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Suggested citation format:

Lewis, K. E., M. R. Manfredo, I. Altman, and D. R. Sanders. 2013. "Risk Premiums and Forward Basis: Evidence from the Soybean Oil Market." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [<http://www.farmdoc.illinois.edu/nccc134>].

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Karen E. Lewis, Mark R. Manfredo, Ira Altman, and Dwight R. Sanders\*

*Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis,  
Forecasting, and Market Risk Management  
St. Louis, Missouri, April 22-23, 2013*

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## **Risk Premiums and Forward Basis: Evidence from the Soybean Oil Market**

*Soybean oil is a primary ingredient in a number of food products, and is also one of the primary oils used in the production of biodiesel. Thus the price volatility of soybean oil represents a major input price risk to food and energy companies. Forward pricing is often extended to end-users by soybean oil processors where the forward price quote is a function of futures price and basis. If the end-user locks in the basis component, the processor assumes the risk of any basis fluctuations. This research examines if soybean oil processors extract a premium for assuming this risk. Using forward basis quotes and realized basis values for soybean oil provided by The Trade News Service, Inc., it was found that soybean oil processors do not charge an embedded cost for their forward pricing services. Furthermore, the results suggest that the absence of a statistically significant embedded cost may be due to the inability of soybean oil processors to adequately forecast soybean oil basis levels.*

**Keywords:** Soybean Oil, Basis, Forecasting

### **Introduction**

Soybean oil is the primary ingredient in fry oils, margarines, sauces, and salad dressings. For end-users of soybean oil such as restaurants (e.g., McDonald's) and food manufacturers (e.g. Frito Lay), expenditures on soybean oil constitute a significant portion of overall input costs. Also, due to mandates in blending levels, the biodiesel industry is expected to utilize over eight billion pounds of fats and oils (as of 2012), much of this soybean oil. Forward pricing is one way that these diverse end-users can manage the volatility of soybean oil input prices.

In the soybean oil market, forward pricing is extended by soybean processors to end-users where the soybean oil price (final product price) is a typical formula price that is a function of futures price and basis. These two components are delineated in the forward price quote allowing the end-user to "book the futures" or "book the basis" separately. Clearly, if the end-user wants to lock in the futures component, the processor simply makes the corresponding hedge in the futures market thus eliminating that price risk. However, if the end-user locks in the basis component, then the processor assumes the risk of any basis fluctuations. Specifically, the end-user has taken a long basis position leaving the processor short the basis relative to the quote they offered the end-user. Given this, an important question arises. That is, do soybean oil processors extract a premium for assuming this risk?

Indeed, the situation described above for soybean oil producers is not markedly different from grain elevators offering forward basis quotes to grain producers. For example, Elam and Woodworth (1989) calculate that forward contracting soybeans in East Central Arkansas costs 18¢ per bushel at 10 months prior to harvest and only 2¢ per bushel one month before harvest. Harris and Miller (1981) find that forward contracting corn and soybeans in South Carolina costs between 2¢ and 7¢ per bushel versus traditional futures hedging. Using more advanced modeling techniques, Townsend and Brorsen (2000) find that forward contracting Oklahoma

hard red winter wheat one hundred days before harvest costs 6¢ to 8¢ per bushel, while Shi, Irwin, Good and Hagedorn (2004) estimate that the cost of forward contracting corn in Illinois is 1¢ per bushel at one hundred days prior to harvest. Most recently, Stringer and Sanders (2006) find that the cost of forward contracting in the different regions of Illinois are essentially zero for corn, but as much as 7¢ per bushel for soybeans.

Therefore, the overall objective of this research is to examine forward basis quotes for soybean oil to determine if soybean oil processors are realizing a premium for providing end-users the benefit of locking in their forward basis. Specifically, this research will expand on the existing literature regarding forward contracting premiums by examining a unique data set for soybean oil. In the soybean oil markets, processors frequently offer forward basis quotes to end-users, which serve as one portion of typical cost-plus formulations for items such as fry oils, margarine, and salad dressings. While these forward basis quotes are transmitted daily to soybean processors' customers, they are not reported by the USDA or other public agencies. However, a private firm, The Trade News Service, Inc., (TNS) reports these forward prices in their weekly newsletter. The TNS forward quotes will first be examined for bias to detect if soybean processors are indeed reaping a premium for providing end-users the benefit of locking in their forward basis. Second, the basis quotes will be examined for their forecast properties, namely efficiency as well as accuracy over time.

This research is important for several reasons. First, the empirical results provide additional evidence on premiums embedded in forward basis quotes and further our understanding of this important market. Second, the findings will help end-users of soybean oil better assess the relative benefits of securing basis levels in advance of the procurement window. Given the importance of basis and forward contracting in agricultural risk management (Tomek and Peterson, 2001), it is crucial that parties understand the magnitude of these embedded costs in order to make informed decisions among alternative forward pricing methods. Also, in order for soybean oil processors to effectively charge an embedded cost for their forward basis contracts (if this in fact is their ultimate strategy) it is necessary for soybean oil processors to accurately forecast the soybean oil basis. Thus the results presented here provide insight into how good soybean oil processors are at forecasting the soybean oil basis.

## **Data**

TNS gathers basis quote information by surveying market participants, and therefore the forward basis quotes TNS reports essentially reflect an average of all the soybean processors' quotes. The forward basis quotes reported by TNS are available for the one, two, and three month ahead horizons from 1997 through 2012. The monthly "unrestricted" basis quotes, as well as the actual realized basis values, were taken from historical TNS newsletters. This yields a sample of 192 one month ahead, 191 two month ahead, and 190 three month ahead forward basis quotes and subsequent realized basis values for analysis. Table 1 reports the summary statistics for the one, two, and three month ahead soybean oil processors' basis quotes as well as the actual realized basis over the sample period. Figures 1, 2, and 3 provide a graphical comparison of the respective forward basis quotes relative to the realized basis over time (1997 – 2012).

A casual examination of the summary statistics of the soybean oil processors' basis quotes versus the actual basis reveals that the one month ahead basis quotes are not markedly different from the actual basis quotes. For example, for the one month ahead soybean oil processors' basis quote, the average basis was -84.6¢ per pound compared to the average actual basis quote which was -86.6¢ per pound. Thus, the implied cost to the soybean oil user of using the one month ahead basis option is 2.0¢ per pound. Similarly, the two month ahead and three month ahead soybean oil processors' basis quotes were not noticeably different from the observed actual basis. However, figures 1, 2 and 3 show that as the forecast horizon goes further out (e.g. three month ahead versus one month ahead comparison), the soybean oil processors' basis quotes differed more noticeably from the actual realized basis levels. By examining the standard deviation of the three contracting options, it is apparent that all three horizons carry similar risks because the standard deviations are not much different from one another. Interestingly, the standard deviation actually gets smaller as the horizon increases.

## Methods and Results

### *Tests for Embedded Cost*

In order to determine if soybean oil processors charge an embedded cost for their forward basis contracting service, it is necessary to estimate the size of the embedded cost and determine if it is indeed statistically significant. Doing this is equivalent to testing if the one month, two month, and three month ahead basis quotes are systematically biased relative to the actual realized basis. Following a methodology suggested by Pons (2000), the cost of contracting with the soybean oil processors is defined as follows:

$$(1) \quad \text{Cost}_t = \text{Basis}_t^A - \text{Basis}_t^P$$

where  $\text{Basis}_t^A$  is the actual basis in month  $t$ ,  $\text{Basis}_t^P$  is the soybean processors' forward basis quote for month  $t$  and  $\text{Cost}_t$  is the embedded cost of forward contracting with the soybean oil processor. Thus, if at month  $t$ , the soybean processor offers a forward basis of 50¢ per pound ( $\text{Basis}_t^P$ ) and the actual basis ( $\text{Basis}_t^A$ ) is 0¢ per pound, then the soybean oil processor received a premium of 50¢ per pound. To calculate the magnitude and test the statistical significance of this cost over the sample period, the following regression is estimated:

$$(2) \quad \text{Cost}_t = \gamma + \mu_t$$

where,  $\text{Cost}_t$  is defined in equation (1),  $\gamma$  is the sample estimate for the average cost, and  $\mu_t$  is a random error term. The null hypothesis of no embedded cost,  $\gamma = 0$ , is tested with a t-test. If the null hypothesis cannot be rejected, the forward basis quotes are unbiased. In other words, on average there is no embedded cost contained in the basis quotes and soybean oil processors do not extract a premium for their forward contracting service. The two-tailed alternative hypothesis is that soybean oil processors charge an embedded cost ( $\gamma < 0$ ) or soybean oil processors actually subsidize forward contracting as a customer service ( $\gamma > 0$ ). Equation (2) is estimated using OLS. Error terms are tested for serial correlation using a Lagrange multiplier

test, and the standard errors are corrected using the Newey-West estimator where appropriate (Sanders and Manfredo, 2002).

The estimated premiums,  $\gamma$ , and the corresponding t-statistics are presented in table 2. For each horizon the  $\gamma$  coefficient is negative indicating that an embedded cost is indeed present ( $\gamma$  equals -2.00, -1.91, and -3.66 respectively for the one, two, and three month horizons), but in no case are the coefficients statistically significant. These results do not support the notion that soybean oil processors charge an embedded cost for their services.

The embedded cost results raise the following question - are soybean oil processors purposely not extracting a premium for their services, or are soybean oil processors just not very good at predicting what the future soybean oil basis levels are going to be? To answer this particular question, the soybean oil processors' basis quotes are further examined in terms of their ability to forecast realized basis values, with particular attention paid to the efficiency of the forecasts, as well as their accuracy over time.

### *Tests for Forecast Efficiency*

To determine how well soybean oil processors forecast the soybean oil basis, the forecast efficiency of the forward basis quotes is examined. Following Pons (2000) and Nordhaus (1987), the forecast efficiency tests are:

$$(3) \quad e_t = \alpha_1 + \beta FB_t + \mu_t$$

and

$$(4) \quad e_t = \alpha_2 + \rho e_{t-1} + \mu_t$$

where  $\mu_t$  is a random disturbance term,  $e_t$  is defined the same as  $Cost_t$  in equation (1) and is the difference between the actual realized basis in month  $t$  and the soybean oil processors' basis forecast in month  $t$ , and  $FB_t$  is the soybean oil processors' forecasted basis in month  $t$ . The null hypothesis for forecast efficiency is that  $\beta=0$  in equation (3) and  $\rho=0$  in equation (4). Equation (3) is commonly referred to as the *beta efficiency test* and equation (4) is referred to as the *rho efficiency test*. Both of the individual hypotheses are tested using a two-tailed t-test on the estimated parameters. If  $\beta \neq 0$  in equation (3), then the soybean oil processors' forecast is inefficient because information is not being efficiently incorporated into the soybean oil processors' basis forecast (Sanders and Manfredo, 2002). If  $\beta > 0$  this would suggest that the forecast errors are positively related to the forecast. Thus, a large negative forecast would result in a large negative error, and a large positive forecast would generate a large positive error. Alternatively, if  $\beta < 0$  in equation (3), this would suggest that the forecast errors are negatively related to the forecast. Thus, a large positive (negative) forecast would result in a large negative (positive) error. If  $\rho \neq 0$  in equation (4), then the forecasts are inefficient because the current soybean oil processors' basis forecast errors are related to past forecast errors. If  $\rho > 0$  this would suggest that the soybean oil processors' forward basis quotes show a pattern of repeat errors

(e.g., overestimates of basis are followed by overestimates of basis). Likewise, if  $\rho < 0$ , then underestimates of basis are followed by underestimates of basis.

The results from equations (3) and (4) are presented in table 3 and table 4 respectively. The null hypothesis of weak efficiency ( $\beta=0$ ) is rejected at the 5% level only for the “Three Month Ahead” soybean oil processor forward basis contract. Thus, the soybean oil processors do not efficiently incorporate the information contained in past forecasts. The negative  $\beta$  coefficient of -0.132 indicates that a large positive (negative) forecast results in a large negative (positive) error. Thus, soybean oil three month ahead forward basis contracts are too extreme in both directions. The null hypothesis of weak efficiency ( $\rho = 0$ ) is rejected at the 5% level for all of the soybean oil processor forward basis contracts. The estimated  $\rho$  for all of the contracts is positive; thus, the soybean oil processors’ forward contracts show a pattern of repeat errors.

#### *Tests for Accuracy over Time*

In addition to testing for forecast efficiency, the forecast accuracy of the basis quotes is examined over time. Specifically, the model in equation (5) determines if the soybean oil basis contracts offered to end processors have become more or less accurate compared to the actual realized basis over the sample period (Bailey and Brorsen, 1998):

$$(5) \quad |e_t| = \theta_1 + \theta_2 \text{Trend}_t + \mu_t$$

where  $e_t$  is the error between the actual basis and the soybean oil processors’ basis quote,  $\text{Trend}_t$  is a time trend variable, and  $\mu_t$  is the random disturbance term. A failure to reject the null suggests that, over time, there is no systematic increase or decrease in the absolute value of the error.

Table 5 presents the results of estimating equation (5). The null hypothesis is rejected for each of the soybean oil producers’ forward contracts (one month, two month, and three month ahead respectively). All of the  $\theta$  coefficients are positive and significant which suggests that the soybean oil producers’ forward basis quotes at each horizon have declined in their ability to predict the realized (actual) soybean oil basis. While the forecast accuracy has declined over time, it is difficult to determine why this is the case. It may be that the soybean oil processors are just not doing a good job in forecasting, or, that the basis is just becoming more difficult to forecast.

#### **Conclusions**

The findings of this research suggest that soybean oil processors do not extract a premium for use of their soybean oil forward basis contracts. In other words, the forward basis quotes are unbiased. Thus, on average, the forward basis contracting service offered to soybean oil users does not cost the soybean oil processors any money. It is unclear though if soybean oil processors’ business goal is to charge an embedded cost for their forward contracts, or whether they want to subsidize the cost of their forward basis contracts as a service. This is unclear because based on the forecast efficiency and accuracy tests, soybean oil processors are quite poor

at predicting soybean oil basis levels. The forecast efficiency tests suggest that the soybean oil processors may make large amounts of money on their basis level positions for a while, but this is followed by time periods where they lose a large amount of money on their basis level positions. Furthermore, the results from the accuracy over time tests make it apparent that the soybean oil processors are getting worse at forecasting soybean oil basis.

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**Table 1. Soybean Processors' Versus Actual Basis Comparison Summary Statistics (cents per pound)**

	Mean	Std. Dev.	Min	Max	# Obs
Actual Basis	-86.6	144.23	-450	336	192
Processors' One Month Ahead Basis	-84.6	140.19	-425	275	192
Processors' Two Month Ahead Basis	-84.3	138.16	-425	225	191
Processors' Three Month Ahead Basis	-82.2	137.34	-425	225	190

**Table 2. Embedded Costs Results (cents per pound)**

	One Month Ahead	Two Month Ahead	Three Month Ahead
Premium	-2.00	-1.91	-3.66
(t-statistic)	(-0.84) <sup>a</sup>	(-0.35) <sup>a</sup>	(-0.46) <sup>a</sup>
p-Value	0.404	0.730	0.646

<sup>a</sup>standard errors are corrected using the Newey-West estimator

**Table 3. Beta Efficiency Tests (cents per pound)**

	One Month Ahead	Two Month Ahead	Three Month Ahead
Estimated $\beta$	0.005	-0.067	-0.132
(t-statistic)	(0.25) <sup>a</sup>	(-1.50) <sup>a</sup>	(-2.29) <sup>a</sup>
p-Value	0.805	0.136	0.023

<sup>a</sup>standard errors are corrected using the Newey-West estimator

**Table 4. Rho Efficiency Tests (cents per pound)**

	One Month Ahead	Two Month Ahead	Three Month Ahead
Estimated $\rho$	0.174	0.345	0.562
(t-statistic)	(2.93) <sup>a</sup>	(3.08) <sup>a</sup>	(8.11) <sup>a</sup>
p-Value	0.004	0.002	0.000

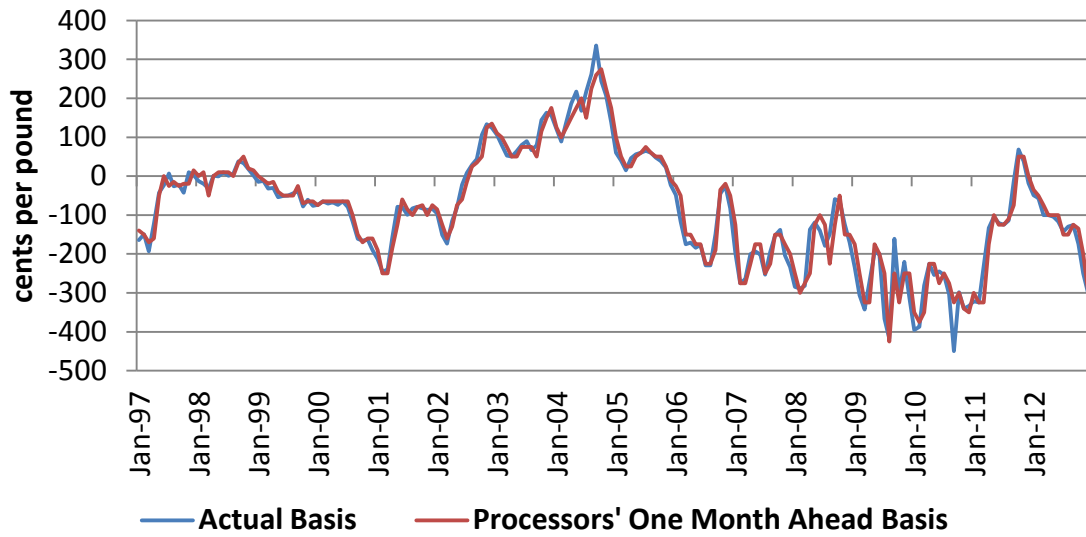
<sup>a</sup>standard errors are corrected using the Newey-West estimator

**Table 5. Accuracy Over Time Test (cents per pound)**

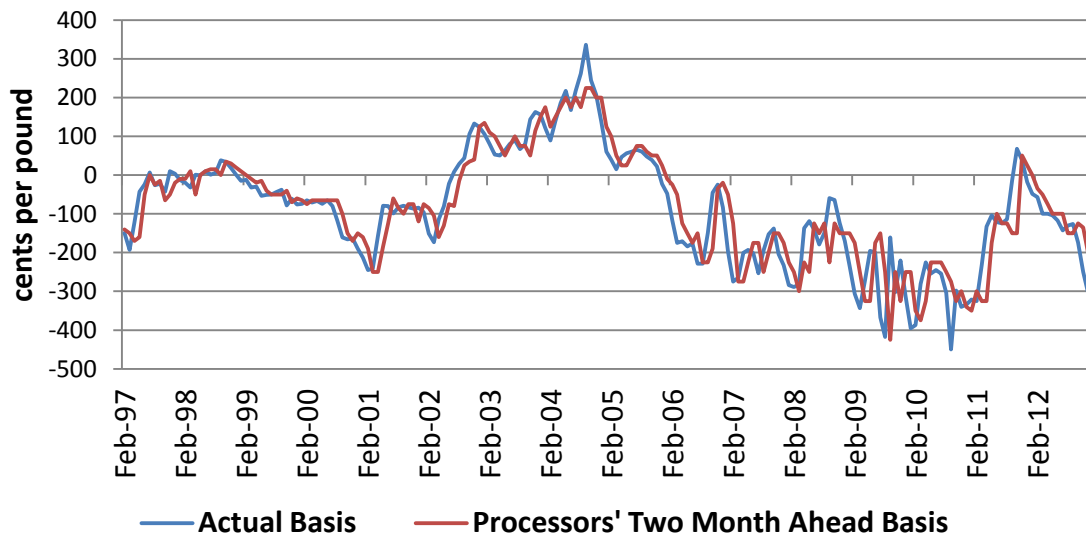
	One Month Ahead	Two Month Ahead	Three Month Ahead
Estimated $\theta$	0.104	0.306	0.377
(t-statistic)	(3.60) <sup>a</sup>	(4.97) <sup>a</sup>	(5.24) <sup>a</sup>
p-Value	0.00	0.00	0.00

<sup>a</sup> Standard errors were estimated with White's covariance estimator

**Figure 1. One Month Basis Ahead Comparison**



**Figure 2. Two Month Basis Ahead Comparison**



**Figure 3. Three Month Basis Ahead Comparison**

