Establishing and Forecasting Quality Adjusted Basis for Texas Rice Markets

by

Mark Waller, M. Edward Rister, and Earl Taylor

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INTRODUCTION

Recent changes in the scope and structure of the U.S. rice industry have highlighted the need for additional market research. The major impetus for this need can be linked to i) a change in government farm programs that instituted the rice marketing loan in 1986, and dramatically changed the way rice is marketed, ii) a lack of widely available cash market price quotes for rough rice, iii) re-emergence of a rough rice futures market, and iv) the loss of a major co-op marketing alternative.

Interest by producers and other industry participants concerning information on available marketing alternatives has increased significantly in recent times, given the changes that have occurred in the markets. The Rice Marketing Loan (RML) was developed in response to previous government policies that were effective in reducing price volatility but resulted in decreased exports and a buildup of government held stocks. The RML-related calculation of an adjusted world market price (AWP) for each individual lot of rice marketed by producers has prompted rough rice mill buyers to significantly change their bidding procedures in the bid/acceptance markets.

Prior to the change in corporate structure by American Rice, Inc. from a cooperative to a privately owned mill in 1988, in excess of 55% of the rice produced in Texas and Louisiana was marketed through the cooperative. That change has resulted in a dramatic increase in the number of producers who are relatively inexperienced in marketing, seeking to market their rice through bid/acceptance markets and forward contracts. This has lead to a heightened interest in rice marketing information and education.

The focus of the study is on utilizing a hedonic regression approach to identify premium/discount market signals incorporated into prices received for rough rice at bid/acceptance markets. This information is then used to generate a standardized (adjusted) rough rice cash price series which is compared to rough rice futures market prices to develop a localized adjusted rough rice basis. A major objective of this study is to investigate the value of quality adjusted basis information for Texas rice producers. The average basis (cash-futures price) (AVGBasis) and the adjusted average basis (quality standardized cash price-futures price) (ADJBasis) are first compared using descriptive statistics. An explanatory econometric model is then developed to identify factors that influence changes in the basis. Finally, an attempt is made to forecast basis fluctuations utilizing out of sample data.

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REVIEW OF LITERATURE AND ANALYTICAL METHODS

Quality Adjustments

The lack of a quoted standardized cash rough rice price and quality adjustments obscures local market price signals. Variation in observed bid prices are convoluted due to i) differences in individual lot quality characteristics, ii) local market-to-mill site transportation differentials, iii) local supply/demand phenomena, and iv) the relatively small proportion of rice lots actually confirmed as sold following individual bid/acceptance auction sales. The hedonic price estimation procedure has been accepted as an appropriate method for determining the implicit value of quality characteristics when analyzing this type of data.

Hedonic prices are defined as the implicit prices associated with the specific quality characteristics of a given commodity (Rosen). Statistically, the hedonic price model regresses the observed product or commodity price on the respective quality characteristics (Lucas, Rosen). The hedonic price model is of the form:

$$P_i = P(V_{i1}, \ldots, V_{ij}; U_j) \tag{1}$$

where P_i is the observed price of commodity i, V_{ij} (j = 1, ... ,j) measures the amount of some "intrinsic quality" per unit of commodity i, and U_i is the error term.

The hedonic price relationship can be decomposed into two distinct components:

$$dp_i = dp_i{'} + \sum_j \frac{\partial p_i}{\partial d_{ij}} d\alpha_{ij} \tag{2}$$

Adelman and Griliches (1961) identified the first term of the price change, dp_i', as the "polygenetic" price change that would occur in the absence of any variation in quality. The second term,

$$\sum_j \frac{\partial p_i}{\partial d_{ij}} d\alpha_{ij} \tag{3}$$

represents price changes due to variation in quality. Thus $\partial p_i/\partial d_{ij}\ d\alpha_{ij}$ is the price change observed for the ith commodity given an incremental change in quality of the jth quality index by the amount $d\alpha_{ij}$. Multiple regression analysis is used to evaluate the partial derivatives. The regression coefficients for p_i and α_{ij} relate to the partial derivatives, $\partial p_i/\partial d_{ij}$, differently based on the form of the equation estimated. Linear estimation on cross-section data yield regression coefficients that are the partial derivatives, $\partial p_i/\partial d_{ij}$.

Agricultural commodities provide a broad base for hedonic analysis and the implicit pricing of intrinsic quality characteristics. Previous attempts to measure the implicit prices of quality attributes of agricultural commodities include corn (Ladd and Martin), barley (Wilson), cotton (Ethridge and Davis; Ethridge and Neeper), and rice (Brorsen, Grant, and Rister (1984, 1988); Fryar et al.; Traylor, Dennison, and Conger; Martinez, Traylor, and Fields; Taylor et al.). While numerous studies have considered the effect of price and quality attributes, none have related that back to basis variability or its potential impact on hedging.

Ladd and Martin based their study of the corn grading system on the premise that the price of an input equals the sum of the values of the inputs characteristics. Linear programming was utilized to measure the marginal monetary value of input characteristics. In turn, the linear programming results were used to evaluate and suggest revisions to the current corn grading system.

Ethridge and Davis, and Ethridge and Neeper developed models to identify hedonic prices for cotton lint. The Ethridge and Davis study indicated that prices received by producers varied with respect to fiber length, micronaire, and trash content of cotton lint. They also noted a difference in the implicit price schedule between the years tested. The Ethridge and Neeper study identified additional important intrinsic quality characteristics and concluded that more complete and accurate price reporting on all relevant fiber quality attributes would increase market efficiency.

Brorsen, Grant and Rister (1984) developed a framework for analyzing the quality differentials for Texas rough rice bid/acceptance markets. They conclude that rice grades were useful, but did not completely explain rice quality price differentials. Taylor et al. analyzed prices received by producers in Texas rough rice bid/acceptance markets during the 1987 and 1988 marketing years in order to determine if the changing structure of the rice industry, mainly the implementation of the Rice Marketing Loan, substantially impacted the implicit price structure previously identified by Brorsen, Grant and Rister in 1984 and 1988. Taylor et al. concluded World Market Price is statistically significant in explaining observed price differences of confirmed rough rice sales. In addition, it was determined that the adjusted World Market Price often over- or under-values rice quality characteristics.

The questions raised by previous research into the implicit prices for rice quality are relevant in today's rice marketing environment, especially when considering the revised bid/acceptance market protocol in which buyers state their offers on a premium/discount basis relative to the calculated World Market Price or loan for each individual lot of rice offered for sale. Because of the new bidding procedures, however, it is hypothesized that the market signals regarding rice quality are more obscure than those previously reported by Brorsen, Grant, and Rister.

DATA

Texas Rough Rice Cash Price Data

Bid/acceptance market sales offices hold sales on an infrequent weekly basis, with sellers' volume of offerings and buyers' demand being the primary determining factors as to when a sale will occur. As one might expect, sales occur on a more frequent basis immediately following harvest as opposed to later in the marketing year. On the day of the sale, buyers make sealed bids based on a premium relative to the lower of the weekly announced World Market Price or the annual Government Loan value. Producers have twenty-four hours to either accept or reject the highest bid received on each lot. Lots for which the initial bids were rejected are usually marketed at a later date, either through a subsequent bid/acceptance market or a privately negotiated "off-the-table" sale -- generally referred to as a trade. The spuratic nature of sales and lack of any price quotas between sales results in large data gaps for individual offices. Aggregating sales across offices lessens but does not completely eliminate this problem.

As rice is submitted for sale at a bid/acceptance market sales office, each individual lot that is to be sold is sampled and evaluated based on the amount of damaged kernels, chalk, red rice, objectionable seeds and/or colors, and other types of rice. Based on criteria for these evaluations, a federal grade is assigned to each of the individual lots of rice. In addition, milling of the sample provides the total milling turnout, head and broken rice yields for each lot of rice. This information, along with visual inspection, a need for a specific quality, and available supplies and demand provide the basis on which buyers formulate their bids.

Data were collected from sales offices on the west-side of the Texas Rice Belt. For the 1987, 1988, 1989 marketing years and the first two quarters of the 1990 marketing years, premiums paid were adjusted for transportation from each sales office to Houston, the major milling region for the Texas Rice Belt to remove any explainable or adjustable market differential, leaving only unexplained variation in the transportation adjusted premiums. The transportation adjustments made for the analysis yielded transportation rates comparable to industry estimates (McCann).

Futures Prices

The futures prices utilized in this study consist of the Wednesday closing price for rough rice futures contracts traded on the Chicago Rice and Cotton Exchange market. The weekly prices were then averaged in order to provide the monthly futures prices used in the calculation of the rice basis values.

Empirical Model

The implementation of the RML program altered the underlying structure of the rough rice market from when it was examined by Brorsen, Grant, and Rister (1984, 1988). A major provision of the RML is the calculation of a weekly World Market Price for rough rice. In the prevailing rice marketing environment, this rate has become the standard on which market bids are based. In the previous work by Brorsen, Grant and Rister, the hedonic price model was a function of the mill price (U.S. No. 2 long grain, FOB mill, Houston) as well as the various quality attributes of the rice. For this study, however, it was deemed appropriate that the premium/discount with respect to the adjusted WMP (AWP) would provide a better means of identifying the implicit price structure of the rough rice market.

Several static quality adjustments are incorporated into the AWP. The WMP provides discounts for smut and grade as well as adjustments for grain type, i.e., short, medium, and long grain, for the percent of head rice, or whole grains, and the percent of broken grains (note: the milling yield equals head rice plus broken grains). Thus, the AWP quoted for each of the individual lots of rice represents an adjusted price level. Whereas the AWP serves as the standard on which premiums for the individual lots are bid, the premium above the AWP will serve as the relative measure of the seasonal rough rice price level for the hedonic price function estimated within.

The change in the bidding protocol for Texas bid/acceptance auction markets where premiums are paid above the AWP raises questions regarding the quality adjustments associated with the AWP. A major issue of concern is whether quality adjustments accounted for in the AWP adequately reflect premiums being paid by rice millers. To determine if the hedonic price structure of Texas bid/acceptance markets is fully reflective of the implicit price adjustments for quality in the AWP, the following model was estimated for each of the three marketing years (1987, 1988, and 1989) to determine the implicit pricing structure. The same model is later run on data from the first two quarters of the 1990 marketing year to develop an adjusted basis for comparison with estimates from the forecasting model.

$$PREM_i = a + b_1\, HEAD_i + b_2\, BROKENS_i + b_3\, BPECK_i + B_4\, BRED_i + b_5\, SMUT_i + b_6\, SEED_i + b_7\, TRADE + b_1\, QTR_y + b_j\, MKT + b_k\, VAR_k + b_{yj}\, (QTR_y * MKT_j + b_{j7}\, (MKT_j * TRADE) + e_i \qquad (4)$$

where:

$PREM_i$	: the transportation adjusted premium ($/cwt);
$HEAD_i$	: the percent whole grains;
$BROKENS_i$	: the percent broken grains;
$BPECK_i$	: the percent peck damage;
$BRED_i$	: the red rice content;
$SMUT_i$	: the percent smut damage;
$SEED_i$	: the total number of objectionable seeds;
TRADE	: a binary variable denoting "off-the-table" trades;
QTR_y	: a set of binary variables denoting the quarter of the marketing year;
MKT_j	: a set of binary variables denoting the market location;
VAR_k	: a set of binary variables denoting the rice variety;
QTR_y*MKT_j	: a slope shifter measuring the interaction between market and time;
$MKT_j*TRADE$	: a slope shifter measuring the interaction between the market location and market activity.

It is hypothesized that the quality adjustments represented in the AWP accurately reflect the implicit value of the various quality factors characterizing rough rice in the Texas bid/acceptance markets during the 1987, 1988, and 1989 marketing years. The empirical test of this hypothesis is in the analysis of the respective beta coefficients. As previously stated, the AWP takes into account quality factors and determines a price for each individual lot of rice based on the prices of whole and broken grains, as established by the USDA. If the market and the AWP are placing the same values on each of the quality attributes, then each of the quality characteristic beta coefficients should be equal to zero. If there are statistically significant beta coefficients that are not equal to zero, one can conclude that market participants are valuing the quality characteristics differently than does the norm, the AWP.

In addition to the six hedonic variables for quality (HEAD, BROKENS, BPECK, BRED, SMUT, SEED), four sets of linear dummy variables and two sets of interaction terms were included in the model. Seasonality was denoted by an intercept shifter (QTR_y) for the various quarters of the August - July marketing year. The first quarter, August - October, was collapsed into the intercept. An intercept shifter for each of the market locations (MKT_j) providing data was also included, with a major bid/acceptance market collapsed into the intercept term. Although the premiums paid were adjusted for transportation differentials, this family of binary variables were included in the analysis to determine if there were significant differences in market location not related to transportation differentials. An intercept shifter was also included to denote the type of transaction (TRADE), representing whether or not the lot was sold on the date of the sale or if the sale occurred via an "off-the-table" negotiated trade at a later date. For this term, all sales occurring "on-the-table" were included in the intercept. The final set of binary variables was used to denote the rice variety (VAR_k). Whereas rice is not commingled prior to the sale, testing of the impact of the rice variety on the implicit price schedule for rice quality is possible. Collapsed into the intercept term is Lemont, a predominant rice variety grown in Texas. Other varieties of rice included in the data are; Gulfmont, Rexmont, LaBelle, LeBonnet, Skybonnet, Newbonnet, Tebonnet, CB801, XH7843, V7713, Ri-Tec, CB7713, V7817, CB7817, and RA2003. Thus, the intercept term for the hedonic model contains confirmed sales of Lemont during the first quarter of the marketing year occurring at a major west-side bid/acceptance market.

In addition to the intercept shifters, two families of slope shifters were included in the analysis. These variables were included to denote the interaction between seasonality and market location (QTR_y*MKT_j), and the interaction between the market location and the type of transaction (MKT_j*TRADE). Only the interaction terms for which there was complete market and quality data were estimated; that is, if for some reason, a sale did not occur in a market and/or a quarter, that term was deleted from the analysis.

ANALYTICAL RESULTS

HEDONIC ANALYSIS

A major concern was the significance of the respective sets of dummy variables and interaction terms included in the model. For each set of dummy variables, hedonic factors and interaction terms (quality factors, seasonality, market location, type of sale, variety, and interaction terms), F tests were used to determine the significance of the set of variables as a whole. The F-tests results, summarized in Table 1, indicate that at the .05 level of significance, each set of explanatory variables tested was significantly different from zero, with the exception of head and broken rice during 1989. These F-tests provided the justification for the inclusion of the respective sets of binomial variables, quality factors and interaction terms in the regression models (Table 2).

The analysis for each of the three marketing years indicate the implicit price structure for rough rice is dynamic and market forces have a significant impact on the magnitude and direction of the implicit prices for quality attributes. The three marketing years analyzed in this study exhibit vast differences in the market forces of supply and demand. As a result, the hedonic equations estimated herein portray the changing market forces by the varied coefficients and level of significance from year to year. The 1987

Table 1. "F" Test for Sets of Dummy Variables.

Class Variables	1987 F-Test	1989 F-Test	1989 F-Test
Quality	8.5561 *	230.8283 *	182.2582 *
Heads & Brokens	16.8007 *	6.2363 *	0.6158 *
Peck, Smut, R. Rice, Obj. Seed	3.7634 *	342.6548 *	263.9078 *
Quarters	15.4902 *	72.7206 *	335.0591 *
Markets	32.7685 *	31.8602 *	12.7195 *
Market*Quarter	6.2665 *	14.8870 *	9.6042 *
Quarter, Market*Quarter	68.2690 *	40.2362 *	150.8319 *
Market, Market*Quarter	14.2785 *	16.5336 *	9.0704 *
Trade	4.8012 *	283.9808 *	6.2514 *
Trade*Market	4.3868 *	22.7093 *	6.6200 *
Trade, Trade*Market	12.9607 *	54.8018 *	9.2581 *
Varieties	3.1060 *	1.6784 *	4.7221 *

* Significant at the .05 level

marketing year was dominated by dramatically escalating rough rice prices during the first half of the marketing year as a result of anticipated short supplies of rough rice in the world market. The tight rough rice supplies present during the first half of the 1987 marketing year greatly influenced the hedonic coefficients herein estimated. The implicit price adjustments during the 1987 marketing year, with the exception of objectionable seeds, were significantly different from the quality adjustments associated with the adjusted World Market Price. The 1988 and 1989 marketing years were more "normal" marketing years. As a result, the implicit price adjustments for quality factors where smaller in magnitude than for the 1987 marketing year. The differences in the underlying supply and demand conditions for each of the three marketing years is shown by the variation and magnitude and level of significance of the coefficients for the respective marketing years. Thus, it appears that when under "normal" market conditions, the adjusted World Market Price for rough rice accurately reflects market forces, and appears to make quality adjustments accordingly. As for adverse market conditions, as demonstrated by the 1987 marketing year, the adjusted World Market Price dramatically over- or under-values rough rice quality factors.

BASIS VARIABILITY ANALYSIS

Hamilton suggests that a direct result of the trading of rough rice futures contracts is that rice producers now have a primary price discovery tool to use in their individual marketing plans. This is extremely important given the nature of the sealed bid auction markets where rough rice trades, since their sealed bid nature inhibits the flow of information concerning the actual prices paid and received for rough rice. However, while futures markets provide a price discovery mechanism as well as additional marketing alternatives, basis information and an understanding of the fundamental economic composition of the basis, basis risk, and anticipating basis changes are essential for the prudent use of futures markets in evaluating pricing opportunities. Ward and Dasse state "If the basis cannot be explained, then there is reason to question both the market's performance and economic usefulness."

Table 2. Hedonic Coefficients for Texas Rough Rice Bid/Acceptance Markets: 1987, 88 and 89 Marketing Years.

	1987		1988		1989		1990	
Coefficient	Estimate	T Value	Estimate	T Value	Estimate	T Value	Estimate	T Value
Intercept Term								
Intercept	-14.41 *	-4.41	0.16	0.57	1.51 ***	1.71	1.62 *	2.64
Seasonality								
Quarter 2	3.92 *	5.02	0.14 *	5.43	1.71 *	23.68	0.53 *	3.42
Quarter 3	2.32 *	4.36	-0.30 *	-6.92	2.24 *	22.23		
Quarter 4	0.98 **	1.91	0.11 *	2.92	2.23 *	26.15		
Market Location								
Market 3	3.77 *	4.62	-1.72 *	-8.49				
Market 5			-0.50 *	-5.77	-0.22 *	-2.17	0.03	0.22
Market 6	1.82 **	2.25	0.38 *	5.64	-0.11	-1.02	-0.05	-0.37
Market 8	1.94 **	2.38	0.04	0.50	0.03	0.42	0.09	0.75
Market 9			0.35 *	6.10	0.73 *	5.82		
Market 12			0.16	1.64	0.06	0.50	-0.29 **	-2.20
Market 17					1.30 *	5.45		
Market 18					-0.31 *	-2.46	-0.15	-1.22
Quality								
Head rice	0.22 *	5.08	0.01 *	3.08	-0.01	-1.01	0.00	0.39
Brokens	0.21 *	4.32	0.01 *	3.43	-0.01	-1.09	-0.00	-0.30
Peck - Brown Analysis	-0.15 **	-1.89	0.02 **	2.04	0.02	1.09	-0.05 *	-3.15
Red Rice	-0.26 **	-2.23	0.10 *	6.24	0.15 *	4.07	0.10 *	4.14
Smut - percent	0.36 **	2.44	-0.34 *	-4.44	0.12	1.48	0.07	0.79
Objectionable Seeds	0.00	0.39	0.04 *	36.40	0.05 *	32.13	0.03 *	9.95
Transaction Type								
Trade	0.40 **	2.19	0.38 *	16.85	0.18 *	2.50	0.09	0.38
Variety								
Variety 2	0.47 *	2.70	-0.05 *	-3.62	0.01	0.36	-0.04	-1.04
Variety 3	-0.59	-0.90						
Variety 4	0.00	0.00	-0.09 ***	-1.93	-0.36 *	-3.41	-0.46	-1.09
Variety 5			-0.23	-0.91	-0.23	-0.62	-0.35	-0.83
Variety 6	-0.35 **	-1.98	-0.04 **	-2.15	-0.16 *	-3.36	-0.35 *	-4.45
Variety 10	-3.61 **	2.43	0.07	0.52				
Variety 11			0.26	0.96				
Variety 12			0.01	0.07	-0.97	-1.48		
Variety 13	0.80	0.60	-0.15	-0.87	-0.24	-0.79		
Variety 14			-1.06	-1.42				
Variety 15							-0.39	-0.77
Variety 16			0.00	0.01				
Variety 18			0.12	0.61	-2.00 *	-4.16		
Variety 20			-0.34	-1.55				
Variety 22			-0.13	-0.19				
Variety 23			0.11	0.28	-1.28	-0.76	2.13 *	4.83
Variety 24					0.45	0.72		
Interaction Terms								
Seasonality * Market								
Quarter 2 x Market 3	-2.47 *	-2.97	2.12 *	9.70				
Quarter 3 x Market 3			2.11 *	10.34				
Quarter 4 x Market 3	-5.52 *	-3.51	1.29 *	4.35				
Quarter 2 x Market 5			0.16 *	2.85	-0.80 *	-7.66	-0.02	-0.11
Quarter 3 x Market 5			0.13 **	2.21	-0.39 *	-2.72		
Quarter 4 x Market 5					-0.35 *	-2.47		
Quarter 2 x Market 6	-1.07	-1.34	-0.11 **	-2.03	-0.46 *	-3.65	0.20	1.09
Quarter 3 x Market 6	-1.54 **	-1.87	-0.10 **	-1.88				
Quarter 4 x Market 6	-1.93	-1.61	-0.21	-0.72				
Quarter 2 x Market 8	-0.71	-0.89	-0.03 ***	-0.41	-0.10	-0.94	-0.34 **	-2.06
Quarter 3 x Market 8			-0.02	-0.39	-0.15	-1.01		
Quarter 4 x Market 8			0.24 **	2.52	-0.10	-0.51		
Quarter 2 x Market 9			-0.08	-1.43	-0.95 *	-8.09		
Quarter 3 x Market 9			-0.02	-0.41	-0.41 *	-2.90		
Quarter 4 x Market 9			0.25 *	3.01	-0.17	-1.16		
Quarter 2 x Market 12			-0.07	-0.84	-0.48 *	-3.77	0.20	1.10
Quarter 3 x Market 12			-0.19 ***	-1.95	-0.22	-0.78		
Quarter 4 x Market 12			-1.10 *	-8.07				
Quarter 2 x Market 17					-1.98 *	-5.43		
Quarter 3 x Market 17					-1.60 *	-5.04		
Quarter 2 x Market 18					0.08	0.45		
Quarter 3 x Market 18					-0.15	-0.56		
Market Transaction								
Market 3 x Trade	-0.45	-0.98	-0.53 *	-6.49				
Market 5 x Trade			0.22 **	2.93	0.35 *	3.02	0.35	1.35
Market 6 x Trade	0.59 **	2.39	-0.34 *	-6.20	0.04	0.32	-0.05	-0.18
Market 8 x Trade			0.00	-0.02	0.03	0.27	0.89 *	3.63
Market 9 x Trade			-0.38 *	-7.40	-0.48 *	-3.94		
Market 12 x Trade			-0.25 *	-3.54	-0.05	-0.39	0.17	0.67
Market 17 x Trade								
Market 18 x Trade					0.25	1.27	-0.12	-0.31
R-Square	0.5644		0.4181		0.7672		0.5994	
F Value	29.18		48.19		118.98		41.47	

The asterisks denote the level of statistical significance.
* - significant at the .01 level.
** - significant at the .05 level.
*** - significant at the .10 level.

Tilley and Campbell suggest that basis performs the function of allocating supplies over time and space. If the Texas farm level basis is functioning efficiently, it should encourage rice to move to the Houston area for milling and movement into the domestic or export market when supplies are needed, or encourage storage in private or public facilities for future delivery to the Houston mill sites for processing and/or export. Since rice is seasonally produced, proper timing of deliveries involves incentives to store or remove rice from storage. To encourage storage when supplies are plentiful, cash must fall relative to futures prices. The resulting basis will decrease and provide the holders of the cash rice with a greater return to storage, and thus the incentive to hold their rice for sale at a later date. If supplies are tight and the millers need the rice, the cash price of rice will need to increase relative to futures. This will result in an increase in the basis and an erosion of the available return to storage, providing an incentive for the producer to sell now.

Considering the importance of basis, one objective of the study is to investigate the need for quality adjusted basis information. Due to the complexities of the rice market, and the numerous quality factors that influence rice prices, it may be important to account for these factors when providing basis information. Problems of obtaining and providing basis values are compounded by the limited number of sales offices providing sales and quality information, and the varying number of participating sales offices during the study period. These factors lead to complications for producers, sales office managers, marketing professionals, and researchers alike.

In order to arrive at a quality adjusted basis, it is necessary to adjust the actual cash price series for any premiums and/or discounts associated with deviations from the quality being used as the standard which, in this case, is the 55/70 #2 quality deliverable against the rice futures contract. While this, in theory, may seem the best way to proceed, the vagaries of the grading system do not provide an adequate standard. There is not a specifically stated tolerance level for each quality characteristic in the grade. The grade instead provides a tolerance level for groups of quality factors. This presents a problem since the implicit prices from the hedonic analysis are not the same across characteristics. As a proxy, the means for the various quality factors which average out to a 55/70 #2, were used as the quality factors for each lot of rice in the estimation procedure seen below.

$$\begin{aligned} ADJCP_i = {} & a_i + MWMP_i + b_1\, MHEAD_i + b_2\, MBROKENS_i + b_3\, MBPECK_i + B_4\, MBRED_i \\ & + b_5\, MSMUT_i + b_6\, MSEED_i + b_7\, TRADE + b_1\, QTR_y + b_j\, MKT_j + b_k\, VAR_k \\ & + b_{yj}\,(QTR_y * MKT_j) + b_{j7}\,(MKT_j * TRADE) + e_i \end{aligned} \tag{5}$$

Where:

$ADJCP_i$: the quality adjusted cash price ($/cwt);
$MWMP_i$: world market price for 55/70 #2 quality rice;
$MHEAD_i$: the mean percent whole grains;
$MBROKENS_i$: the mean percent broken grains;
$MBPECK_i$: the mean percent peck damage;
$MBRED_i$: the mean red rice content;
$MSMUT_i$: the mean percent smut damage;
$MSEED_i$: the mean total number of objectionable seeds;
$TRADE$: a binary variable denoting "off-the-table" trades;
QTR_y : a set of binary variables denoting the quarter of the marketing year;

MKT_j	: a set of binary variables denoting the market location;
VAR_k	: a set of binary variables denoting the rice variety;
QTR_y*MKT_j	: a slope shifter measuring the interaction between market and time;
$MKT_j*TRADE$	: a slope shifter measuring the interaction between the market location and market activity;
b	: the coefficients from the hedonic analysis;
e_i	: error term from the hedonic analysis.

The resulting adjusted price (ADJCP), while standardized for quality, will still include all of the other factors involved in determining the actual price including the error term.

The Texas rough rice weekly average cash price and the quality adjusted weekly average price are used to develop the average basis (AVGBasis) and the quality adjusted average basis (ADJBasis) by subtracting the nearby Wednesday closing futures price from the respective cash price.

The objective of this section then is to compare AVGBasis and ADJBasis to determine whether the quality adjusted basis provides more information and is more meaningful. As stated earlier, a major concern of rice producers, when considering the use of the futures markets as a marketing alternative, is the extreme variability in the basis. Taylor, et al. suggest that a significant portion of the variability in rice futures prices is due to differences in quality. Therefore, it may be possible to reduce the basis variability faced by a producer if an accurate quality adjusted basis series can be established.

Another test of the value of the adjusted basis would be to econometrically model the basis and then attempt to forecast it into the future. If the adjusted series provides better information about the future and, hence, potentially reduce basis risks, the series would be of value to producers and other market participants.

An econometric model is developed to explain variation in the Texas rice basis. It is hypothesized that the basis will be negatively related to the level of supplies, and the level of the current futures price. It is also hypothesized that the basis will be positively related to the level of total use and exports/total use, and past basis.

$$AVGBasis_t = a + b_1\, SUPL_t + b_2\, ETU_t + b_3\, USE_t + b_4\, FP_t + b_5\, LB_{t-1} + e_t \quad (6)$$

$$ADJBasis_t = a + b_1\, SUPL_t + b_2\, ETU_t + b_3\, USE_t + b_4\, FP_t + b_5\, LB_{t-1} + e_t \quad (7)$$

Basis Analysis Results

The above hedonic analysis provides valuable information to rice producers concerning quality and other factors that are significant in determining the price they will receive for their rice. The resulting implicit prices will prove useful to the producer in making a number of production and management decisions such as varietal planting choices, and provide important data for use in assessing the economic costs and returns of practices associated with producing different qualities of rice. The analysis of the adjusted basis series suggests that there are also benefits to standardizing the basis series for quality difference.

Descriptive Analysis

The simple descriptive analysis comparing the average basis and the quality adjusted average basis provides some interesting results (Table 3). The mean of the adjusted average basis is greater than that of the unadjusted basis and reflects a significant cash premium over the nearby futures price and over the unadjusted basis for a 55/70 #2 quality rice. The a priori expectation concerning the variability of the adjusted basis series when compared to the unadjusted series, however, proved to be incorrect. While it had been hypothesized that standardizing the quality would result in a lower variance, the empirical evidence suggests that the variance is actually greater for the adjusted basis series. One explanation for this could be the adjustment process used.

Table 3. Descriptive Statistics for Average and Adjusted Average Basis, 1987-1989 Marketing Years.

	N	Mean	Minimum	Maximum	Variance	Standard Deviation
AVGBasis	36	0.028	-1.790	2.540	0.421	0.649
ADJBasis	36	0.621	-0.870	3.150	0.445	0.667

Basis Modeling Results

The original estimations was done using OLS, however, a check for serial correlation using the Durbins H statistic revealed a problem with serial correlation in the AVGBasis model. The model was rerun using the auto procedure in Shazam, which utilizes a Cochrane - Orcutt procedure to correct for the serial correlation problem. The results, seen in Table 4, show that the coefficients were of the expected sign, and the variables were significant. The R^2 and R^2 of the models suggest that a fair amount of the variation in each dependent variable was explained by variation in the independent variables. The goodness of fit results also suggest that the model performs slightly better when explaining the average basis than the adjusted average basis. The R^2 and R^2 were slightly lower for the AVGBasis model in the original OLS estimation; however, the adjustment for serial correlation improved the models fit and resulted in the AVGBasis being better explained.

Since the explanatory model was developed using variables in time *t*, the out of sample forecasts performed with this model would be limited usefulness at best. This is a common problem when econometric models with economic variables are developed to explain variation in the dependent variable and then forecasts are desired. Several possible solutions to this problemexist, such as attempting to forecast the time *t* variables, lagging them, or looking for a different model, but each has some disadvantages. Hauser, Garcia and Tumblin utilized several simple basis forecasting models based on past basis

Table 4. Estimation Results for Monthly Texas Rough Rice Basis.

Variable	ADJBasis		AVGBasis	
	Coefficient	T Value	Coefficient	T Value
LB_{t-1}	0.294	1.869***	0.293	2.503**
FP_t	-0.165	-3.035*	-0.247	-6.505*
USE_t	0.044	2.557**	0.031	2.687**
ETU_t	8.431	1.773***	8.719	2.335**
$SUPL_t$	0.025	-1.729***	-0.011	-1.004
Intercept	-4.479	-0.778	-5.137	-1.122
R^2	0.6906		0.7090	
R^2	0.6203		0.6429	
Durbins H	-1.0262		0.0104	

* -significant at the .01 level.
** -significant at the .05 level.
*** -significant at the .10 level.

values and implied carrying charges based on the spread between futures contracts. After some experimentation, the final choice here was to use lagged independent variables and see whether the model still had any explanatory value. The results seen in Table 5 suggest that both models do explain a significant amount of the variation in the average and the adjusted average basis series. The Durbins H statistic again indicated a serial correlation problem with the AVGBasis model, so it was corrected as before using the Cochrane - Orcutt procedure in the auto function of Shazam. Lagging the explanatory variables three periods, performed better than expected. While the R^2 and R^2 decreased slightly for the AVGBasis model, they actually increased slightly for the ADJBasis model. Use and supply continued to have the expected sign and are significant at the .05 level. The third period lag of the export/use variable, while remaining significant, changed sign from having a positive to a negative effect on the size of the basis in both the AVGBasis model and the ADJBasis model.

The lagged basis, Lb_{t-3}, was insignificant in both the ADJBasis and the AVGBasis models. While the three month lag of the futures price was significant at the .05 level in the AVGBasis model and had the expected sign, it was insignificant in the ADJBasis model. Since the R^2 did not drop substantially for the models in which the three month lags were used, and most of the variables were still significant, it was used to produce forecast estimates into the first six months of the 1990 marketing year.

Forecast Results

The mean square errors (MSE) over the forecast period are used to compare the model's ability to forecast the two basis series.

The MSEs for the models forecasting out three months suggest that the model performs much better forecasting the ADJBasis series three months ahead with an MSE of 0.317 than it performs forecasting the AVGBasis series three months out with an MSE of 1.002. These results lend additional support for the estimation and use of a quality adjusted or standardized basis series.

Table 5. Estimation and Forecast Results for Monthly Texas Rough Rice Basis Using Lagged Variables.

Variable	ADJBasis		AVGBasis	
	Coefficient	T Value	Coefficient	T Value
LB_{t-3}	-0.020	-0.287	0.141	1.650
LFP_{t-3}	-0.005	-0.101	-0.169	-4.041*
$LUSE_{t-3}$	0.060	4.108*	0.041	3.375*
$LETU_{t-3}$	-13.838	-3.497*	-19.946	-5.823*
$LSUPL_{t-3}$	-0.051	-3.737*	-0.056	-4.792*
Intercept	7.424	1.404	14.980	3.180*
R^2	0.7179		0.6636	
R^2	0.6538		0.5871	
Durbins H	0.7399		0.1965	
Forecast Period MSE	0.3170		1.0022	

* -significant at the .01 level.
** -significant at the .05 level.
*** -significant at the .10 level.

SUMMARY AND CONCLUSIONS

This study reinforces the findings that rice quality (whole and broken grains, peck, red rice, smut, and objectionable seeds) play an important role in the determination of rough rice prices. Furthermore, this study indicates that market participants often value these quality attributes differently than does the adjusted World Market Price, which provides the base for the pricing mechanism in the current bid/acceptance marketing environment. The study additionally indicated that varietal differences, market activity, seasonality, and market location all played significant roles in the hedonic pricing of rough rice.

The results discussed herein have significant results and implication for participants in the Texas rough rice market. For producers, the study has indicated that the market forces impacting upon rough rice premiums and prices are wide in scope and nature. Although these factors impact rough rice prices, the World Market Price is still a major factor in the formulation and determination of the rough rice price level. Under normal supply and demand condition for rough rice, the adjusted World Market Price tends to adequately reflect premiums and discounts paid by rice mills in the bid/acceptance auctions. One of the most dramatic implications of the study is the significant difference between market locations even after transportation adjustments are made for each of the respective lots of rice. This would indicate a potential benefit in selecting a market location. Although the magnitude of benefit varies year to year and within the year, relative benefits and a potential for gain does exist.

The basis analysis performed herein has prompted considerable thought and concern. Even though the basis values obtained from the average confirmed price series provide values with a lower variance about the means than do the quality adjusted prices, it must be emphasized that the values do not adequately reflect quality adjustments that are prevalent in the rough rice market. This is the major strength of the adjusted basis values. The hedonic adjusted prices and basis values are adjusted for quality, thus providing a basis value for a specified grade and quality of rice. With out the hedonic adjustments, the individual producers are not only faced with basis risk, but also a certain amount of risk associated with transportation rates, quality, and market differences. The forcasting results also suggest that the removal of the quality induced variability from the basis series provides better information to the producer or miller to be used in planning pricing strategies.

References

Adelman, I. and Z. Griliches. "On an Index of Quality Change." Journal of the American Statistical Association 56(1961):535-48.

Brorsen, B.W., W.R. Grant, and M.E. Rister. "A Hedonic Price Model for Rough Rice Bid/Acceptance Markets." American Journal of Agricultural Economics 66,2(1984):156-63.

Brorsen, B.W., W.R. Grant, and M.E. Rister. "Some Effects of Rice Quality on Rough Rice Prices." Southern Journal of Agricultural Economics 20,1(1988):131-140.

Ethridge, D.E. and B. Davis. "Hedonic Price Estimation for Commodities: An Application to Cotton." Western Journal of Agricultural Economics 7(1982):293-300.

Ethridge, D.E. and J. Neeper. "Producer Returns From Cotton Strength and Uniformity: An Hedonic Price Approach." Southern Journal of Agricultural Economics 19,1(1987):91-97.

Fryar, E.O., L.D. Parsch, S.H. Holder, and N.P. Tugwell. "Reducing Peck: Is It Worth It?" Paper Presented at the 21st Rice Technical Working Group Meeting, Houston, Texas, February 23-25, 1986,

Grant, W.R., M.E. Rister, and B.W. Brorsen. "Rice Quality Factors: Implications for Management Decisions." Texas Agricultural Experiment Station, B-1541, July 1986.

Hamilton, M.C. "Rough Rice Futures and the U.S. Rice Industry." Presented to U.S. Rice Millers Association 90th Annual Meeting, Maui, Hawaii, June 9, 1989.

Hauser, Robert J., Philip Garcia, and Alan Tumblin. "Basis Expectations and Soybean Hedging Effectiveness." North Central Journal of Agricultural Economics 12(1990):125-136.

Ladd, G.W. and M.B. Martin. "Prices and Demands for Input Characteristics." American Journal of Agricultural Economics 58(1976):21-30.

Lucas, R.E.B. "Hedonic Price Functions." Economic Inquiry 13(1975):157-78.

Martinez, A., H.D. Traylor, and L.L. Fielder. "Analysis of Effects of Quality and Non-Quality Factors on Prices of Medium and Long Grain Rough Rice in Louisiana." Department of Agricultural Economics and Agribusiness, Louisiana State University. D.A.E. Research Report Number 507, September 1976.

McCann, R.F. Jr. Affiliated Rice Milling, Inc. Personal Correspondence, February 4, 1990.

Rosen, S. "Hedonic Prices and Implicit Market Product Differentiation in Pure Competition." Journal of Political Economics 82(1974):34-55.

Taylor, E.L., M.L. Waller, M.E. Rister, E.G. Smith, W.R. Grant, D.A. Koop. "A Hedonic Model of Texas Rice Markets: A Study of the 1987 and 1988 Marketing Years", Paper presented at the Southern Agricultural Economics Association,Annual Meeting, Little Rock, Arkansas, February 3-7, 1989.

Tilley, Daniel S., and Steven K. Campbell. "Performance of the Weekly Gulf-Kansas City Hard-Red Winter Wheat Basis." American Journal of Agricultural Economics 70(1988):929-935.

Traylor, H.D., J.F. Dennison, and S.L. Conger, Jr. "An Analysis of the Effect of Selected Quality Factors on Prices Paid Producers for Rough Rice in Louisiana." Louisiana Rural Economist 49,4(1987):5-7.

Ward, R.W., and F.A. Dasse. "Empirical Contributions to Basis Theory: The Case of Citrus Fruit." American Journal of Agricultural Economics 59(1977):71-80.

Wilson, W.W. "Hedonic Price in the Malting Barley Market." Western Journal of Agricultural Economics 9(1984):29-40.