectiveness of Hedging in Potato Futures." Journal of Futures Markets, Vol. 2, No. 1 (1982): 9-18.

Keynes, J.M. "Some Aspects of Commodity Markets." Manchester Guardian Commercial, European Reconstruction Series, Section 13 (1923): 784-786.

Leuthold, R.M. "The Price Performance on the Futures Markets of a Nonstorable Commodity: Live Beef Cattle." American Journal of Agricultural Economics, Vol. 55, No. 2 (1974): 271-279.

Miller, S. "Simple and Multiple Cross-Hedging of Mill Feeds." Journal of Futures Markets, Vol. 5, No. 1 (1985): 21-28.

Miller S. and D. Luke. "Alternative Techniques for Cross-Hedging Wholesale Beef Prices." Journal of Futures Markets, Vol. 2, No. 2 (1982): 121-129.

Peck, A. "Hedging and Income Stability: Concepts, Implications, and an Example." American Journal of Agricultural Economics, Vol. 57, No. 3 (1975): 410-419.

Rolfo, J. "Optimal Hedging Under Price and Quantity Uncertainty: The Case of a Cocoa Producer." Journal of Political Economics, Vol. 88, No. 1 (1980): 100-116.

Stein, J.L. "Speculative Price: Economic Welfare and the Idiot of Chance." Review of Economics and Statistics, Vol. 63, No. 2 (1981): 223-232.

Stein, J.L. "The Simultaneous Determination of Spot and Futures Prices." American Economic Review, Vol. LI, No. 5 (1961): 1012-1025.

Tomek, W.G. and R.W. Gray. "Temporal Relationships Among Prices on Commodity Futures Markets: Their Allocation and Stabilizing Rates." American Journal of Agricultural Economics, Vol. 52, No. 3 (1970): 372-380.

Wilson, W.W. "Cross-Hedging Versus Forward Contracting in Sunflower Marketing." The Sunflower (January 1985): 28-31.

Wilson, W.W. "Hedging Effectiveness of U.S. Wheat Futures Markets." Review of Research in Futures Markets, Vol. 3, No. 1 (May 1983): 64-87.

Wilson, W.W. Price Risk Management in the Sunflower Industry. Department of Agricultural Economics, North Dakota State University, Fargo (forthcoming).

Working, H. "Futures Trading and Hedging." American Economic Review, Vol. XLIII, No. 3 (June 1953): 314-343.

Working, H. "New Concepts Concerning Futures Markets and Prices." American Economic Review, Vol. LII, No. 3 (1962): 431-459.