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The Hedging Effectiveness of Rough Rice Futures

Kye Ryong Lee, Marvin L. Hayenga, and Sergio H. Lence*

The potential effectiveness of the thinly traded rough rice futures market in price risk minimizing hedging is evaluated for milled rice in four states, and for rough rice in Arkansas. Both unconditional and conditional hedge ratios are estimated via regression analysis. While the potential for hedging milled rice is good in Texas, Louisiana and Arkansas, it is not in California. Rough rice can be effectively hedged in Arkansas.

Introduction

The rice futures market has been characterized by intermittent trading, shifts in host exchanges, and thinly traded contracts over the years (Hoffman (1990)). Rough rice futures were traded at the New Orleans Commodity Exchange (NOCE) from April 1981 to June 1983. The rice futures trading at NOCE ended in June 1983 because of reduced trading volume attributed to high U.S. loan rates and low prices in the world rice market. The NOCE was later incorporated into the Chicago Rice and Cotton Exchange (CRCE) which was also affiliated with the Mid America Exchange. The rough rice futures traded at the CRCE for a short period commencing September 1983. Rice futures were traded again at the Mid-America Exchange (affiliated now with the Chicago Board of Trade) beginning in August, 1986.

The marketing loan program for rice begun in 1986 allowed much more price volatility, and facilitated greater hedger and speculator interest in trading futures. Yet, the rice futures market is still a thin market relative to other heavily traded commodity markets such as corn and soybeans, even though the present market volume exceeds a "low volume" designation by the Commodity Futures Trading Commission. While volume increased sharply in late 1993 when Japan began to allow limited imports, the trading volume is still low and liquidity is a problem for large traders. If the futures price links to rough and milled rice cash markets are weak, this could be a contributor to the low trading volume on the exchange.

This study investigates the hedging effectiveness of rough rice futures for rough rice in Arkansas, and cross hedges of several types of milled rice in Arkansas, Texas, Louisiana and California. A survey of leading rice cooperatives and merchandisers in the U.S. suggested that a fixed hedge ratio of 1.82 through 1.89 is used by some processors and brewers as the appropriate hedge ratio for milled rice. This fixed hedge ratio (called the industry hedge ratio hereafter) is based on an expected head yield of around 53-55 percent. In this study, both unconditional and conditional (utilizing recent basis information) risk minimizing hedge (cross hedge) ratios are estimated for rough (milled) rice. They are compared to industry practices,

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and the strength of the futures-cash price linkages is evaluated to determine whether it is a likely contributor to low trading volumes.

Previous Literature

A direct hedge is a hedge of the same commodity as the one in the cash position which the hedger has now or expects to have in the future. Anderson and Danthine (1981) developed the formula for an optimal cross hedging futures position. The proportion of output that should be hedged by futures contracts is given by the coefficient of the multiple regression of cash prices on futures prices, which provides the incremental change in cash prices related to a unit change in futures prices. When a commercial interest wants to hedge a commodity for which no futures exists, the hedger may use cross hedging, if the price relationship between his commodity and the commodity specified in the futures contract moves in a predictable pattern.

There have been a number of related studies which serve as a foundation for this analysis of rough rice futures. Johnson (1960) applied modern portfolio theory to the hedging problem and the price risk minimizing methodology was elaborated by Ederington (1979). Hayenga and DiPietre (1982) applied the price risk minimizing method to estimate optimum hedge ratios and hedge effectiveness for wholesale pork and beef products by using live hog and cattle futures, respectively. Witt, Schroeder, and Hayenga (1987) contrasted the optimum hedge ratios estimated in three different ways; price level regression, price change regression, and percentage price change regression. They argued that the appropriate way to estimate hedge ratios should depend on the type of decision problem being faced by the agent. They suggested that the price level regression method should be more appropriate for nonstorable commodities.

Myers and Thompson (1989) argued that simple regression approaches (price level, price change, price ratio) are not appropriate for estimating price risk minimizing hedge ratios except under special circumstances, because the slope parameter from a simple regression is only the ratio of the unconditional covariance between the dependent (cash price) and explanatory variable (futures price) to the unconditional variance of the explanatory variable. They suggested adding relevant conditioning market information to the simple regression used in estimating the unconditional hedge. Yet, their additional market factors failed to contribute much in price risk minimizing hedge analysis for corn and soybeans.

Viswanath (1993) accepted Myers and Thompson's argument, but also took into consideration the possible convergence of spot-futures prices and the dependence of the hedge ratio on both the hedge duration and the time left to maturity. Instead of including a large number of lagged spot and futures prices changes as suggested by Myers and Thompson, Viswanath used a regression including the current basis as additional market information. The derived basis-corrected model is consistent with convergence of spot-futures prices when the futures contract matures.

Research Procedures

In this study, three alternative approaches are employed to estimate price risk minimizing hedge or cross hedge ratios for rice. Initially, hedging relationships are estimated via simple regression equations of Chicago Board of Trade futures prices and cash prices in each rice producing state. These regression equations have the form shown in (1):

(1) $CP = \beta\, FP + e$

where CP is the weekly average cash price, FP is the weekly average closing price of the long-grain rough rice futures, e is an error term, and β is the hedge ratio. The βs from (1) provide unconditional price risk minimizing hedge ratios which are approximately equivalent to the milling yield hedge ratios used by many commercial rice merchandisers.

Separate equations are estimated for each type of milled rice (long, medium, or short-grain) produced in each rice producing state (Arkansas, Louisiana, California, Texas). Since seasonal differences in cash-futures price relationships are expected, especially near harvest, separate equations are estimated for each two-month period when a contract is the nearby contract. In addition, rough rice in Arkansas is analyzed in a similar fashion, though using data for a shorter time period.

The expected cash price based on any given futures price from this model could be prone to error if a different equation form, say one with an intercept term significantly different from zero, were appropriate. If the intercept term is significantly different from zero, the expected price based on the cash/futures price ratios could be over or underestimated when the futures price significantly deviates from the mean of the data used for calculating the ratios (Hayenga and DiPietre, 1982). In this situation, model (2) would be more appropriate:

(2) $CP = \alpha + \beta\, FP + e$

where α is the intercept term which could be interpreted as the average allowance for milling costs and grade or location premiums or discounts. The estimated slope coefficient is the price risk minimizing hedge ratio which provides the appropriate quantities of futures to be hedged relative to the cash position so that the gains or loses in futures position offset the change in cash position. Separate equations are estimated for each two-month period when a contract is the nearby contract to allow different intercepts and slope coefficients, and to provide individual measures of fit for each two-month period associated with a particular nearby contract (e.g. January).

The third price risk minimizing hedge model is similar to the basis corrected model employed by Viswanath which incorporates recent market (basis) information in the equation:

(3) $CP = \alpha + \beta_1\, FP + \beta_2\, (CP - FP)_{t-i} + e$

where $(CP - FP)_{t-i}$ is the lagged basis, estimated with 2, 4, or 6 month lags for milled rice (1-3 month lags for rough rice, where the data series was shorter). The price risk minimizing hedge ratio in (3) is given by β_1.

The estimated equation including the recent basis term as additional information seems reasonable because the most recent cash-futures price relationship should reflect any recent developments affecting the relative prices of rough rice and its futures and the milled rice being analyzed. Thus, to the extent that recent changes in market relationships persist during the period of the hedge contract, the fit of the hedge equation should improve.

Data Description and Tests for Stationarity

Daily futures closing prices for rough rice (in cents per hundredweight) for the period August, 1986 to December, 1993 were provided by the Chicago Board of Trade. Unlike more heavily traded commodities, rough rice futures show non-trading periods when no prices were established for one or two months between old and new contracts.

Weekly average futures prices were calculated to coincide with the weekly cash price series. Weekly average cash prices of milled rice per cwt are from USDA Agricultural Marketing Service "Rice Market News." The rough rice January 1991-December 1993 cash prices were provided by Creed Rice, a Houston rice broker considered the most credible source of cash prices by many rice industry participants.

Initially, an analysis of the stationarity of the cash and futures price series was conducted. Augmented Dickey-Fuller tests were performed for all yearly life-long rough rice futures series for each delivery month and cash price series of all types of milled rice from each rice producing state. The tests rejected the null hypothesis of a unit root for 14 out of 48 samples (29%) at a significance level of 0.05. Tests at a significance level of 0.10, however, rejected the null hypothesis of a unit root for 27 out of 48 samples (56%).

While the life long series provides a large number of cash and futures price observations, the cash-futures price behavior might change in the last month or two prior to contract termination as the threat of delivery forces rough rice futures and cash prices together. This would be expected to influence the related milled rice prices as well. Since traders typically use the nearby futures contract, the cash-futures price relationship was expected to be closer when estimated based on nearby futures, and the nearby futures and corresponding cash price series was selected for analysis. Nearby futures series are not appropriate for stationarity tests (unit root test) by the augmented Dickey-Fuller test since that test requires continuous time series data. Tomek (1994) argued that commodity prices should not be expected to follow a random walk, and that good reasons exist for commodity prices to be autocorrelated. Based on Tomek's argument, agricultural commodity cash price series should not be nonstationary.

Dorfman (1994) investigated asset price behavior and market efficiency. He employed Bayesian tests for the stationarity tests of corn and soybeans' futures price series. The posterior odds ratios were computed and the test results were compared to those of unit root tests on the same samples by augmented Dickey-Fuller tests. The comparison of test results revealed that augmented Dickey-Fuller tests had very low power.

Because of the rejection of unit roots in a large percentage of the series, the low power of the unit root tests, and Tomek's argument, cash and futures prices are assumed to be stationary for the remaining analyses.

Preliminary Graphical Analysis

Figure 1 provides the graphical relationship of long grain milled rice cash prices in different rice producing states and nearby futures prices (switching contracts every two months). Long and medium grain milled rice prices exhibit a very similar pattern. Futures prices patterns are similar to those of milled rice cash prices, though with a price gap, for Arkansas, Louisiana and Texas. The price gaps between milled rice prices in the three southern states and California (and the futures prices) have been widening. The diverging price differentials may be attributable to varietal differences. California produces primarily the Japonica variety (sticky rice), which is preferred in Japan, Korea and China, while the southern states produce indica varieties.

The graphical analysis suggests that futures prices and cash prices in three southern states are strongly correlated with each other, but California is weakly correlated to futures. When there is a higher correlation between cash and futures prices, commercial use of the futures market becomes more feasible.

Statistical Results

The simplest unconditional cross hedge model (1) results are compared to the head yield hedge used in the industry first, and then to the unconditional cross hedge model (2) which incorporates an intercept. Third, consideration is given to the use of the conditional hedge model (3) in milled rice cross hedging programs. Finally, unconditional and conditional price risk minimizing hedge estimates for Arkansas rough rice are analyzed.

The estimated slope coefficients are unconditional price risk minimizing hedge ratios in the analytical models (1) and (2), and conditional price risk minimizing hedge ratios in model (3). They represent the proportional change in the cash price of milled or rough rice to the rough rice futures prices within the period when the hedge transaction would be terminated. The standard error of the estimated equations reflect the error distribution around the expected cash price. Higher standard errors relative to their price level reflect greater risk that a potential hedger would face using a cross hedge. The coefficient of determination also measures hedging effectiveness -- the proportional reduction in (net) cash price variance that would result from maintaining a hedged position in rough rice futures.

The estimated unconditional price risk minimizing hedge ratios from equation (1) can be compared to the industry hedge ratio (1.82-1.89) which is currently used by some processors and brewers in the rice industry. If the estimated unconditional optimum hedge ratios prove to be close to head yield, the current industry practice using the fixed hedge ratio (1.82-1.89) based on head yield (53%-55%) are validated. The futures market specifies the standard head yield as 55%, but not less than 48%. Most of estimated hedge ratios for nearby futures in Table 1 are higher than the fixed hedge ratio (1.82-1.89) currently used in the rice industry. In case of long grain, 83% of the estimated hedge ratios deviated more than 10% from the average of the head yield hedge ratios (1.86). 39% of the estimated hedge ratios for medium grain deviated from the average industry head yield hedge ratio more than 10%. The estimated hedge ratios from equation (1) vary over different delivery months reflecting seasonal changes in the relationship between rough rice futures and milled rice prices. Furthermore, the hedge ratios for the same delivery month often differ from each other according to different locations and type of rice (long, medium and short grain). Thus, the hedgers using a hedge ratio based on head yield typically would be underhedged, and exposed to higher risk than those using the estimated hedge ratio from model (1).

Table 2 presents the estimated nearby cross hedge relationships between the cash prices of milled rice and the rough rice futures prices at the Chicago Board of Trade. The estimated intercept term could be interpreted as processing, transport costs, and premium or discount for the differential in commodity quality. If the intercept term is significantly different from zero, equation (2) will provide a more appropriate hedge ratio to use. All of the estimated intercepts of equation (2) are significantly different from zero at the 5% significance level, and the regression standard errors are smaller than in (1). The estimated price risk minimizing hedge ratios from equation (2) are lower than the head yield hedge ratio (1.82-1.89). Based on analytical model (2), a head yield hedge would typically result in an overhedged position. Eighty-five percent of the estimated hedge ratios from equation (2) deviated more than 10% from the average industry hedge ratio (1.86). The estimated hedge ratios and intercept terms from equation (2) do vary seasonally and by state and by type of rice. The estimated results for equation (2) exhibit a common pattern of cross hedge ratios and hedge effectiveness for the three southern states, with most of them being lowest in the period when July is the nearby contract.

Despite futures for rough rice being based on Arkansas delivery, cross hedge regressions for long-grain Louisiana milled rice have higher R^2 and slightly lower standard errors compared to Arkansas and Texas. In contrast to long grain, futures provide more effective hedges for Arkansas compared to Louisiana and Texas medium grain milled rice.

Cash prices for long, medium and short-grain milled rice of California show the weakest relationship with futures prices. The estimated hedge ratios for July contracts are not significantly different from zero, indicating that variation in futures prices has little power to explain the cash price behavior in California when July is the nearby contract. Most of the other estimated relationships for California are relatively weak compared to three southern states, with lower R^2 and larger standard errors.

California milled rice differs from the other states in grade, location, and variety. In a competitive market structure with a homogeneous commodity, price differences between any two markets that trade with each other should equal transfer costs. Diverging price series of

California versus the southern states do not appear to be fully explained by grade and transfer cost differentials. California's water shortages may have affected relative supplies in recent years. Beyond that, industry participants suggest that medium and short grain rice in California (japonica type) is not a substitute for the indica varieties produced in Arkansas, Texas, and Louisiana, at least for some markets (e.g. Japan and Korea).

Cross hedging model estimates using recent basis information are not presented in this paper to achieve brevity, but are available from the authors upon request. As in the case of unconditional model (2), hedgers using the industry hedge ratio are overhedged compared to hedge ratios estimated using the lagged basis corrected model. The lagged basis corrected model, equation (3), results in improved cross hedging model fits with cash prices from three southern states' milled rice. Almost all basis lags of two and four months were significantly different from zero for the southern states long and medium grain milled rice. In contrast, approximately a third of the six month lag basis variables were not significantly different from zero for the southern states. The current basis, especially for short hedge time spans, seems to provide information that helps to predict cash prices more accurately. For milled rice cross hedges, recent basis behavior reflects changes in cash-futures relationships which may be due to changes in milling costs, transfer costs, grade premiums or discounts, byproduct values, or other local market supply - demand factors. California results didn't improve enough to provide a reliable hedge.

Unconditional price risk minimizing hedge ratio estimates for Arkansas rough rice are presented in Tables 3 and 4. Rough rice prices were only available for the period from January, 1991 through November, 1993. Thus, these estimates are based on a smaller number of observations. The hedge effectiveness for rough rice is consistently higher than the estimates of milled rice cross hedges, and standard errors are smaller. The direct hedge ratios often are close to 1 and most intercepts are near zero. In part of the year, a standard 1:1 hedge seems appropriate. However, using a 1:1 hedge may not be appropriate for September and November contracts based on the short time series available for analysis. Most estimation results using equation (1) are poor compared to those of equation (2), generating larger standard errors. Equation (2) appears more appropriate for rough rice price risk minimizing optimum hedges.

The direct hedge for rough rice using model (3) provides almost the same level of hedging effectiveness as those from equation (2) (not shown for brevity). Hedge ratios for September and November futures contracts remain near 1.2. Adding the current lagged basis between cash and futures prices of rough rice typically results no difference in estimated fits when the basis lags vary from 1-3 months, though the lagged basis (1-3 months) variable is typically significantly different from zero.

Summary and Conclusions

The cross hedging relations between prices of rough rice futures and cash prices of two or three different types of milled rice from four rice producing states were analyzed using three different analytical models and 1986-1993 data. The direct hedge for Arkansas rough rice was also estimated using the same procedures for a shorter time period (3 years). The estimated results from each equation were compared to the fixed hedge ratio based on head yield which is used in the rice industry.

Milled rice cross hedges based on head yield are more prone to error than those based on standard unconditional hedge models with intercept terms or conditional hedges using recent basis information. The head yield hedge used in the rice trade results in higher risk to hedgers.

The analysis suggests that milled rice hedgers in Texas, Louisiana, and Arkansas could improve their hedging performance using more complex models, and incorporating recent basis information (1-4 months) in determining appropriate hedge ratios and expected cash prices based on futures prices. In contrast, California milled rice cross hedging is ineffective using virtually any of the analytical models.

The direct hedge of Arkansas rough rice produces excellent fits using nearby futures, offering a relatively stable hedge ratio (though not always 1:1 hedges) and a small standard error throughout the entire year.

Based on the analysis of recent cash and futures price relationships, rough rice futures can provide rice producers, processors and exporters with effective measures to hedge price risks in small volume transactions, though not in California, until trading volume increases to allow larger scale transactions.

Futures trading volume has been increasing since Japan lifted its import ban on foreign rice and began to import rice from the international market. Recent developments in international trade agreements seem likely to further increase trade opportunities and price volatility, which should increase more speculative and hedging activity in U.S. and world rice markets. In the future, the market environment seems conducive to increased use of rough rice futures by rice millers, processors and exporters, but also by producer cooperatives beginning to offer fixed price forward contracts to producers or customers, as is done in other grain processing and merchandising industries.

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Figure 1. Nearby Futures Price vs Cash Prices of Long-Grain Milled Rice

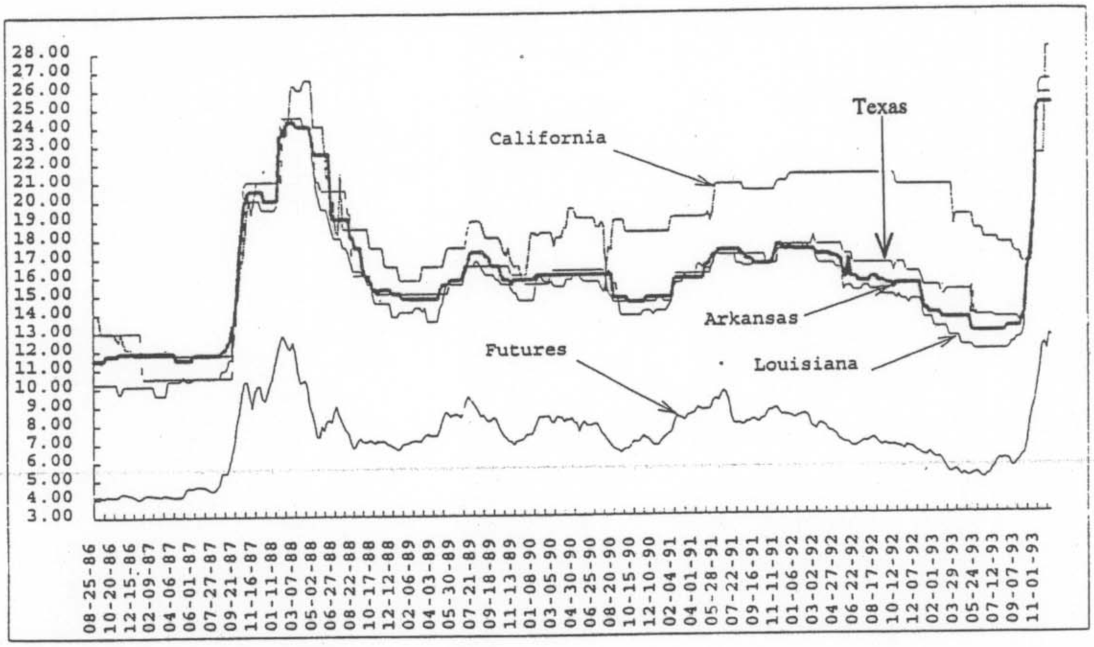

Table 1. Milled Rice Cross-Hedge Model (1) Estimates; Nearby Futures

State	Type	Estimates	Jan	Mar	May	Jul	Sep	Nov
Arkansas	Long	Slope	2.10	2.05	2.19	2.04	2.21	2.14
		Std. Error	1.66	1.88	2.59	1.70	1.26	1.47
	Medium	Slope	2.04	1.94	2.10	2.01	2.18	2.09
		Std.Error	2.09	2.48	2.36	1.83	1.16	1.90
Louisiana	Long	Slope	2.04	2.01	2.12	1.98	2.09	2.07
		Std.Error	1.28	1.42	2.17	1.39	1.00	1.18
	Medium	Slope	1.85	1.83	2.01	1.93	2.04	1.90
		Std. Error	2.46	2.09	1.85	1.60	1.94	2.22
Texas	Long	Slope	2.12	2.06	2.21	2.06	2.19	2.18
		Std.Error	1.94	2.05	2.64	2.21	1.60	1.85
California	Long	Slope	2.31	2.34	2.57	2.49	2.56	2.36
		Std.Error	3.26	3.73	3.43	3.64	2.44	3.06
	Medium	Slope	2.02	2.00	2.20	2.23	2.36	2.13
		Std.Error	3.42	1.98	3.31	3.45	1.87	3.05
	Short	Slope	2.02	2.00	2.20	2.22	2.36	2.13
		Std. Error	3.42	1.98	3.31	3.41	1.85	2.96
Number of Observations			73	62	70	46	63	71

Note: All the estimated slope coefficients are significantly different from zero at 5% level.

Table 2. Milled Rice Cross-Hedge Model (2) Estimates; Nearby Futures

State	Type	Estimates	Jan	Mar	May	Jul	Sep	Nov
Arkansas	Long	Intercept	4.69	5.00	5.38	8.12	4.35	4.21
		Slope	1.55	1.46	1.49	0.99	1.60	1.61
		Std.Error	1.00	1.17	2.26	0.73	1.07	1.12
		R^2(%)	93	90	58	80	73	87
	Medium	Intercept	5.62	8.07	8.26	9.21	5.37	5.68
		Slope	1.37	0.98	1.02	0.82	1.42	1.36
		Std.Error	1.36	0.70	1.29	0.57	0.78	1.40
		R^2(%)	84	92	66	81	78	75
Louisiana	Long	Intercept	2.15	2.50	2.84	6.10	2.53	1.83
		Slope	1.79	1.71	1.74	1.19	1.74	1.84
		Std. Error	1.13	1.22	2.07	0.78	0.93	1.11
		R^2(%)	93	92	69	83	81	90
	Medium	Intercept	5.04	6.11	5.78	7.39	4.21	5.54
		Slope	1.25	1.10	1.25	0.97	1.44	1.20
		Std. Error	2.02	1.05	1.24	0.78	1.14	1.84
		R^2(%)	67	86	76	77	66	60
Texas	Long	Intercept	5.25	4.98	5.41	10.82	3.02	5.67
		Slope	1.50	1.47	1.50	0.67	1.74	1.46
		Std.Error	1.25	1.43	2.32	0.84	1.53	1.33
		R^2(%)	88	86	57	57	61	79
California	Long	Intercept	8.39	9.26	7.971	7.64	6.60	10.54
		Slope	1.32	1.24	1.52	0.22[a]	1.64	1.02
		Std.Error	2.24	2.56	2.87	1.34	2.23	1.90
		R^2(%)	65	57	47	14	40	48
	Medium	Intercept	10.78	12.73	12.07	17.08	7.76	11.93
		Slope	0.74	0.48	0.61	0.03[a]	1.27	0.61
		Std.Error	1.52	1.63	1.63	1.23	1.44	1.36
		R^2(%)	56	34	31	0	49	39
	Short	Intercept	10.78	12.73	12.10	16.89	7.70	11.38
		Slope	0.74	0.48	0.61	0.05[a]	1.28	0.69
		Std. Error	1.53	1.63	1.63	1.20	1.43	1.40
		R^2(%)	55	33	31	0	49	43

[a]: Estimated slopes are not significantly different from zero at 5% significance level.

Table 3. Standard-Hedge Model (1) Estimates; Nearby Futures vs Arkansas Long Grain Rough Rice

Estimates	Jan	Mar	May	Jul	Sep	Nov
Slope	1.13	1.11	1.12	1.07	1.11	1.23
Std. Error	0.46	0.54	0.35	0.50	0.39	0.39
Number of Observations	34	40	30	30	29	30

Table 4. Standard-Hedge Model (2) Estimates; Nearby Futures vs Arkansas Long Grain Rough Rice

Estimates	Jan	Mar	May	Jul	Sep	Nov
Intercept	0.95	1.06	0.22[a]	0.31[a]	(1.68)	(0.28)[a]
Slope	1.02	0.99	1.09	1.03	1.35	1.16
Std. Error	0.41	0.47	0.35	0.50	0.33	0.39
R^2(%)	96	95	96	92	94	95

( ): Negative estimate
[a]: Not significantly different from zero at 5% significance level