# *IMPLICATIONS OF THE FAIR ACT ON THE RISK-RETURN RELATIONSHIP OF SOUTHWEST LOUISIANA PRODUCERS*

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## ABSTRACT

Stability in net farm income resulting from government price support payments has historically affected the optimum crop mix combination that results in risk-efficient portfolios. The Federal Agriculture Improvement and Reform (FAIR) Act of 1996 significantly changed agricultural price support policies. This paper quantifies the degree to which rice deficiency payments have affected the risk-return relationship for optimal production mixes of rice and soybeans for a representative farm in Southwest Louisiana. Parametric analysis of scenarios including and excluding rice deficiency payments illustrates the dramatic impact of direct government payments on income variability of the typical Southwest Louisiana producer.

## INTRODUCTION

The pioneering work of von Neumann and Morgenstern (1947) in expected utility theory and later works by Markowitz (1952 and 1959) in portfolio theory have generated great interest in risk analysis in agriculture (Freund, 1956; Heady and Candler, 1958; Stovall, 1966; and Tintner, 1955). Since these early efforts, numerous studies have applied risk and return analysis to the variability of commodity prices, production yields, and costs associated with production, the three components from which net farm income is derived (Goodwin and Ker, 1998; Pope and Just, 1998; and Ray, Richardson, De La Torre Ugarte, and Tiller, 1998). Variation in these components arises from a variety of causes including trends in demand and supply of inputs and outputs, seasonal factors, economic and biological cycles, and random variation.

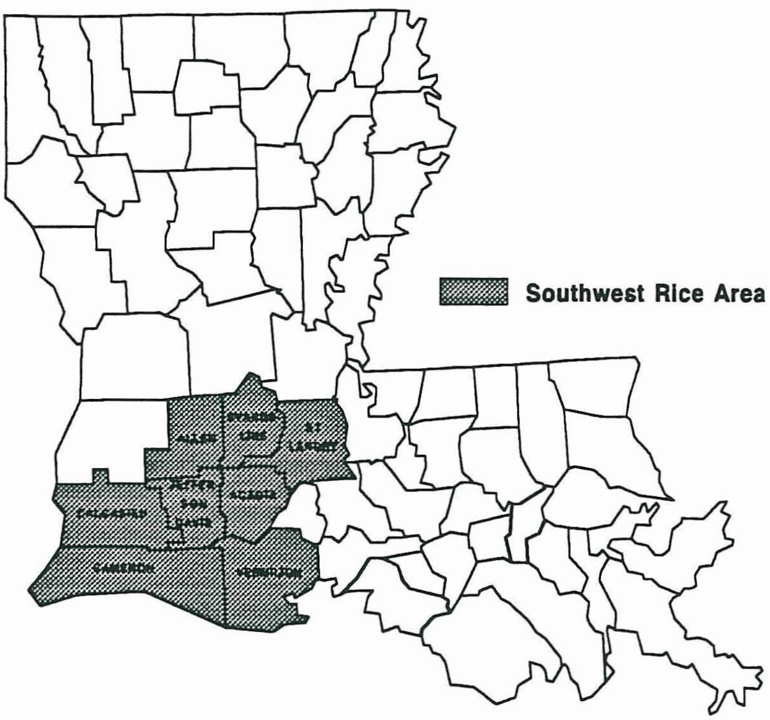
Previous studies focusing on variability in commodity prices, input prices, and yields in agricultural risk analysis have typically ignored the influence of government programs in stabilizing income. In the past, omission of the influence of government programs on the producer's risk-return relationship may not have been critical due to the relative stability of these programs over time. However, recent reform of domestic agricultural policies, resulting in the phase out of government price supports on basic crops, emphasizes the need for estimating how price supports have historically affected risk-efficient portfolios of producers.

The Agricultural Adjustment Act of 1933 designated rice as a basic commodity, eligible for specific price support programs. Subsequent legislation in 1938 expanded rice program provisions to include nonrecourse loans, authority for marketing quotas, and parity payments, depending on the availability of funds. Rice marketing quotas and acreage allotments were in effect for every year from 1955 to 1973. The Rice Production Act of

1975 authorized rice to be a program crop, with deficiency payments being made to eligible producers for the difference between a target price set by the government and the market price. In an effort to control the federal budget, the 1985 farm bill lowered rice target prices and loan rates. Similarly, the Omnibus Budget Reconciliation Act of 1990 mandated the elimination of deficiency payments on 15 percent of a producer's eligible acreage. Policy changes for the rice program occurred in relatively small increments until the Federal Agriculture Improvement and Reform (FAIR) Act of 1996. The FAIR Act eliminated target prices and changed deficiency payments to production flexibility contract payments which are scheduled to be phased out by 2002.

Rice base accounts for 760,065 acres, or 29 percent, of total government enrolled acreage in Louisiana (USDA, 1994). More than 70 percent of enrolled rice base acreage in Louisiana is included in what is known as the Southwest Rice Area. This area consists of the following eight parishes: Acadia, Allen, Calcasieu, Cameron, Evangeline, Jefferson Davis, St. Landry, and Vermilion (Figure 1). The coastal prairie soils in this area have an impervious subsoil, poor runoff, poor internal drainage, low phosphorus content, and medium organic content. These soils are suitable for rice and soybean production, but are limited in their ability to support alternative crops. The high participation rate in the rice program in this area has historically affected the optimum crop mix combination that results in risk-efficient portfolios. The objective of this paper is to estimate how rice deficiency payments have impacted the risk-return relationship of a representative farm in Southwest Louisiana.

**Figure 1**
**Southwest Louisiana Rice Production Area**



## MODEL DEVELOPMENT

A form of the Markowitz portfolio model, as developed by Stovall (1966), is used to estimate the risk-return relationship of a representative rice and soybean farm in the Southwest Rice Area under scenarios of including and excluding rice deficiency payments. This model assumes that the producer has only two considerations when constructing a crop-mix portfolio, expected income and variance in income. The quadratic form of the model minimizes net income variance subject to expected income and land acreage constraints. Implicitly, the model is specified in the following form:

$$\text{MIN } V(I) = \sigma_1^2 x_1^2 + \sigma_2^2 x_2^2 + 2\sigma_{12} x_1 x_2 \qquad (1)$$

subject to

$$q_1 x_1 + q_2 x_2 \leq b_1$$

and

$$x_1 + x_2 \leq b_2$$

where

$V(I)$ = net income variance
$\sigma_1^2$ = rice net returns variance
$\sigma_2^2$ = soybeans net returns variance
$x_1$ = acres of rice produced on the representative farm
$x_2$ = acres of soybeans produced on the representative farm
$\sigma_{12}$ = covariance of rice and soybeans net returns
$q_1$ = mean net returns of rice per acre
$q_2$ = mean net returns of soybeans per acre
$b_1$ = expected annual income for the representative farm
$b_2$ = total representative farm land acreage.

The problem is to minimize income variance subject to an expected income level and the total amount of acreage that is available. Equation (1) is used to estimate a set of optimal enterprise mixes of rice and soybeans with a corresponding range of expected income levels, given an amount of acreage. Algorithms for linear programs can be applied to quadratic programming because the first derivative of a quadratic function is a linear function (Schrage, 1997). Equation (1) is converted to true linear form by Kuhn-Tucker first order conditions where a dual variable (Lagrange multiplier) is introduced for each constraint in the equation (Chiang, 1984). INCOME and LAND are used as dual variables in the Lagrangian expression:

$$Z = \sigma_1^2 x_1^2 + \sigma_2^2 x_2^2 + 2\sigma_{12} x_1 x_2 + \text{INCOME}(-b_1 + q_1 x_1 + q_2 x_2) + \text{LAND}(-b_2 + x_1 + x_2) \qquad (2)$$

The appropriate Kuhn-Tucker conditions for the minimization problem include the following four marginal conditions,

$$\begin{aligned} \partial Z / \partial x_1 &= 2\sigma_1^2 x_1 + 2\sigma_{12} x_2 + q_1 \text{INCOME} + \text{LAND} \geq 0 \qquad (3) \\ \partial Z / \partial x_2 &= 2\sigma_{12} x_1 + 2\sigma_2^2 x_2 + q_2 \text{INCOME} + \text{LAND} \geq 0 \\ \partial Z / \partial \text{INCOME} &= -b_1 + q_1 x_1 + q_2 x_2 \leq 0 \\ \partial Z / \partial \text{LAND} &= -b_2 + x_1 + x_2 \leq 0, \end{aligned}$$

plus the nonnegativity conditions,

$$\begin{aligned} &x_1 \geq 0 \\ &x_2 \geq 0 \\ &INCOME \geq 0 \\ &LAND \geq 0, \end{aligned} \tag{4}$$

and the complementary-slackness conditions,

$$\begin{aligned} &x_1(\partial Z / \partial x_1) = 0 \\ &x_2(\partial Z / \partial x_2) = 0 \\ &INCOME(\partial Z / \partial INCOME) = 0 \\ &LAND(\partial Z / \partial LAND) = 0. \end{aligned} \tag{5}$$

The complementary-slackness conditions require that, if $x_i$ ($i = 1,2$) is greater than zero, then $\partial Z / \partial x_i$ in (5) must be binding, i.e., hold as an equality.

The four marginal conditions described in (3) serve as the basis for developing the linear model which is estimated by means of a LINDO software package. The input procedure for LINDO is LP-based and requires an objective function, even though there is no explicit objective listed in the first-order conditions (Schrage, 1997). The objective function here serves the purpose of identifying the order of variables, which in turn determines the correspondence between variables and rows. LINDO must know this correspondence between variables and constraints in order to enforce the complementary-slackness conditions. The LINDO input is:

$$\begin{aligned} &\text{MIN} \quad x_1 + x_2 + INCOME + LAND \\ &2\hat{\sigma}_1^2 x_1 + 2\hat{\sigma}_{12} x_2 + \hat{q}_1 INCOME + LAND \geq 0 \\ &2\hat{\sigma}_{12} x_1 + 2\hat{\sigma}_2^2 x_2 + \hat{q}_2 INCOME + LAND \geq 0 \\ &\hat{q}_1 x_1 + \hat{q}_2 x_2 = b_1 \\ &x_1 + x_2 = b_2 \end{aligned} \tag{6}$$

If the solution value of the dual variables is positive, the solution is bound, and, therefore the equality assumption of the income and land acreage constraints given in (6) is acceptable.

A set of efficient enterprise combinations for rice and soybeans is generated by setting the expected income at an arbitrary low level and raising the expected income until a minimum feasible solution is obtained. After each feasible solution, the expected income can be raised by some increment until the solution is infeasible. The last feasible solution indicates the maximum expected income from the crop mix. Because there is no practical way to determine the correct enterprise combination for the representative farm (i.e., typical Southwest Louisiana producer), parametric analysis allows an overall examination of the tradeoff between risk and return.

**DATA AND PROCEDURES**

Representative farm size, price, yield, and cost (including opportunity costs of capital) data for rice and soybeans in the Southwest Rice Area for the period 1985 to 1995 were collected by the Department of Agricultural Economics and Agribusiness, Louisiana State University Agricultural Center. Data were collected by annual producer surveys using statistically designed sample survey methods[1]. From this data, the acreage level for the representative farm in the Southwest Rice Area was estimated to be 856 acres. Corresponding data on rice deficiency payments paid to Southwest Rice Area rice producers were obtained from the United States Department of Agriculture, Farm Service Agency, Alexandria, Louisiana. The Gross National Product (GNP) implicit price deflator, indexed to 1992 = 100, was used to adjust nominal price and cost values for inflation.

The impact of yield, price, and cost variability was examined by estimating the variability of economic returns per acre. Descriptive statistics for net economic returns per acre for rice, both with and without deficiency payments, and for soybeans are given in Table 1. These estimates illustrate the dramatic effect of rice deficiency payments on per acre economic profitability in Southwest Louisiana. The per acre economic return for rice on the representative farm without rice deficiency payments ranged from a loss of $298 to a loss of $50, with a mean loss of $156 per acre. When rice deficiency payments were included, the per acre economic return ranged from a loss of $50 to a profit of $137. The mean economic return was increased to a profit of $15 per acre when rice deficiency payments were considered. The variance of economic returns without rice deficiency payments was 5,511, as compared to 2,777 when rice deficiency payments were included. Per acre economic returns for soybeans in Southwest Louisiana ranged from a loss of $158 to a profit of $77, with a mean loss of $23 per acre. Soybeans are not considered to be a basic crop by the government and are ineligible for any type of price support payment.

**Table 1**
**Net Economic Returns Statistics for Representative 856 Acre Southwest Louisiana Rice and Soybean Farm, 1985 through 1995**

| Per Acre Return[a] | Rice Without Deficiency Payment | Rice With Deficiency Payment | Soybeans |
|---|---|---|---|
| Mean ($) | (156)[b] | 15 | (23) |
| Minimum ($) | (298) | (50) | (158) |
| Maximum ($) | (50) | 137 | 77 |
| Variance | 5,511 | 2,777 | 3,396 |
| Probability of Economic Loss[c] | 0.98 | 0.39 | 0.99 |
| Covariance (rice, soybeans) | 2,046 | 1,312 | |
| Correlation (rice, soybeans) | 0.52 | 0.47 | |

[a] Constant (1992) dollars.
[b] Negative values (losses per acre) are given in parentheses.
[c] Assuming a normal distribution for net economic returns.

The impact of rice deficiency payments on economic profitability is further evidenced by comparing the probability of economic loss for the scenario that includes rice deficiency payments to the scenario that excludes rice deficiency payments. Assuming a normal distribution for net economic returns, probabilities of economic losses for the representative farm over the time period were estimated to be 98 percent for rice production excluding government deficiency payments as compared to 39 percent for rice production including government deficiency payments. Mean levels of economic return, variance of economic returns, and estimated probabilities of economic loss under scenarios of inclusion and exclusion of rice deficiency payments demonstrate the importance of rice deficiency payments on the economic viability of Southwest Louisiana producers.

Production diversification can reduce yield, price, and income variation, or risk, to the producer. The degree to which a two-asset (two-crop) portfolio reduces the variance of net returns depends on the degree of correlation between the two enterprises. Because the rice and soybean net returns given in Table 1 are less than perfectly correlated (0.52 without deficiency payments and 0.47 with deficiency payments), reductions in income variation can be gained by a rice-soybean crop combination under both the inclusion and exclusion of rice deficiency payments.

A set of efficient mean-variance (E-V) production mixes for rice and soybeans was estimated for a representative 856 acre farm in Southwest Louisiana by applying the estimates provided in Table 1 to the model in equation (6), under scenarios including and excluding rice deficiency payments. Differences in these two E-V optimal crop mixes provided a basis for evaluating the effect of rice deficiency payments on the risk-return relationship for the representative rice and soybean farm in Southwest Louisiana.

**RESULTS**

The ranges of expected annual income (economic profit or loss) for the representative farm and the corresponding ranges of annual income variance are given in Table 2, under scenarios of excluding and including rice deficiency payments. Exclusion of rice deficiency payments resulted in a loss in expected annual income for both the minimum and maximum efficient portfolios. Inclusion of rice deficiency payments had a dramatic effect on increasing both the minimum and the maximum expected annual income. Without rice deficiency payments, the expected annual income for efficient combinations of rice and soybeans ranged from an economic loss of $52,000 to an economic loss of $20,000. Corresponding income variances, excluding rice deficiency payments, ranged from 2,211 for the minimum income portfolio to 2,483 for the maximum income portfolio. When rice deficiency payments were included, the expected annual income increased from an economic loss of $1,000 for the minimum efficient portfolio to an annual economic profit of $12,000 for the maximum portfolio. Corresponding income variances were reduced when rice deficiency payments were included, ranging from 1,592 for the minimum efficient portfolio to 1,981 for the maximum efficient portfolio. Results presented in Table 2 demonstrate the impact of rice deficiency payments on the economic profitability of efficient combinations of rice and soybeans. Inclusion of rice deficiency payments substantially increased expected income while reducing income variance for both the minimum and maximum efficient portfolios.

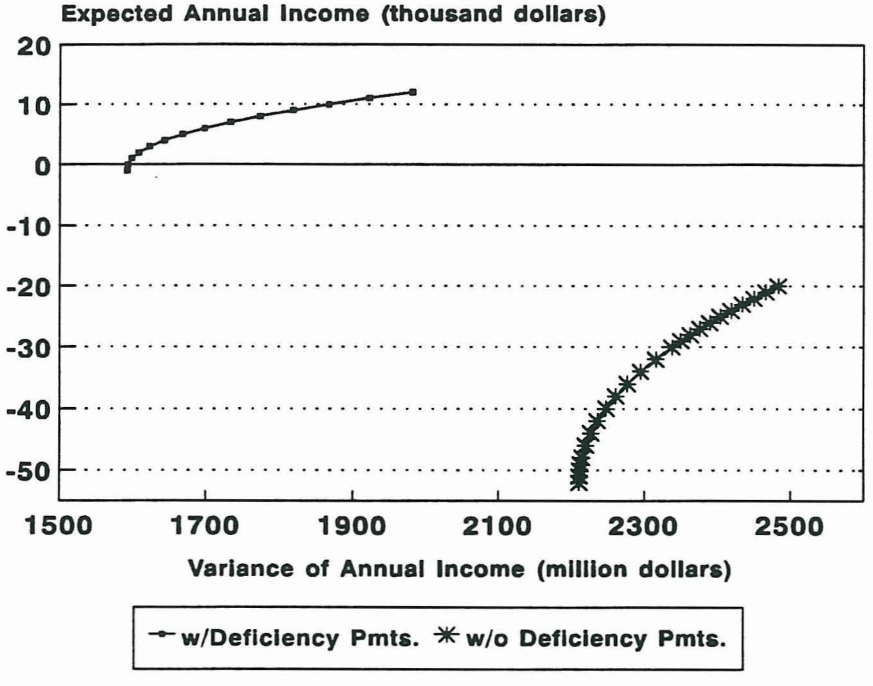
Results from the parametric analysis of expected annual income for the representative farm are illustrated in Figure 2. The relationship between expected annual income levels and corresponding income variances illustrates that the impact of eliminating rice deficiency payments is to shift the typical Southwest Louisiana rice and soybean producer's risk-return relationship substantially downward and to the right. This represents increases in minimum and maximum expected annual income of 98 percent and 160 percent, respectively. Corresponding minimum and maximum annual income variance levels decreased by 28 percent and 20 percent, respectively, when rice deficiency payments were included. Because agricultural commodity producers are price takers and operate in an almost perfectly competitive market, economic theory suggests that producers will earn a zero economic profit in the long run. Figure 2 illustrates excess economic profits for the scenario of including government deficiency payments and economic losses under the scenario of excluding government deficiency payments.

**Table 2**
**Ranges of Expected Annual Income and Annual Income Variances for Efficient Combinations of Rice and Soybeans, Southwest Louisiana Rice and Soybean Farm**

| Efficient Combination | Without Rice Deficiency Pmts. | | With Rice Deficiency Pmts. | |
|---|---|---|---|---|
| | Expected Income ($ thousand) | Income Variance ($ million) | Expected Income ($ thousand) | Income Variance ($ million) |
| Minimum | (52)[a] | 2,211 | (1) | 1,592 |
| Maximum | (20) | 2,483 | 12 | 1,981 |

[a] Negative values (annual losses) are given in parentheses.

**Figure 2**
**Efficient E-V Frontiers, With and Without Rice Deficiency Payents**




## SUMMARY AND CONCLUSIONS

Representative farm data for rice and soybean net returns and rice deficiency payments for the period 1985 to1995 were used to estimate the tradeoff between risk and income for rice and soybean producers in Southwest Louisiana. A portfolio analysis for scenarios of including and excluding rice deficiency payments indicated that the exclusion of rice deficiency payments substantially deteriorates the risk-return position of the typical southwestern Louisiana rice and soybean producer.

The reduction and eventual phase out of direct government rice payments, as mandated by the FAIR Act of 1996, are expected to have a dramatic and detrimental impact on the profitability of Southwest Louisiana agricultural producers due to limited production alternatives in this area. The elimination of commodity deficiency payments and their replacement with declining transition payments will impact production agriculture by shifting price and income risk away from government programs and to agricultural producers. By the year 2002, this new policy environment will require producers to consider alternative land use strategies and/or alternative risk management strategies, such as the use of futures and options and forward contracts in managing output price risk. Because the value of price support programs has been capitalized into the value of government enrolled acreage, the phase out of government programs is likely to have a detrimental impact on land values and the equity position of landowners. Moreover, the alteration of the producer's risk-return relationship is expected to substantially and adversely affect the debt carrying capacity and the overall capital structure of the typical farm in Southwest Louisiana.

## ENDNOTES

1. Southwest Rice Area representative farm data for the years 1985-1995 were obtained from annual producer surveys. A complete description of the survey procedures and data can be found in "Projected Costs and Returns and Cash Flows for Major Agricultural Enterprises in Louisiana," *D.A.E.and A.E.A. Information Series*, 1985-1995, published by Louisiana State University Agricultural Center, Department of Agricultural Economics and Agribusiness, Baton Rouge, Louisiana.

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