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HOW EFFICIENT IS THE ROUGH RICE FUTURES MARKET? *

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ABSTRACT

Efficiency of the rough rice futures market is analyzed relative to the Arkansas cash market. Market activity is examined and various efficiency tests are performed. Inefficiencies were found in beginning or low volume contracts, but some market efficiency criteria improved with time and greater contract volume.

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INTRODUCTION

Members of the U.S. rice industry have a growing interest in the performance of the rough rice futures market. [1/] Changing Government programs, uncertain yields, and fluctuating export demand have contributed to volatile prices. As prices become more volatile, activity within the rough rice futures market increases. Market participants have become interested in the efficiency of this futures market given its increasing use and young age (approaching its four year anniversary)

An efficient futures market is beneficial to society and can provide alternative marketing strategies for producers, elevator operators, and processors. Futures facilitate price discovery and provide price level information to market participants. Price risks, typical of commodity inventory ownership, can also be reduced with an efficient futures market.

Rice futures trading has had a checkered history. Rough and milled rice were traded for about 2 years from April 1981 to June 1983 at the New Orleans Commodity Exchange (NOCE). Thereafter, the NOCE was incorporated into the CRCE which was affiliated with the MidAmerica Exchange. For a brief period of time, rough rice was traded at the CRCE commencing September 1983. Rough rice trading is presently conducted at the Chicago Rice and Cotton Exchange (CRCE).

The present contract's unit of trading is 2,000 hundredweight. All futures contracts are for No. 2 or better long grain rough rice and no other grade is deliverable.

[1/] Participants in the entire grain industry are interested in an efficient commodity futures market. The National Grain and Feed Association is funding a study of the performance of the corn, soybean and wheat futures contracts traded at the Chicago Board of Trade. Final report is due March 1, 1991.

[2]/ Delivery months include January, March, May, September, November, and beginning in 1989, July. "Regular" delivery points, as determined by the exchange, are in and around Stuttgart, Arkansas.

The purpose of this paper is to analyze the efficiency of the rough rice futures market. Volume, open interest and deliveries per contract are examined to determine whether they exhibited characteristics of an efficient market. Hedging and pricing efficiency tests are employed.

LITERATURE REVIEW

Gordon assessed the performance of three thinly traded futures markets, rough rice, milled rice, and sunflower seeds (5). Several statistical tests showed that these commodities retained some of the pricing and hedging properties of more heavily traded markets. Each of the three markets exhibited randomness in day-to-day price changes. Without this property they would be of little value to the potential hedger. Each commodity's hedging performance, as measured by basis regressions, was mixed. The forecast accuracy test of the futures market was rejected because futures prices apparently overreacted to changes in supply and demand.

In a more recent study of the current rough rice futures market Traylor and Denison found a mixed performance in rough rice futures market during the 1986-87 period (15). Their results suggest that cash and futures market reflect related information. The correlation of price changes indicated improvement in market efficiency from the first year, 1986/87 to the second year 1987/88. A significant basis trend was not found and a low R^2 suggested that time did not explain much of the basis variation. Although price changes appeared random in the 1986/87 marketing year, autocorrelation was found in 1987/88.

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[2]/ Rough rice of deliverable quality must have a milling yield of not less than 65 percent, including not less than 48 percent head rice. Each percent of head rice over or below 55 percent shall receive a 1.75 percent premium or discount, respectively, toward the settlement price for long grain rough rice and each percent of broken rice over or below 15 percent shall receive a .5 percent premium or discount, respectively. All rough rice shall be of a Southern origin or such other origin as the Exchange may approve.

In another recent analysis, the rough rice futures market was deemed an efficient hedging and pricing medium for the rice industry. Over 90 percent of the variation in Arkansas cash price and world price was reflected in the rice futures price (CRCE) (1).

Many economists have used a forecast accuracy test to evaluate the pricing performance of the futures market. Some include Tomek and Gray (13), Kofi (7), and Leuthold (9), Martin and Garcia (11) and Leath and Garcia (8). Several of these studies reject the null hypothesis of unbiased forecasts and suggest that the futures markets are not performing efficiently and so some traders could profit at the expense of others.

Some economists have questioned the use of this forecast accuracy test. Maberly (10) concluded that forecast bias was due to censoring of the dependent variable. Gordon (6) found that forecast bias is due to a misspecified model and that Maberly's hypothesis does not apply to the usual market test. In a recent paper Elam concludes that pricing efficiency is not the result of applying OLS to a censored sample but due to biases in coefficient estimates (3).

THEORETICAL FRAMEWORK

An important reason for participating in the futures market is to hedge against price changes of the commodity. Producers sometimes sell a portion of their crop forward on the futures market, known as a short hedge. In contrast processors often buy contracts for future delivery, known as a long hedge. Thus, if cash and futures interact efficiently, a hedgers' price risk will be reduced rather than increased.

Hedging requires a predictable relationship between the futures and cash market price. The end-of-period basis, the difference between the futures price and the cash market price at the end of the hedging period, should be predictable. For a futures contract later in the marketing year, the basis is generally widest at harvest time as the cash price is less than the futures price. Under ideal theoretical conditions the old-crop basis reflects the cost of storing the commodity until the future delivery date. Thus, it would vary little between days, but the cash price would gradually approach the futures price as the contract maturity date is approached.

Differences between the price of different futures contracts represent the market-determined carrying charge. These prices provide incentives or disincentives for producers or elevator operators to store rice.

Arbitrage in the cash and futures market forces both prices to converge at contract maturity assuming both markets are in the same location. For example, if cash prices exceed futures at maturity, market participants could buy futures and take delivery acquiring rice cheaper than in the cash market. Alternatively, if futures exceed cash at maturity, cash rice could be bought, futures contracts sold, and delivery made on those contracts. In practice, cash prices are sometimes higher than the maturing futures price because of the cost associated with taking delivery (14). Therefore, the ability to take or make delivery assures that prices will differ by no more than transaction prices.

ANALYTICAL FRAMEWORK

The level of futures market activity is examined first for characteristics of an efficient market. Levels of open interest are compared with production. Contract volume is compared with CFTC's definition of low volume contracts. Deliveries are compared to past standards.

If the cash and futures market behave efficiently, hedging a crop will reduce a producer's price risk rather than increase it. A futures price quotation is considered to be an unbiased forecast of the cash price at delivery time. Thus, the futures and cash price should approach equality at delivery time and so changes in both futures and cash prices should be highly correlated. This relationship shows the hedging efficiency of markets. Price correlations were computed to examine this aspect of hedging efficiency: the first differences of weekly (Tuesday) November futures and Arkansas cash prices were correlated. A simple model was specified to test the statistical significance of this relationship.

(1) Change (lnFP) = a + b(Change(lnCP)) + e

where: FP = first difference of the logarithm of futures price for the November contract.

CP = first difference of the logarithm of cash price in the Arkansas market.

Another test for hedging efficiency is to examine the basis relationships. If the futures and cash price behave as expected, they will approach equality at contract maturity, assuming both markets are in one location. Therefore, the basis narrows or declines as contract maturity is reached. A trend model was formulated to test for basis behavior using a weekly basis derived from the May contract:

(2) Basis = a + b(Time) + e .

where: Basis = Futures price less cash price, Time = Number of observations in the data series.

The efficient market hypothesis assumes that prices should reflect all available information about supply and demand. Based on the efficient market hypothesis, on average, excess profits cannot be earned by any market participant. Prices are random and thus there is no opportunity for consistent arbitrage. Price efficiency requires that price changes be random. Otherwise, excess profits can be earned by arbitration. A second order autoregressive model was specified which tested for random price changes of the daily November futures price.

(3) $\text{Change}(\ln FP_t) = a + b_1(\text{Change}(\ln FP_{t-1})) + b_2(\text{Change}(\ln FP_{t-2})) + e$

where: first differences for the logarithm of daily futures prices were computed: FP_t = futures price in t, FP_{t-1} = futures price in t-1, and FP_{t-2} = futures price in t-2. b_1 and b_2 = autoregressive parameters.

DATA

Prices for both the futures (daily and weekly) and cash market (weekly), contract volume, open interest, and deliveries per contract were required for this study (1986-89). Futures prices, contract volume, and peak open interest were obtained from the Chicago Rice and Cotton Exchange. Cash prices for the Arkansas market were obtained from industry sources. These prices reflect traded values for good quality No. 2 rice. The Commodity Futures Trading Commission provided the deliveries per contract.

RESULTS

The findings of this study pertain to futures market activity and market efficiency. Results of the market activity are used to help interpret the analysis of hedging and pricing efficiency.

Futures Market Activity

Standard measures of trading activity include volume and open interest. Open interest represents the number of outstanding contracts. Deliveries on contracts are examined because an unusually large number of deliveries may suggest problems with performance of the contract and some traders may tend to avoid such markets.

Volume

Trading in rough rice futures began slowly, reaching almost 800 contracts in December of 1986 (fig. 1). Volume surged to nearly 10,000 contracts in October of 1987 and ranged between 7,500 and 1,700 contracts during 1988. In 1989 monthly volume ranged between 1,400 and 6,400 contracts. In general volume initially increased but has plateaued between April and October of 1989.

Present market volume exceeds a "low volume" contract as defined by the Commodity Futures Trading Commission (2). A low volume contract is one where all trading falls below 1,000 contracts per calendar month during four of any six consecutive calendar months. Thus, at present activity levels the rice contract avoids any special reporting requirements the CFTC may require of "low volume" contracts.

Open interest

Open interest peaked in October of 1987 at 3,500 contracts, since then it has ranged between 1,700 and 3,400 contracts per month (fig. 2). Maximum open interest of any contract represents only a small portion of annual production. For example, the November 1987 contract represented about 2 percent of 1987 production, March 1988 contract 2.5 percent of 1988 production and November 1989 contract 1.7 percent of 1989 production. The harvest-time contracts of September and November and the March contract usually represented a large volume and maximum open interest.

FIGURE 1--MONTHLY VOLUME OF THE ROUGH

RICE FUTURES CONTRACT, 1986-89.

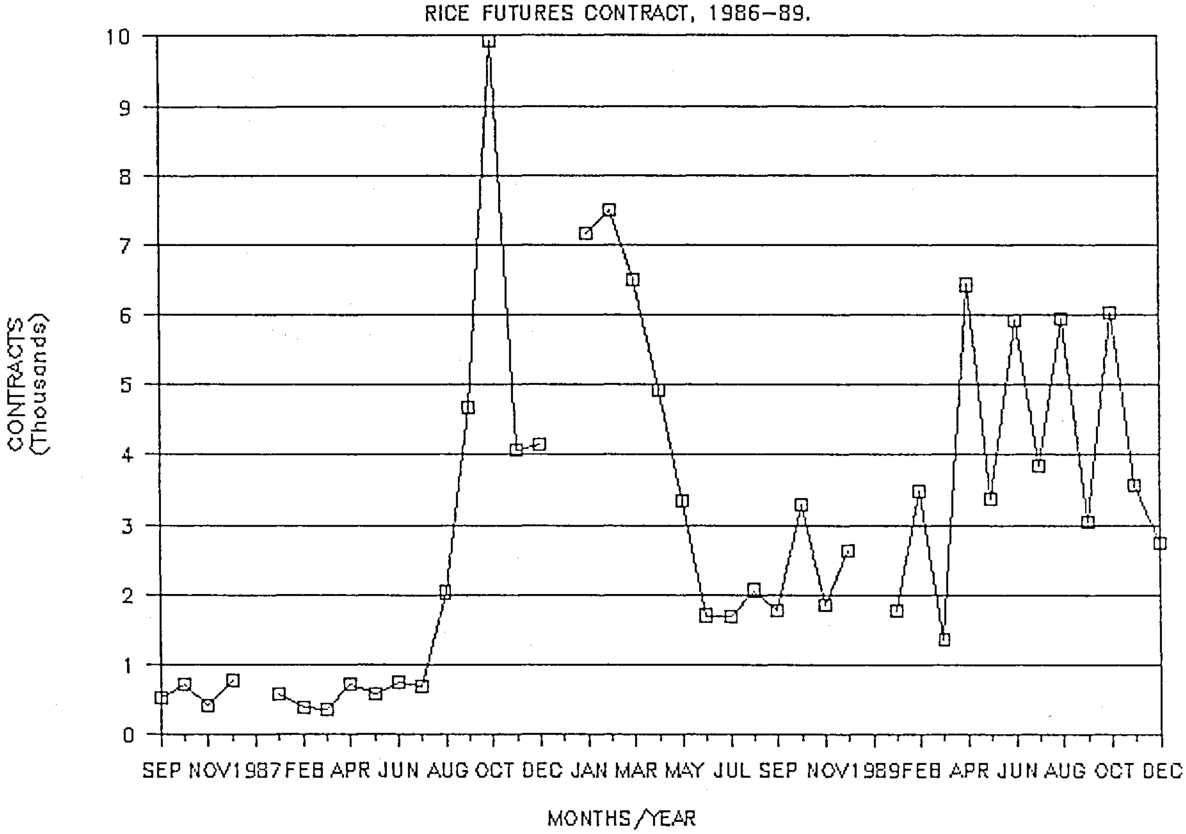
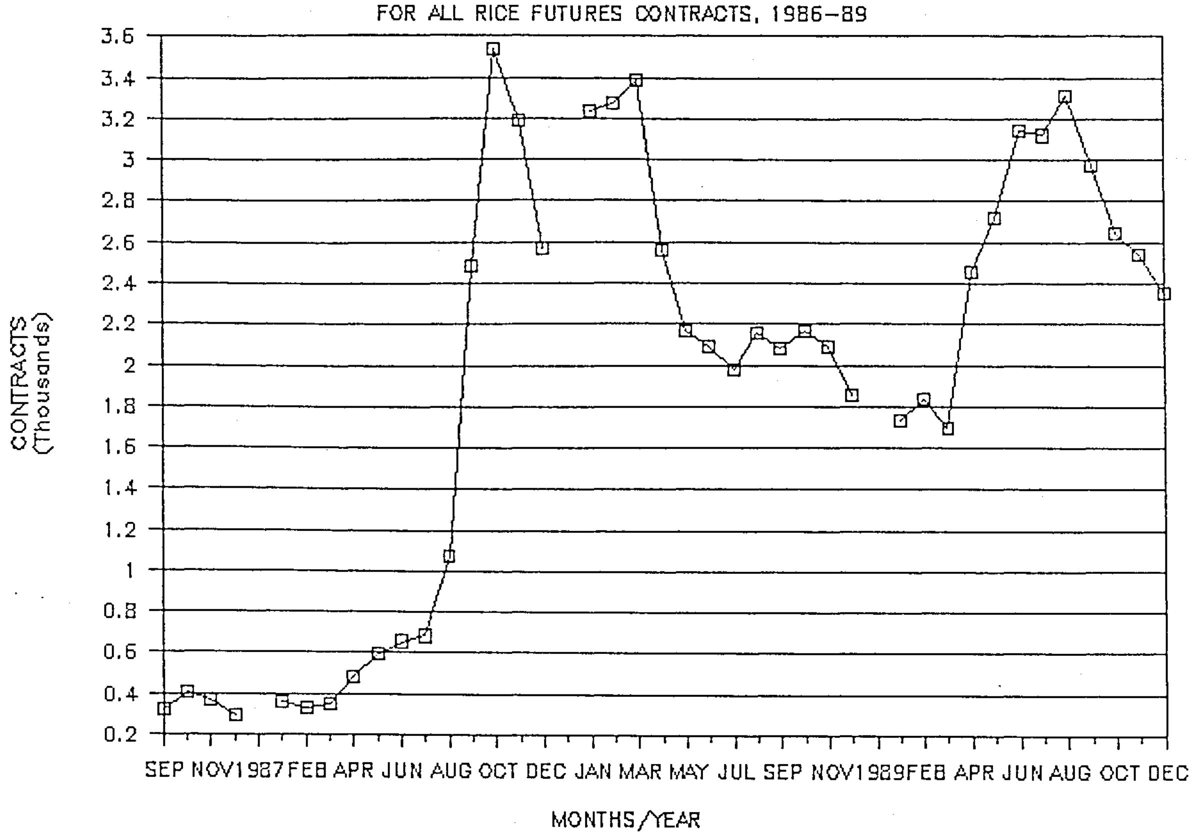


FIGURE 2--PEAK OPEN INTEREST PER MONTH

FOR ALL RICE FUTURES CONTRACTS, 1986-89



Deliveries on contracts

Deliveries on contracts ranged from 1 to 13 percent of contract volume (table 1). Most futures contracts have a relatively low percentage of deliveries, with an average of less than 2 percent of total volume (5). The larger ratio of deliveries to open contracts suggests an immature pricing mechanism that doesn't yet reflect an efficient market. It is generally less efficient to deliver on a futures contract than to offset the position in the futures market and deliver at a local cash market. In the case of rice this may be explained by the delivery point being located in a major cash market. Thus, a large number of farmers may find it as convenient to deliver on the futures as on the cash market. [3]/

Table 1 also shows the maximum open interest per contract and relates deliveries to open interest. This ratio emphasizes that specific contracts have more deliveries than others. For example, early on contracts had a larger percentage of deliveries. More recently, especially the September and November contracts in 1988 and 1989, they had a lower percentage of deliveries. Deliveries compared to agricultural futures contracts usually amount to less than 5 percent of the average number of open positions (12). The high percentage of deliveries in the early contracts, 1986-87, was probably due to contract start-up, as some participants found making or taking delivery preferable to offsetting their position.

Hedging Efficiency

One characteristic of the futures market is that it should reflect activity in the cash market. Two approaches are used to study hedging efficiency. First, the correlation between the first differences of the Arkansas cash market and the futures market shows how closely the series move together. Second, a simple equation was constructed to determine

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[3]/ For all 1991 contract months the milling yield adjustments are being changed from 1.75 percent premium or discount for head rice and .5 percent premium or discount for broken rice to 1.50 percent for head and .75 percent for brokens. This change should reduce the incentive to deliver high milling rice. For example, at $8 a cwt. the futures pays about $.25 a cwt. more for rice than the cash market.

Table 1--Rice Futures Statistics: Life of Contract Volume, Maximum Open Interest per Contract, and Deliveries per Contract.

Contract	Total Volume	Maximum Open Interest	Deliveries Per Contract 1/	Deliveries Percent of Vol.	Deliveries Percent of Open Int.
	- - - -Contracts- - - -			- -Percent- -	
November 1986	1,111	204	142	12.8	69.6
January 1987	1,032	176	7	.7	4.0
March 1987	1,293	187	48	3.7	25.7
May 1987	792	142	72	9.1	50.7
September 1987	1,809	290	166	9.2	57.2
November 1987	8,336	1,342	672	8.1	50.1
January 1988	11,332	1,583	772	6.8	48.8
March 1988	15,699	1,994	1,061	6.8	53.2
May 1988	13,215	1,886	976	7.4	51.7
September 1988	9,796	1,051	200	2.0	19.0
November 1988	8,570	1,171	153	1.8	13.1
January 1989	5,036	945	221	4.3	23.4
March 1989	6,184	1,134	59	1.0	5.2
May 1989	6,444	922	666	10.3	72.2
July 1989	3,993	959	482	12.1	50.3
September 1989	10,186	1,189	270	2.7	22.7
November 1989	10,094	1,391	267	2.6	19.2
January 1990	10,189	1,252	185	1.8	14.8

1/ May include some double counting.

Source: Chicago Board of Trade and Commodity Futures Trading Commission

whether first differences in the logarithm of cash price could be used to predict the log of November futures price first differences.

Price correlation

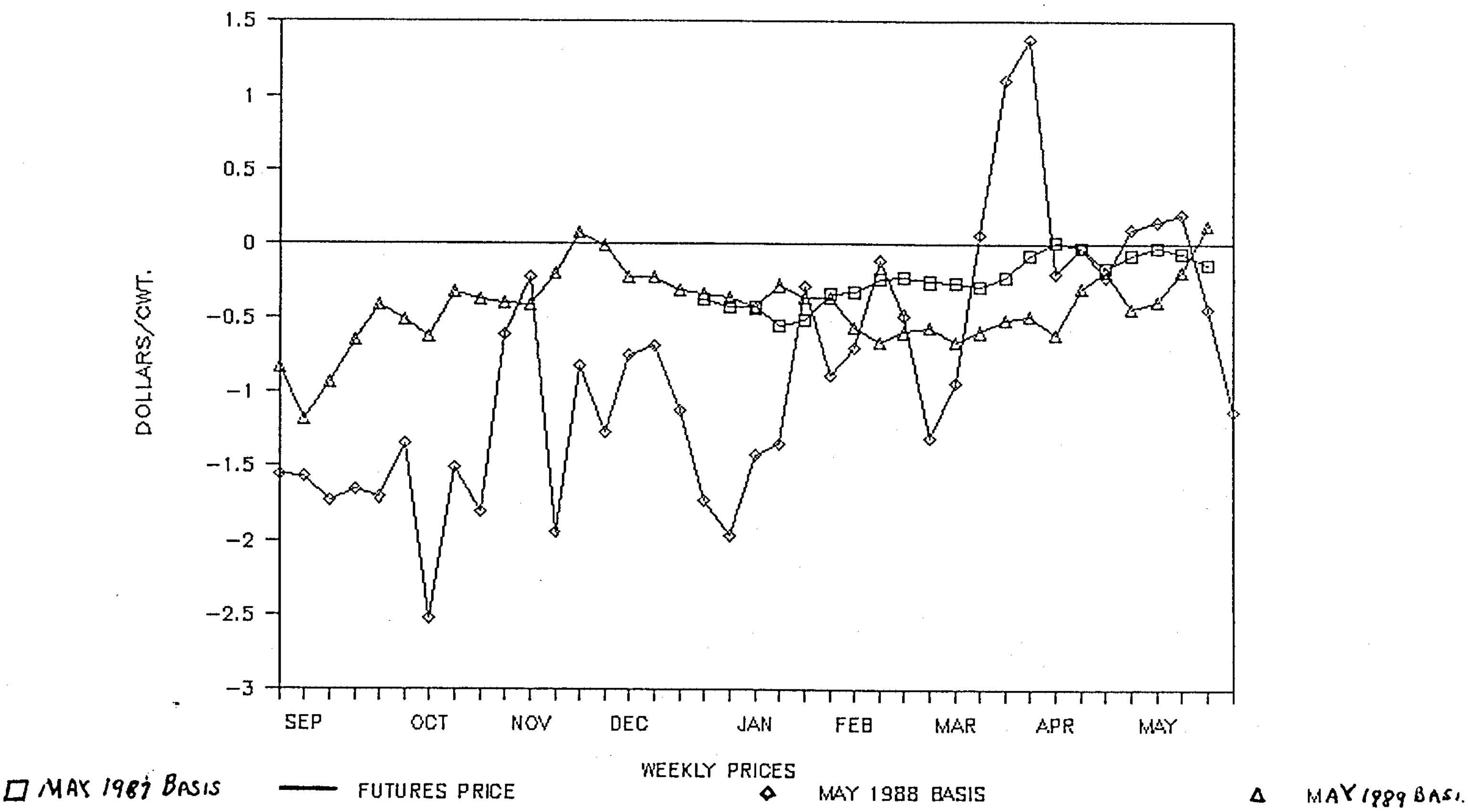
First differences of the Arkansas cash price and futures price were not highly correlated for the November 1986 contract (table 2). The degree of correlation improved after the beginning November contract ranging from .432 for November 1987 to .574 for November 1989. This suggests that hedgers were better able to avoid price risk by using the futures market.

Table 2--Correlation between weekly Arkansas cash prices and Rough Rice Futures Prices (November Contracts), 1986-90

Computation Method	November 1986	November 1987	November 1988	November 1989
Correlation between the two price series price differences	.019	.432	.515	.574
Estimation of equation (1).				
Constant	-.004 (-.803)	-.008 (-1.031)	.002 (.384)	.003 (.720)
Cash Price	.020 (.097)	.542 * (3.882)	.417 * (4.779)	.493 * (4.141)
R^2	.001	.256	.318	.335
Durbin Watson	1.394	2.790	1.837	2.715
Observations	12	46	51	36

* Statistically different from zero at 95 percent level.
t-ratios are in parentheses.

FIGURE 3--MAY RICE BASIS, ARKANSAS



Results from the equation of log differences suggests that there is a significant relationship between the cash and futures market (table 2). The coefficient for cash prices represents the percentage change in futures prices resulting from a 1-percentage change in cash prices. For example a 1-percentage change in the cash price would cause a .542 percent change in the November 1987 futures price. Excluding the November 1986 contract, all contracts produced a coefficient which was statistically different from zero at the 95 percent level. Apparently, the information transfer between markets improved after the initial contract months.

Basis trends

If the basis behaves as expected, it will decline over the marketing year and approach the cash price at contract maturity thereby reflecting the costs of storing the cash commodity. The rough rice basis appears to follow its expected pattern for each May contract (fig. 3).

The results in table 3 confirm the observations from figure 3. The basis declined over time for the three May contracts 1987, 1988, and 1989. The coefficients for time were statistically significant for each year except 1989.

Pricing Efficiency

If an autoregressive process exists in the rough rice futures market, a trader could use that information to benefit at the expense of others. However, an efficient market assumes that this phenomenon does not exist. If a statistically significant relationship is found among the autoregressive coefficients, prices may not be random and the potential for excessive profit exists. Such a finding suggests an inefficient market.

A second order autoregressive model was estimated for the November contract. Results from table 4 suggest that autocorrelation was a problem in three of the four November contracts analyzed, November 1987, November 1988 and November 1989, but surprisingly not in November 1986. For example, the autoregressive coefficient on t-1 for the November 1989 contract means that if price increases 1 percent during day t, we can predict it will increase .251 percent during day t+1.

Table 4--Results of the Autoregressive Model Using Daily Prices (Equation (3))

Contract	Constant	FPt-1	FPt-2	R^2	Observations
November 1986	-.001 (-.974)	.198 (1.486)	.054 (.407)	.046	61
November 1987	-.003 * (-2.004)	.328 * (4.844)	.021 (.308)	.113	221
November 1988	.001 (.662)	.298 * (4.880)	-.161 * (-2.699)	.090	264
November 1989	.000 (.579)	.251 * (3.275)	.021 (.271)	.066	173

t-ratios in parentheses.
Statistically different from zero at the 95 percent level.

Table 3--Results of Basis Trend Model Using Weekly Prices (Equation (2))

Contract	Constant	Time	R^2	Observations
May 1987	.461 * (7.808)	-.002 * (-4.179)	.772	22
May 1988	1.862 * (6.497)	-.051 * (-4.014)	.523	39
May 1989	.607 * (2.985)	-.007 (-.730)	.480	38

All equations have been adjusted for autocorrelation.
t-ratios are in parentheses.
* Statistically different from zero at the 95 percent level.

Market inefficiencies are also suggested by the ratio of deliveries to total contract volume and the ratio of deliveries to maximum open interest for the November 1986 and November 1987 contract but less so for November 1988 and 1989 (table 1). While a high degree of autocorrelation has been found to be present among thinly traded markets (5), it may be a symptom of the problem and not the problem itself. Analyses of the relationships between cash and futures price and other variables such as world market prices and Government rice program provisions (loan rates) may explain these experiences but such an analysis is beyond the scope of this effort. Also, results in table 4 rely on data that did not exclude days without trading, thereby having the potential of introducing non-randomness.

SUMMARY AND CONCLUSIONS

Activity in the rough rice futures market has expanded significantly since opening in 1986. Trading volume has exceeded the levels of a "low volume" contract. While some inefficiencies were found, some efficiency criteria appear to be improving. For example, the ratio of deliveries to total volume is declining, as is the ratio of deliveries to maximum open interest, and the correlation between the cash and futures price has strengthened. However, price changes appear autocorrelated despite expansion of trading activity and fewer deliveries made on contracts. Maximum open interest has not exceeded 3 percent of annual production which suggests the opportunity for additional expansion of trading.

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