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THE IMPACT OF CHANGES IN PRICE AND PRODUCTION COSTS ON U.S. AND REGIONAL RICE ACREAGE

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Contents

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Michael E. Salassi[1]

Introduction

The production, milling, and marketing of rice in the United States has over 300 years of history and is one of the nation's oldest agribusinesses. Current production is concentrated is six states: Arkansas, California, Louisiana, Mississippi, Missouri, and Texas. Major rice production areas of the U.S. are shown in Figure 1. These production areas are defined by similar soil characteristics and production practices. Major production areas include the nondelta region of Arkansas (which comprises the Grand Prairie region and northeast Arkansas), California, the Mississippi River Delta (which includes southeast Arkansas, northeast Louisiana, western Mississippi, and the boothill area of Missouri), and the Gulf Coast area, which comprises three production areas: southwest Louisiana and the upper and lower Texas coast. The five states shown in Figure 1 produce over 95 percent of the total annual U.S. rice production.

Rice acreage in the United States has varied considerably over the past two decades in response to a variety of factors. In the early 1970s, production was tightly controlled through the use of marketing quotas and acreage allotments that had been in effect since 1955. As a result of

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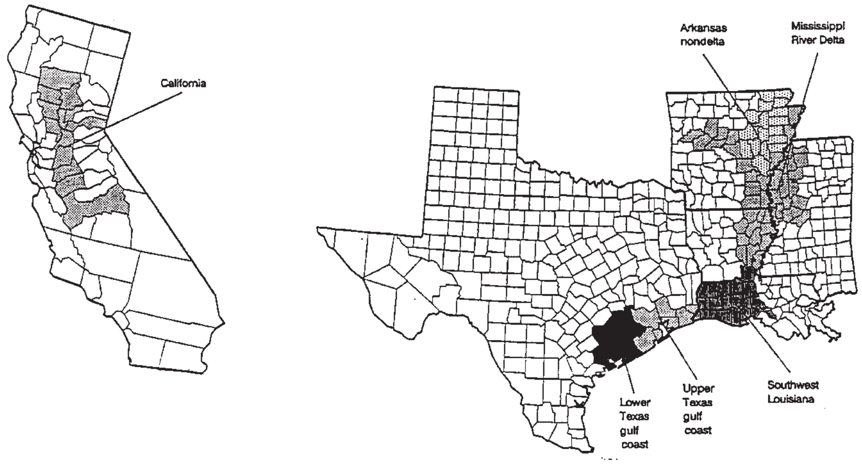
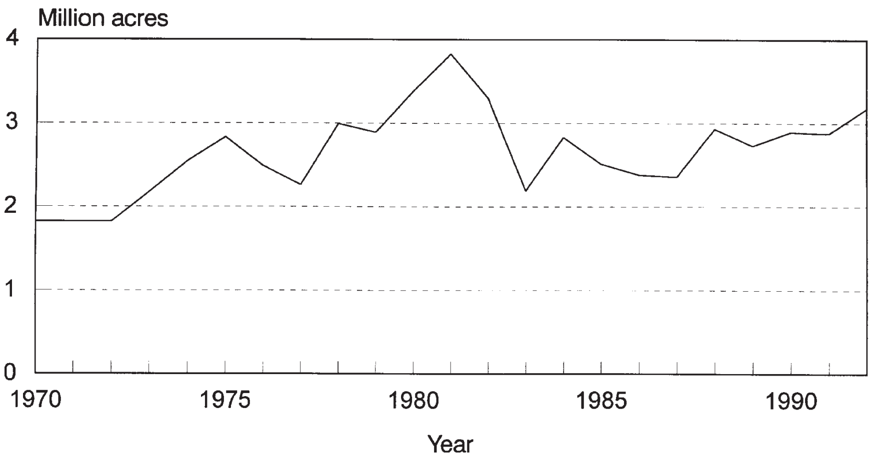
Figure 1. Major rice production areas.



these programs, changes in planted rice acreage from year to year were constrained. Total planted acreage in 1970 was only 13 percent higher than in 1960. In response to increasing export demand, marketing quotas were suspended after 1973, and rice acreage increased 30 percent in two years to just over 2.8 million acres in 1975 (Figure 2). The first deficiency payments on rice production were paid on the 1976 crop. Strong export demand kept market prices high throughout the late 1970s and helped push total planted acreage upward to a record 3.8 million acres in 1981.

In the early 1980s, increased domestic production combined with weakened export demand caused domestic carryover stocks to rise. Acreage reduction programs were instituted under the Agricultural and Food Act of 1981 to limit production. The Payment-In-Kind (PIK) program of 1983 reduced total planted rice acreage to 2.2 million acres, a decline of 34 percent from the previous year. Lower market prices throughout the latter half of the decade kept farm program participation rates for rice well above 90 percent. More market-oriented farm program provisions in the early 1990s lowered acreage reduction requirements for rice and allowed producers greater freedom in making planting decisions. Total U.S. planted rice acreage exceeded 3 million acres in 1992 for the first time in 10 years.

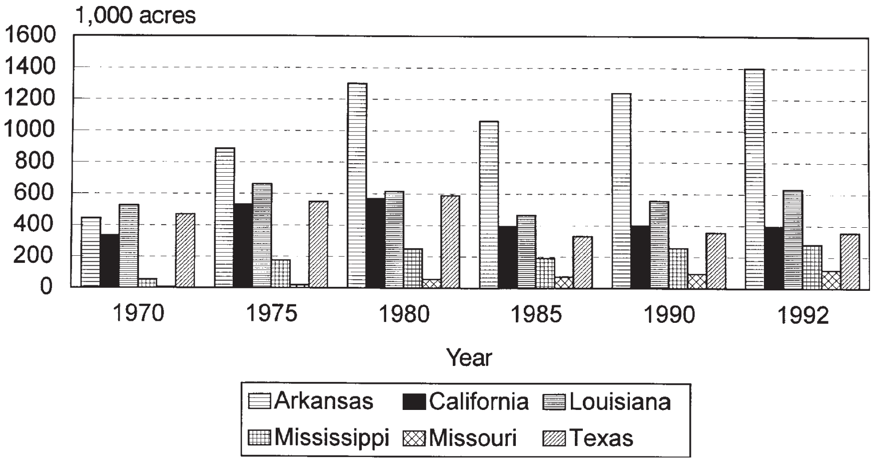
Figure 2. U.S. planted rice acreage, 1970-92.



As farm programs for rice have changed over the years, so has the distribution of rice production. In 1970, Louisiana had 525,000 planted acres of rice, more than any other state. This represented 29 percent of U.S. planted acreage and accounted for 24 percent of total production (Setia, *et al.*). Planted acreage in other major rice-producing states included 469,000 acres in Texas, 468,000 in Arkansas, and 333,000 in California. Mississippi planted only 52,000 acres of rice in 1970, while Missouri had only about 5,000 acres. When acreage allotments and marketing quotas were suspended after the 1973 crop, rice acreage in all states expanded, although this expansion varied from state to state.

The greatest expansion occurred in the delta areas along the Mississippi River, including areas in Arkansas, northeast Louisiana, Mississippi, and Missouri. Rice acreage increased the most in these areas because of the large amount of land available with soil characteristics suitable for rice production. By 1980, planted rice acreage in Arkansas had climbed to 1.3 million acres (Figure 3), an increase of 278 percent above its 1970 acreage. Rice acreage in Mississippi increased almost 500 percent to 250,000 acres. Despite the expansion of rice acreage in northeastern Louisiana, the state's total acreage only increased 17 percent from 1970 to 1980 due to the fact that the vast majority of rice acreage in Louisiana is located in the southwestern part of the state, an

Figure 3. State-level planted rice acreage, 1970-92.



area that has a long history of rice production and little capacity for acreage expansion.

Since 1980, the proportional distribution of rice acreage in the U.S. has remained fairly constant, despite changes in farm program provisions. Arkansas has remained the dominant producer of rice, accounting for slightly more than 40 percent of U.S. planted acreage (Figure 3). Louisiana has had the second highest rice acreage, accounting for just under 20 percent of total U.S. planted acreage, while planted acreages in California and Texas have declined somewhat since 1980 to between 10 and 15 percent each.

Acreage response analyses have generally focused on investigations of the impacts of changes in the level of support prices or market prices on the resulting production decisions and financial positions of producers. Little attention, however, has been given to the impact of changes in production costs. The level of rice production costs has become an increasingly important factor in producers' planting decisions over the past several years. As market prices have declined throughout the 1980s and into the 1990s, U.S. rice production costs per hundredweight (cwt.) have exceeded both the market price and the loan rate every year since 1981 (Figure 4). This same relationship has existed in every major rice production region (see figures 5-8). Deficiency payments, determined on the basis of the difference between the target price and the higher of either the loan rate or the market price, have helped to cover total production costs and have allowed many rice producers to remain in production.

Figure 4. U.S. rice prices and production costs, 1970-92.

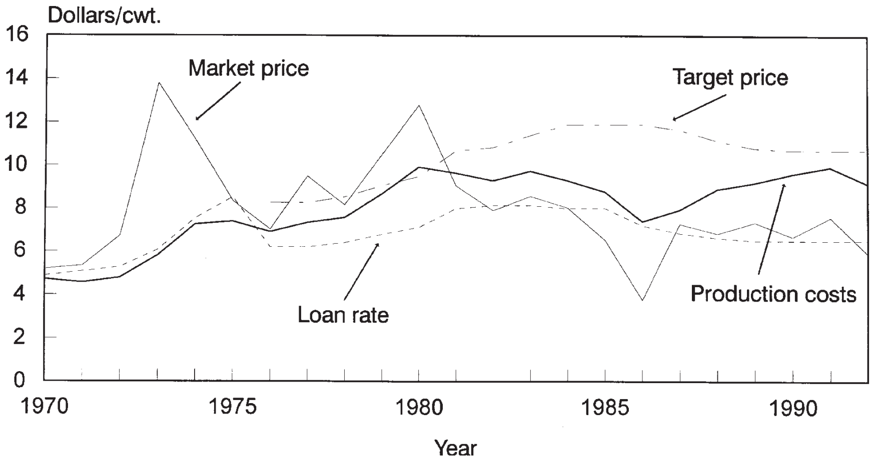


Figure 5. Arkansas nondelta rice prices and production costs, 1970-92.

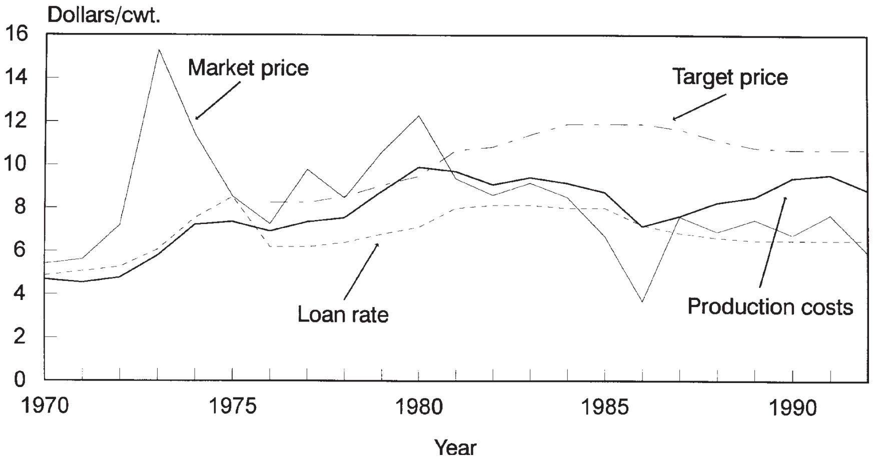


Figure 6. California rice prices and production costs, 1970-92.

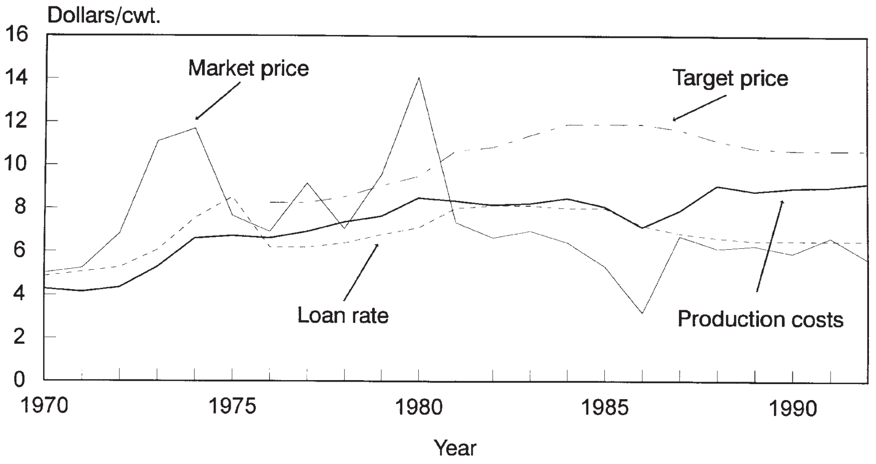
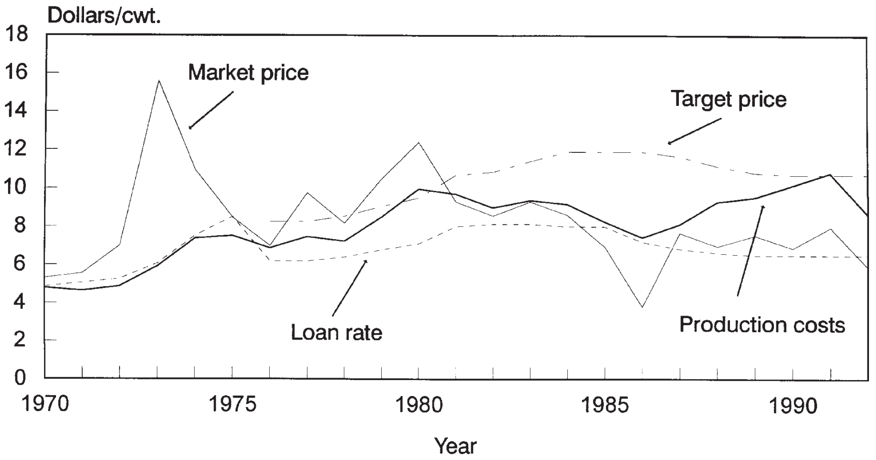


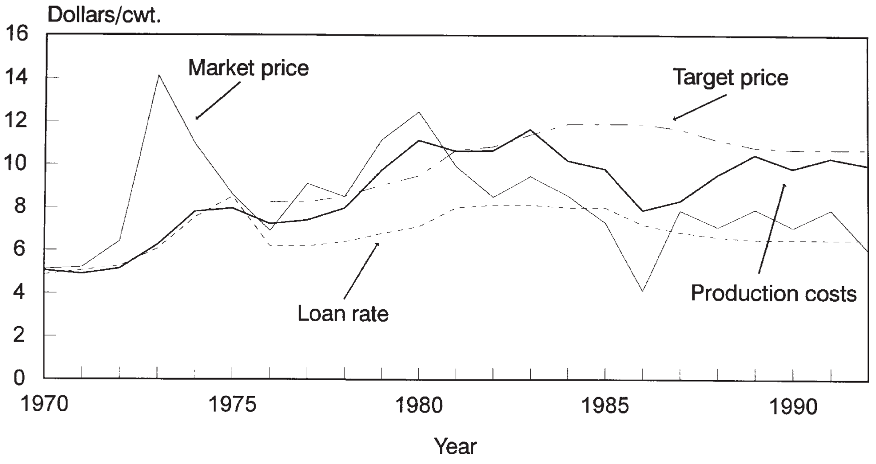
Figure 7. Mississippi River Delta rice prices and production costs, 1970-92.



As target prices have remained at fixed levels over the past several years, and market prices have remained depressed, increasing production costs over time have continued to squeeze profits out of rice production. Knowledge of the impact of changes in production costs on the planting decisions of producers becomes increasingly important as we enter an era of farm policy debate in which environmental and budgetary issues will likely have greater impacts on the formation of farm program provisions. Actions such as restricting the use of certain chemicals and pesticides, requiring specific land conservation measures to protect the environment, or instituting some type of user fee to reduce the budget deficit directly impact commodity production costs.

This study analyzes the relative impacts of changes in price and production costs on U.S. planted rice acreage over the past two decades. A theoretical framework underlying the foundation of the acreage response of rice to changes in price, production costs, and other factors is presented, followed by the specification of a response model. This model is then estimated at both the national and regional level. Model estimation results along with short-run and long-run elasticity measures for both price and production costs are presented and discussed.

Figure 8. Gulf Coast rice prices and production costs, 1970-92.



Theoretical Framework

A simplified acreage response function might be represented by the expression

$$A = f(P,X), \tag{1}$$

where *A* is the planted acreage of the commodity, *P* is the price of the commodity, and *X* is a vector of variables representing supply shifters. Under conditions in which no intervention into the market is made by the government for purposes of supporting prices or controlling production, *P* would represent the market price of the commodity, and *A* would represent the unconstrained acreage of the commodity planted in response to given levels of *P* and *X*.

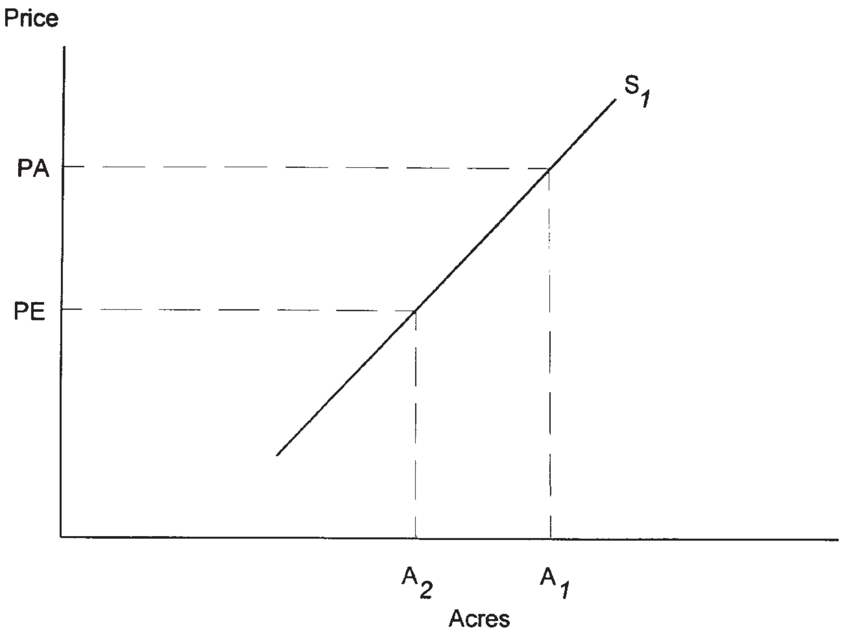
Effective Rice Price

In estimating acreage response models for crops like rice whose prices are supported by federal farm programs, two issues arise in developing a price parameter to be included in the response model. The first issue concerns the relationship between the announced commodity support price and restrictions on planted acreage of the program crop. The second issue concerns the combined impact of the market price and the support price on the planted acreage response of the crop.

Throughout the history of federal farm programs, commodity prices have been supported by the government through the establishment of a minimum support price, along with restrictions on planted acreage of the commodity as supply conditions warrant. This minimum support price is typically the loan rate. Planted acreage of program crops has been controlled or restricted through the use of acreage allotments, marketing quotas, and, more recently, set-aside and acreage reduction programs. Houck and Subotnik developed the concept of an effective or weighted support price as a method of expressing both the support price and the planting restrictions of a particular program commodity into a single term.

The theoretical basis for the concept of an effective support price can be seen in Figure 9. With an acreage response function S_1 and an announced support price of *PA*, producers would plant A_1 acres of the commodity if no planting restrictions were in effect. If the government

Figure 9. Theoretical acreage response function.



wanted to restrict planted acreage to A_2, it could reduce the support price to *PE* with no planting restrictions, or it could leave the announced support price at *PA* and impose planting restrictions that would limit the total planted acreage to A_2. In either case, the effective support price is *PE* and may be expressed mathematically as

$$(2) \qquad PE = \phi * PA,$$

where *PE* is the effective or weighted support price, *PA* is the announced support price, and ϕ is an adjustment factor reflecting planting restrictions.

The development of the effective rice support price for this study followed the procedure used by Duffy, Richardson, and Wohlgenant. They estimated an effective support price for cotton over a time period in which cotton program provisions changed considerably. Farm program provisions for rice and cotton have been similar over the years, despite the fact that the design and operation of farm programs in general have changed over time. Three different specifications of effective rice support price were used in this study to cover three distinct periods of federal farm programs for rice.

Over the 1955-75 period, acreage allotments and marketing quotas were used to support rice prices (Holder and Grant). Acreage allotments for rice were announced each year by the Secretary of Agriculture, and only rice producers with acreage allotments were eligible for price supports. Although producers were permitted to plant acreage in excess of their allotment, they were eligible for price support loans only on their allotment production. When the total supply of rice in a particular year exceeded the normal supply, the Secretary of Agriculture could establish marketing quotas for the following year. These quotas were designed to force producers to comply with the acreage allotment. Producers who overplanted their acreage allotment were subject to a penalty on the excess rice produced. Marketing quotas were suspended for the 1974 and 1975 crops, and acreage allotments for those years were used for price support payment purposes only.

For the period when acreage allotments and marketing quotas were in effect, the effective support price for rice was defined as

$$PE_t = LR_t * (AA_t / DA_t) , \quad (3)$$

where PE_t was the effective support price in year t, LR_t was the rice loan rate, AA_t was the national rice acreage allotment, and DA_t was the desired rice acreage.[2]

The Rice Production Act of 1975 shifted the emphasis of rice production control away from marketing quotas to greater market orientation along the lines of the programs in place for other crops (Childs and Lin). A target price was established, and deficiency payments were paid to producers based on the difference between the August-December average farm price and the target price. Acreage allotments became the payment base. This basic program was in effect

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[2]The desired U.S. acreage of rice represents the amount of acreage that would have been planted in rice in the absence of acreage allotments and was obtained by estimating a linear trend line from 2.610 million acres in 1954 (the maximum rice acreage prior to the implementation of acreage allotments and marketing quotas) to 3.827 million acres in 1981 (the maximum rice acreage in years with no marketing quota or acreage reduction program). This trend function was of the form

$$DA_t = 45.07 + DA_{t-1},$$

where DA_t was the desired U.S. acreage of rice in year t in thousands of acres and DA_{t-1} was the desired U.S. acreage of rice in the previous year.

for the 1976-81 period. The effective support price over this period was defined as

$$(4) \qquad PE_t = LR_t + (DP_t * NAF_t^L) ,$$

where PE_t was the effective support price in year t, LR_t was the rice loan rate, DP_t was the national rice deficiency payment, and NAF_t^L was the lower bound on the national allocation factor, which related national program acreage to total acres harvested.

The Agricultural and Food Act of 1981 eliminated acreage allotments and marketing quotas for rice and made the rice program analogous to those for other grains (Childs and Lin). Target prices were set at minimum levels, and deficiency payments were based on production from permitted plantings. The acreage reduction program was introduced as a more direct acreage control method. Basic provisions set forth in this act have been in effect since the 1982 crop year. The effective support price over this period was defined as

$$(5) \qquad PE_t = TP_t * (1 - ARP_t) ,$$

where PE_t was the effective support price in year t, TP_t was the target price for rice, and ARP_t was the percent of base acreage restricted under the acreage reduction program.

The second critical issue that arises when estimating acreage response models for program crops is in accounting for the simultaneous influence of both the market price and the support price of the crop on the planting decisions of producers. Previous research suggests that both variables are important factors in determining the planted acreage of program crops; however, the methodology used to incorporate these factors in response models has varied considerably (Gallagher; Lee and Helmberger; Morzuch, *et al.*; Shideed and White; Bailey and Womack).

In this study, a naive model of expectation for the market price of rice was utilized. The use of this type of model is common in acreage response research and has been found to be an appropriate model for price expectation based on secondary data. Other studies have analyzed various types of expectation models for crop prices and have found no unique model to be superior (Shideed and White; Orazem and Miranowski). The expectation model used here was of the form

$$(6) \qquad E[PM_t] = PM_{t-1} .$$

This model assumes that the expected market price of rice in year t, $E[PM_t]$, is equal to the actual market price in the previous year.

The effective rice support price and the expected market price for rice were combined into a single variable following a model developed by Romain and employed by Duffy, *et al*. This expected price formulation always places at least some weight on the effective support price. If the effective support price is greater than the expected market price, then the supply-inducing price of rice was set equal to the effective support price. Otherwise, the supply-inducing price of rice was estimated in the following manner. The ratio of market price to support price was estimated as

$$(7) \qquad PPR_t = E[PM_t] / PE_t ,$$

where PPR_t was the ratio of expected market price ($E[PM_t]$) to effective support price (PE_t). This ratio was then used to define a weighting factor

$$(8) \qquad WG_t = 1 / (1 + PPR_t) ,$$

where WG_t was the weighting factor. Finally, the supply-inducing price of rice, when the effective support price was not greater than the expected market price, was estimated by the equation

$$(9) \qquad PS_t = WG_t * PE_t + (1 - WG_t) * PM_t ,$$

where PS_t was the supply-inducing price of rice in year *t*.

Production Costs

It was hypothesized in this study that expected rice production costs per acre directly influence the acreage of rice planted in any given year. Variable cash expenses per acre were chosen as the relevant production costs to be analyzed in this study, since fixed cash expenses would be incurred by the farm regardless of whether or not rice was planted. The expected variable cash costs of production of rice could be defined simply, in a naive model, as the variable costs of production in the previous year. This may be expressed as

$$(10) \qquad ECOP_t = COP_{t-1} ,$$

where $ECOP_t$ is the expected variable production costs per acre in year *t*, and COP_{t-1} is the variable production costs per acre in the previous year.

A more realistic model of expected costs of production might be defined by incorporating some assumption regarding the expected change in production costs per acre from one year to the next. Although production costs per acre may decrease in any given year, historically they have generally been observed to increase over time (USDA, 1992, p.39). Therefore, expected cost of production was defined as

$$(11) \qquad ECOP_t = COP_{t-1} * (1 + \theta) \, ,$$

where $ECOP_t$ was the expected rice production costs per acre in the current year, COP_{t-1} was the actual production costs per acre in the previous year, and θ was the average annual percentage change in production costs over the previous three years.

Other Factors

Previous acreage response research on rice (Grant, Beach, and Lin; Watanabe, Stanton, and Willett) as well as research on other crops have indicated a positive response by producers to lagged planted acreage. This positive response indicates that producers may follow a partial adjustment process in moving into or out of production of rice and various other commodities in response to economic conditions. Therefore, a variable representing lagged planted rice acreage was included in the model. Two additional variables were also included in the model, a dummy variable representing the 1983 PIK program as well as a trend variable.

Although most rice is generally grown under some form of crop or land rotation system, this factor was not represented in the model as it was assumed that the impact of crop rotation on total planted rice acreage would balance out at the aggregated national and regional levels. Specific changes in technology were also omitted from the model. This factor could influence changes in planted acreage by way of increased yields through varietal development or increased production efficiency by way of improvements in production practices and equipment. Generalized changes in technology are hypothesized to be captured by the trend variable. Other than the 1983 PIK program, no other paid land diversion program effects were included in the model. The predominant paid land diversion program in place for rice has been the 50/92 program, which began in 1986. Participation in this program by rice producers has been increasing over the years since its inception. Producers have cited the increasing level of rice production costs and lower returns as reasons for participation in the program (Broussard). Therefore, since 50/92 participation is closely related to changes in the level of production costs, a variable representing the 50/92 program was not included in the model.

Model Specification

By incorporating these variable definitions into the acreage response function of equation 1, the general response model estimated in this study may be specified as

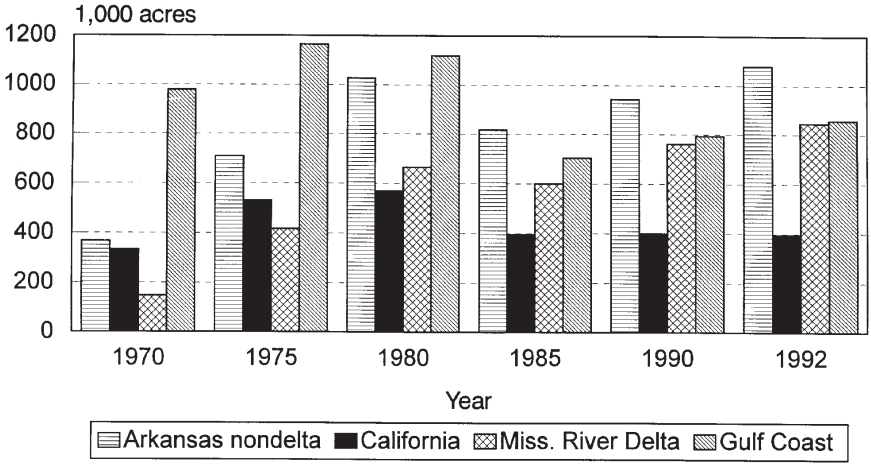
$$(12) \qquad A_t = \beta_0 + \beta_1 PS_t + \beta_2 A_{t-1} + \beta_3 ECOP_t + \beta_4 D83_t + \beta_5 T_t + \epsilon_t ,$$

where A_t is current year planted rice acreage (in thousands of acres), PS_t is the supply-inducing price of rice (in dollars per cwt.) as defined in equation 9, A_{t-1} is lagged planted rice acreage, $ECOP_t$ is the expected variable cash production costs per acre for rice as defined in equation 11, $D83_t$ is a dummy variable for the 1983 PIK program, and T_t is a trend variable.

Data and Model Estimation

This response model was estimated over the time period from 1970 to 1992 at both the national and regional level. Rice production regions were defined to be consistent with those regions for which USDA publishes annual estimates of rice production costs (shown in Figure 1). These regions include (1) the Arkansas nondelta region (Grand Prairie and northeastern areas of Arkansas); (2) California; (3) the Mississippi River Delta (southeastern areas of Arkansas, northeastern Louisiana, western Mississippi, and southeastern Missouri); and (4) the Gulf Coast (southwestern Louisiana and Texas). Planted rice acreage in these four regions over the 1970-92 period is shown in Figure 10. Annual state-level rice planted acreage data were obtained from various issues of USDA's *Crop Production* reports and aggregated into the four production regions using percentage acreage distributions estimated from the Census of Agriculture and various state statistical reports. Supply-

Figure 10. Regional level planted rice acreage, 1970-92.



inducing prices of rice were estimated using seasonal average market prices obtained from USDA's *Agricultural Prices* reports. Rice farm program provisions, such as acreage allotments, loan rates, target prices, and acreage reduction programs, were obtained from Childs and Lin and from various issues of USDA's *Rice Situation and Outlook Report*. Time series estimates of rice variable cash production expenses per acre for the years 1975-90 were taken from *Economic Indicators of the Farm Sector: Costs of Production--Major Field Crops, 1990*, and estimates for 1991 were taken from unpublished USDA data. Since historical production cost data did not cover the entire study period, estimates for the years 1970-74 and 1992 were developed using the *Index of Prices Paid for Production Items*. All price and cost data were deflated using this same index.

Estimation Results

Results from ordinary least squares (OLS) estimation of the U.S. acreage response model are presented in Table 1. All explanatory variables included in the model had the correct signs and were found to be statistically significant at the 5-percent level. Two tests were conducted to check for the presence of autocorrelation. Although Durbin's *h* statistic proved to be significant, Durbin's *m* test failed to reject the hypothesis of no autocorrelation. Since these two tests yielded inconsistent conclusions, it was assumed that autocorrelation was not present in the model. Durbin's *m* test is generally considered to be a more preferred procedure in that it is intuitively more plausible and does not

Table 1 U.S. Rice Acreage Response Model, 1970-92

Variables	Coefficient
Intercept	-81.48
	(-.06)
PS_t	93.77
	(2.47)**
A_{t-1}	.58
	(3.92)***
$ECOP_t$	-10.40
	(-2.60)**
$D83_t$	-886.95
	(-2.84)**
T_t	31.39
	(2.34)**
Adj. R^2	.69
F statistic	10.65***
Durbin's *h* statistic	-1.70

Numbers in parentheses are *t*-statistics.
* = significant at ten percent level.
** = significant at five percent level.
*** = significant at one percent level.

suffer from the indeterminacy that may be encountered in using the *h* test (Kmenta, p. 333).

As expected, price, lagged planted acreage, and trend had positive impacts on planted rice acreage. The estimated price coefficient suggests that a one dollar per cwt. increase in the supply-inducing price of rice, adjusted for inflation, would increase total U.S. planted acreage by 93,770 acres. The coefficient for lagged planted acreage, representing the partial adjustment of producers' planting decisions from one year to the next, was positive and less than one and statistically significant at the 1-percent level. Total U.S. rice acreage exhibited a positive trend of about 31,000 acres per year over the 1970-92 period. Production costs and the 1983 PIK program had negative impacts on planted acreage. The estimated coefficient for production costs suggests that an increase in variable cash expenses of one dollar per acre, adjusted for inflation, would decrease total U.S. planted acreage by 10,400 acres.

A priori expectations regarding price elasticity were that, in the short run, rice planted acreage would be relatively inelastic to changes in price. On farms producing rice, rice is a major enterprise and in some cases the only major enterprise on the farm (see Dismukes, p. 15; Salassi, pp. 17-18). Because of the crop rotation requirements associated with rice production, planting decisions are generally planned out, to a large extent, for two or three years into the future. Although adjustments in planting decisions can always occur within any given year, the majority of rice acreage on farms is planted under established rotational patterns. Furthermore, due to the extremely high participation rate of rice producers in the farm program, as well as the relationship between domestic market prices and support prices, acreage changes from year to year are driven more often by changes in program acreage restrictions than by changes in price. In the long run, the elasticity of acreage with respect to price would be expected to be more elastic than in the short run. Since acreage and production costs were assumed to be inversely related, under *ceteris paribus* conditions, production cost elasticities were expected to be negative in sign. Consequently, it was hypothesized that the acreage response to changes in production costs would be inelastic, at least in the short run. However, due to the limited amount of research available concerning acreage response to changes in commodity production costs, no a priori hypotheses or assumptions were made regarding the level of magnitude of production cost elasticities relative to price elasticities.

Elasticity estimates for price and production costs from the OLS regression model of U.S. rice acreage are shown in Table 2. Elasticities were estimated at the sample mean and for 1992. Short-run price elasticities were estimated to be .26 at the sample mean and .18 in 1992.

Table 2 U.S. Rice Price and Production Cost Elasticities

Elasticity	Short run	Long run
Price:		
Mean	.26	.61
1992	.18	.43
Production cost:		
Mean	-.74	-1.75
1992	-.64	-1.53

These estimates were found to be within the range of price elasticity estimates from previous studies (see Wantanabe, *et al*.; Grant and Leath; Grant, *et al*.; Kincannon). Long-run elasticities were estimated by dividing the short-run elasticities by $(1-b_2)$, where b_2 was the estimated coefficient for lagged planted rice acreage in equation 12. With estimates of .61 and .43 at the sample mean and in 1992, respectively, acreage response to changes in the supply-inducing price of rice was inelastic in the long run at the national level.

The estimated short-run production cost elasticity of U.S. rice acreage was also found to be inelastic. However, with estimates of -.74 at the sample mean and -.64 for 1992, the magnitude of these elasticities is 3 to 4 times greater than that of the price elasticities, indicating that planting decisions have been more responsive to changes in production costs than to changes in price. F-tests conducted to test for equal proportional response to changes in price and production costs showed that these two responses were statistically different at the 10-percent significance level in the short-run at both the sample mean and for 1992. Long-run production cost elasticities were found to be elastic with estimates larger than -1.50.

Under the assumptions of the classical multiple linear regression model, OLS estimators of the regression coefficients are unbiased and efficient. This assumes that the specified model represents all there is to know about the regression equation and the variables involved. However, in estimating a set of similar equations, such as the commodity acreage response equations for various regions estimated in this study, the error terms from one equation are often found to be correlated with the error terms in another equation. Failure to account for this cross-equation, contemporaneous correlation in estimating a set of equations could invalidate the properties of the OLS estimators. Therefore, the four regional equations were estimated as a set through the use of seemingly unrelated regression (SUR), a procedure first proposed by Zellner, which takes cross-equation correlation into account.

Table 3 SUR Regional Rice Acreage Response Model, 1970-92

Variables	Arkansas Nondelta	California	Mississippi River Delta	Gulf Coast
Intercept	-392.91	93.09	-788.86	1168.15
	(-.85)	(.38)	(-2.22)**	(2.40)**
PS_t	26.08	20.64	13.48	28.34
	(2.05)*	(2.21)**	(1.56)	(2.25)**
A_{t-1}	.68	.46	.62	.38
	(5.71)***	(3.59)***	(4.62)***	(2.81)**
$ECOP_t$	-2.48	-1.92	-1.90	-1.64
	(-2.39)**	(-3.16)***	(-2.48)**	(-2.08)*
$D83_t$	-303.38	-149.28	-239.15	-227.43
	(-2.75)**	(-2.67)**	(-2.89)**	(-2.37)**
T_t	11.33	4.94	15.49	-5.73
	(2.24)**	(2.05)*	(3.11)***	(-1.38)
System weighted R^2 = .92				

Numbers in parentheses are *t*-statistics.
* = significant at ten percent level.
** = significant at five percent level.
*** = significant at one percent level.

Estimation of the SUR regional equations (Table 3) resulted in price being statistically significant in three of the four regions, while production costs were statistically significant in every region. Ratios of standard errors given in Table 4 indicate that at least some gain in efficiency in the estimation of all variables in the model was achieved by the use of

Table 4 Ratio of SUR to OLS Standard Errors

Variables	Arkansas Nondelta	California	Mississippi River Delta	Gulf Coast
Intercept	.88	.94	.89	.89
PS_t	.92	.92	.91	.91
A_{t-1}	.79	.89	.79	.83
$ECOP_t$	.71	.87	.71	.77
$D83_t$	.98	.99	.97	.98
T_t	.90	.95	.84	.93

SUR over OLS for this particular model. The greatest gains in efficiency were achieved in the estimation of the production cost parameter, while relatively minor gains were achieved in the estimation of the price parameter. Although Durbin's *h* test indicated possible autocorrelation in two of the four regional models when estimated by OLS, Durbin's *m* test failed to reject the hypothesis of no autocorrelation in each equation at the 5-percent level.

Short-run and long-run elasticities of price and production cost estimated from the SUR model are shown in Table 5. Regional elasticity estimates exhibited relationships similar to those found at the national level in that the production cost elasticity of planted acreage was much higher than the price elasticity in every region. Short-run elasticity estimates revealed rice acreage in California to be more responsive to changes in price and production costs than the other three regions. F-tests revealed proportional acreage responses to changes in price and production costs were significantly different in California and the Mississippi River Delta at both the sample mean and for 1992. In general, elasticity estimates for production costs varied more across regions than estimates for price elasticity.

Table 5 SUR Regional Rice Price and Production Cost Elasticities

	Arkansas Nondelta	California	Mississippi River Delta	Gulf Coast
Short run				
Price:				
Mean	.24	.34	.18	.22
1992	.15	.32	.10	.20
Production cost:				
Mean	-.55	-.95	-.63	-.36
1992	-.40	-1.13	-.45	-.39
Long run				
Price:				
Mean	.75	.63	.49	.35
1992	.46	.60	.26	.33
Production cost:				
Mean	-1.69	-1.78	-1.67	-.58
1992	-1.24	-2.11	-1.19	-.63

A sensitivity analysis of the four regional acreage equations estimated by SUR is shown in Table 6. The base acreage for each region listed in the table represents the predicted values for 1992 from the estimated equations in Table 3. Alternative rice acreage levels are given reflecting the impact of changes in the target price or production costs for that year. A 10-percent decrease in the 1992 target price from $10.71 to $9.64 per cwt., for example, would have reduced planted rice acreage by 16,000 acres in the Arkansas nondelta, 13,000 acres in California, 8,000 acres in the Delta, and 18,000 acres in the Gulf Coast. Due to the higher estimated elasticities for production cost, a similar change in production costs would have had a greater impact on planted acreage in each region. Given a 10-percent increase in production costs, rice acreage in the Arkansas nondelta would have decreased by 44,000 acres, in California by 45,000 acres, in the Delta by 38,000 acres, and in the Gulf Coast by 34,000 acres.

Table 6 Sensitivity Analysis of Rice Acreage to Changes in Target Price and Production Costs, 1992

	Arkansas Nondelta	California	Mississippi River Delta	Gulf Coast	Total
			1,000 acres		
1992 base acreage	1,055	392	795	782	3,024
Target price:					
20% decrease	1,023	366	779	747	2,915
10% decrease	1,039	379	787	764	2,969
10% increase	1,071	404	804	799	3,078
20% increase	1,087	417	812	817	3,133
Production costs:					
20% decrease	1,141	481	871	849	3,342
10% decrease	1,098	436	833	815	3,182
10% increase	1,011	347	757	748	2,863
20% increase	968	303	719	715	2,705

Summary and Conclusions

This study analyzed the impact of changes in rice prices and production costs on U.S. rice planted acreage over the 1970-92 period. Supply-inducing prices of rice were estimated as a function of effective rice support prices and seasonal average market prices. Expected production costs per acre were estimated using lagged actual total variable cash production expenses per acre multiplied by the previous 3-year average annual change in variable expenses. Other explanatory variables included in the model were lagged planted acreage, trend, and a dummy variable for the 1983 PIK program. Acreage response equations were estimated at the U.S. level as well as at the regional level. Estimated short-run price and production cost elasticities were found to be inelastic at the national level. However, the magnitude of the production cost elasticities was 3 to 4 times greater than the price elasticities. Estimated long-run elasticities at the U.S. level were inelastic for changes in price but elastic for changes in production costs. Similar relationships were found at the regional level. The four regional acreage equations estimated by seemingly unrelated regression yielded short-run production cost elasticities that were 2 to 3 times greater in magnitude than the estimated price elasticities.

Two important conclusions may be drawn from the results of this study. First, U.S. planted rice acreage, over the period of study, has been more responsive to changes in production costs than to changes in price. Several factors lend support to this conclusion. The federal farm program for rice has had one of the highest participation rates by producers of any commodity, with yearly participation rates consistently exceeding 90 percent. Since target prices for rice have exceeded domestic rough rice market prices throughout the 1980s and into the 1990s, producers have based planting decisions largely on annual program provisions, i.e., target price and set-aside requirements. As a result, changes in the domestic market price of rice have had a minimal impact on producers' planting decisions. Since the target price has fluctuated within a relatively narrow range since its inception in 1976, and in fact has remained at a fixed level since 1990, changes in planted rice acreage from year-to-year have been more a result of changes in the set-aside requirement. In addition, with average production costs at levels approaching the target price, producers' planting decisions would be expected to be significantly influenced by changes in production costs.

A second major conclusion of this study is that the responsiveness of planted rice acreage to changes in price and production costs is not uniform across all rice-producing regions of the U.S. Rice acreage in California, for example, was found to be more responsive to changes in price and production costs than the other three rice-producing regions. This difference may exist for several reasons, including the fact that although California has the highest rice yields of any state producing rice, it also has the highest production costs per acre as well as the greatest environmental constraints due to stringent air and water pollution controls. In addition, the majority of rice produced in California is short-grain or medium-grain (japonica) rice, whereas the three other regions produce primarily long-grain (indica) rice. Since the consumption characteristics and uses of these types of rice are different, it can be argued that California is producing for a different rice market than the rest of the country. The Gulf Coast region, which has the highest rice production costs per cwt. of any rice-producing area of the country, had the most inelastic acreage response to changes in production costs. This result is primarily due to the fact that the rice farms in the Gulf Coast region have an extremely limited number of viable alternative enterprises compared with the other regions. As a result, Gulf Coast rice producers do not have as much flexibility in selecting enterprises to produce on the farm.

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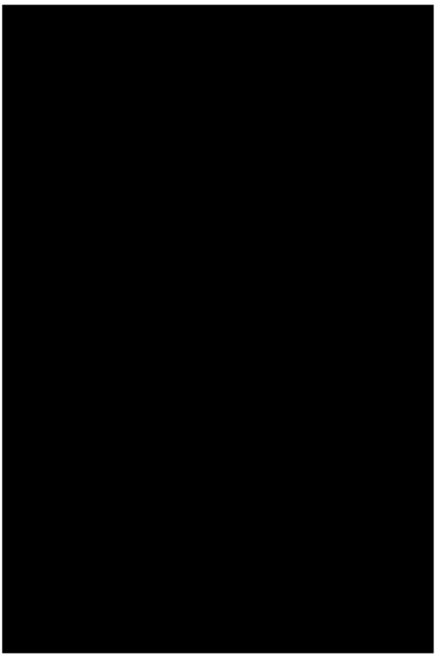

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