THE EFFECT OF DEFICIENCY PAYMENTS ON THE RISK-RETURN RELATIONSHIP OF LOUISIANA COTTON FARMS

Gary A. Kennedy
Department of Agricultural Sciences
Louisiana Tech University
Ruston, LA
Steven A. Henning, Lonnie R. Vandeveer and Hector O. Zapata
Department of Agricultural Economics and Agribusiness
Louisiana Agricultural Experiment Station
Louisiana State University Agricultural Center
Baton Rouge, LA

Abstract

Stability in net farm income resulting from direct government deficiency payments has historically affected the optimum crop mix combination that results in risk-efficient portfolios. This paper illustrates the degree to which cotton deficiency payments affect the risk-return relationship for optimal production mixes of cotton and soybeans for a representative farm in each of Louisiana's three cotton production areas. Results suggest that the impact of the decline and eventual elimination of cotton deficiency payments on the risk-return relationship of Louisiana cotton producers will vary by cotton production region within the state.

Introduction

The study of the risk-return tradeoff in the production of commodities has traditionally focused on variability in commodity prices, input prices, and yields. This emphasis typically ignores 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 stability of these programs over time. However, reform of domestic agricultural policies, resulting from the FAIR Act of 1996, emphasizes the need for estimating how the phase out and eventual elimination of deficiency payments will affect risk efficient portfolios of producers.

Including feed grains, upland cotton, and rice, government program enrollment totals more than 2.6 million acres in Louisiana. Upland cotton base accounts for 1,024,035 acres, or 38 percent, of total government enrolled acreage in Louisiana (USDA, 1994). The extensive enrollment of Louisiana agricultural land as cotton base acreage suggests a need to estimate the impact of government deficiency payments on the risk-return relationship of Louisiana cotton producers.

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Louisiana cotton production is largely limited to three distinct geographic production areas within the state. These areas include the Northeast Delta, Macon Ridge, and Red River (Figure 1). The Northeast Delta and Red River Areas are characterized by the highly productive alluvial soils of the Ouachita, Mississippi, and Red Rivers. Soils of the Macon Ridge Area are loessial, silty, and less productive in nature. The objective of this paper is to illustrate the impact of cotton deficiency payments on the risk-return relationship of cotton producers in these three geographic production areas, prior to the implementation of the FAIR Act.

Data and Methodology

Representative farm price, yield, and cost data for cotton and soybeans from each production region within Louisiana for the period 1981 to 1995 were obtained from the Department of Agricultural Economics and Agribusiness, Louisiana State University Agricultural Center. Corresponding data on cotton deficiency payments 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, cost, and deficiency payment values for inflation.

The impact of yield, price, and cost variability was examined by estimating the variability of net returns per acre. Descriptive statistics for net returns per acre for cotton, both with and without deficiency payments, and for soybeans are given in Table 1. These statistics illustrate the dramatic effect of cotton deficiency payments on per acre profitability across the three production areas. The mean net return for cotton on the representative farm in the Northeast Delta Area without cotton deficiency payments was $47 per acre. The mean net return for the same farm was increased to $220 per acre when cotton deficiency payments were considered. The differences in the mean net cotton return for the Red River and Macon Ridge Areas were even more dramatic. The representative farm in the Red River Area had a mean net loss of $30 per acre for cotton production without deficiency payments. The same farm exhibited a mean net profit of $128 per acre for cotton production when cotton deficiency payments were included. Mean cotton net returns in the Macon Ridge area were losses of $63 per acre without cotton deficiency payments and a profit of $69 when deficiency payments were included. Although there is a high degree of relative variation in the amount of the deficiency payment from year to year, a cotton deficiency payment was made each year between 1981 and 1995. Mean per acre net returns for soybeans for the same time period were $64, $57, and $0.46 for the Northeast Delta, Red River, and Macon Ridge Areas, respectively. Deficiency payments are not available for soybean production.

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 assets. The lower the value of the coefficient of correlation between the net returns of the two assets, the greater the reduction in variance for the portfolio. The low values of the correlation coefficient given in Table 1 for all three production areas indicated that reductions in income variation can be gained by a cotton-soybean portfolio.

A set of efficient mean-variance (E-V) production mixes for cotton and soybeans was estimated for scenarios including and excluding deficiency payments for cotton. Differences in these two E-V optimal crop mixes provided a basis for evaluating the effect of cotton deficiency payments on the risk-return relationship for a representative farm in each production area within Louisiana.

Procedures

The model used is a quadratic form of the Markowitz (1959) portfolio model that minimizes net income variance subject to expected income and land acreage constraints. Implicitly, the model was specified in the following form (Stovall 1966):

$$\text{MIN } V(I) = \sigma_1^2 X_1^2 + \sigma_2^2 X_2^2 + 2\sigma_{12} X_1 X_2 \qquad (1)$$

subject to

$$q_1 X_1 + q_2 X_2 = b_1$$

and

$$X_1 + X_2 = b_2$$

where

- $V(I)$ = net income variance
- σ_1^2 = cotton net returns variance
- σ_2^2 = soybeans net returns variance
- X_1 = acres of cotton produced
- X_2 = acres of soybeans produced
- σ_{12} = covariance of cotton and soybeans net returns
- q_1 = net returns of cotton per acre
- q_2 = net returns of soybeans per acre
- b_1 = expected income
- b_2 = land acreage constraint

The problem is to minimize income variance subject to an expected income level and the total amount of acreage that is available. Equation (1) was used to estimate a set of optimal enterprise mixes of cotton and soybeans with a corresponding range of expected income levels, given an amount of acreage. Acreage levels for each representative farm were determined by survey data collected by the Department of Agricultural Economics and Agribusiness, Louisiana State University Agricultural Center.

For the Northeast Delta Area, the quadratic model was specified using the cotton and soybean statistics from Table 1 (without deficiency payments) as:

$$\text{MIN } V(I) = 1{,}350 X_1^2 + 1{,}847 X_2^2 + 2(30) X_1 X_2 \qquad (2)$$

subject to

$$47X_1 + 64X_2 = \text{Expected Income}$$

and

$$X_1 + X_2 = 1{,}342$$

Equation (2) was converted to true linear form by the Kuhn-Tucker first order conditions (Kuhn and Tucker 1951) where a dual variable was introduced for each constraint in the equation. The model was then 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 served the purpose of identifying the order of variables, which in turn determined the correspondence between variables and rows. The LINDO input was specified as:

$$\text{MIN } \ X_1 + X_2 + \text{INCOME} + \text{LAND} \qquad (3)$$

subject to

$$2{,}700X_1 + 60X_2 + 47\ \text{INCOME} + \text{LAND} > 0$$
$$60X_1 + 3{,}694X_2 + 64\ \text{INCOME} + \text{LAND} > 0$$
$$47X_1 + 64X_2 = \text{Expected Income}$$
$$X_1 + X_2 = 1{,}342$$

INCOME and LAND were used as dual variables. A set of efficient enterprise combinations for cotton and soybeans were generated by setting the expected income at an arbitrary low level and raising the expected income until a feasible solution was obtained. After each feasible solution, the expected income was raised by some increment until the solution was infeasible. The last feasible solution indicated the maximum expected income from the crop mix. The model was then re-estimated for the Northeast Delta Area using the statistics from Table 1 that include cotton deficiency payments. The result was a new set of efficient enterprise combinations for cotton and soybeans. The procedure was repeated using statistics estimated for the Red River and Macon Ridge Areas.

Results

Ranges of expected income for each representative farm in each production area and their respective variances are given in Table 2. The inclusion of cotton deficiency payments had a dramatic effect on increasing both the minimum and maximum expected income for each production area. In the Northeast Delta Area, inclusion of cotton deficiency payments increased the minimum feasible expected income from \$75,000 to \$204,000 and increased the maximum feasible expected income from \$85,000 to \$295,000. This represents increases in minimum and maximum expected income of 172 percent and 247 percent, respectively. Corresponding variance levels for the Northeast Delta Area increased by 124 percent and 178 percent.

In the Red River Area, minimum expected income increased by 485 percent, from \$13,000 to \$76,000, while income variance increased by only 56 percent. Maximum expected income in the Red River Area was increased by 123 percent

($47,000 to $105,000), with a corresponding increase in income variance of 163 percent.

The largest increase in both minimum and maximum expected income, relative to a corresponding increase in income variance, occurred for the Macon Ridge Area. The inclusion of cotton deficiency resulted in an increase in expected income of more than nine times the corresponding increase in income variance for the minimum feasible income and an increase in expected income of more than 213 times the corresponding increase in income variance for the maximum feasible income.

Results from the parametric analysis of expected income for representative farms in the Northeast Delta, Red River, and Macon Ridge Areas are illustrated in Figures 2, 3, and 4, respectively. For all three production areas, relationships between expected income levels and respective variances show that the impact of adding cotton deficiency payments was to shift the producer's risk-return relationship substantially upward.

Summary and Conclusions

Representative farm data for cotton and soybeans net returns and cotton deficiency payments for the period 1981 to1995 were used to estimate the tradeoff between risk and income for cotton and soybean producers in three cotton production regions in Louisiana. A portfolio analysis for scenarios of including and excluding cotton deficiency payments indicated that the inclusion of cotton deficiency payments substantially modified the risk-return position of the representative or typical farm in each cotton production area in Louisiana. The increases in income relative to risk, attributed to the inclusion of cotton deficiency payments, were estimated to be greatest for the Macon Ridge Area.

Evidence presented in this study suggests that the reduction and eventual phase out of cotton deficiency payments, as mandated by the FAIR Act of 1996, will substantially alter the risk-return relationship of producers. Results indicate that the risk-return relationship of producers in the more marginal areas of production may be affected most by these recent policy changes. Alteration of the farm's risk-return relationship is expected to affect the debt carrying capacity and the overall capital structure of the farm.

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Table 1. Descriptive Statistics for Representative Farms by Production Area, Louisiana Cotton and Soybean Net Returns, 1981-95.

Per Acre Return ($)	Cotton Without Deficiency Pmt.	Cotton With Deficiency Pmt.	Soybeans
Northeast Delta Area (1,342 Acre Cotton and Soybean Farm)			
Mean	47	220	64
Minimum	(16)	131	(29)
Maximum	116	358	154
Variance (^{2})	1,350	4,761	1,847
Covariance c,s	30	(24)	
Correlation c,s	0.02	(0.01)	
Red River Area (825 Acre Cotton and Soybean Farm)			
Mean	(30)	128	57
Minimum	(91)	40	(28)
Maximum	47	269	146
Variance (^{2})	1,896	4,665	1,744
Covariance c,s	559	521	
Correlation c,s	0.33	0.20	
Macon Ridge Area (533 Acre Cotton and Soybean Farm)			
Mean	(63)	69	0.46
Minimum	(160)	(48)	(80)
Maximum	8	186	70
Variance (^{2})	1,476	2,953	1,550
Covariance c,s	544	437	
Correlation c,s	0.39	0.22	

Constant (1992) dollars
Negative values are given in parentheses

Table 2. Ranges of Expected Income and Income Variances for Efficient Combinations of Cotton and Soybeans by Production Area, Louisiana, 1995.

	Without Def. Pmts		With Def. Pmts.	
Production Area	Expected Income ($ thousand)	Income Variance (^{2} million)	Expected Income ($ thousand)	Income Variance (^{2} million)
Northeast Delta Area				
Minimum	75	1,490	204	3,340
Maximum	85	3,080	295	8,554
Red River Area				
Minimum	13	808	76	1,257
Maximum	47	1,186	105	3,118
Macon Ridge Area				
Minimum	(17)	292	11	344
Maximum	0.2	440	36	809

Negative values are given in parentheses

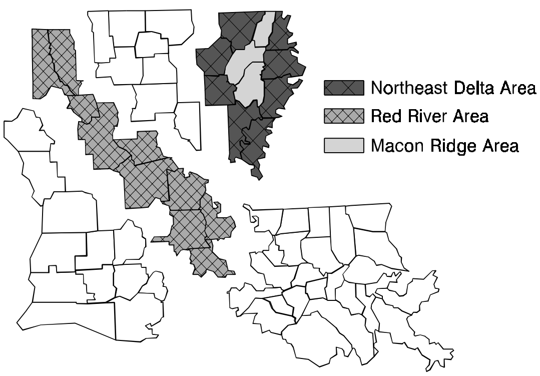

Figure 1. Louisiana Cotton Production Areas, 1995.

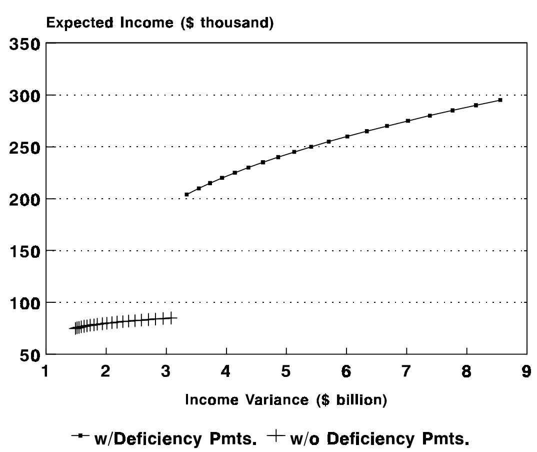

Figure 2. Efficient E-V Frontiers, with and without Cotton Deficiency Payments, 1,342 Acre Cotton and Soybean Farm, Northeast Delta Area, Louisiana, 1995.

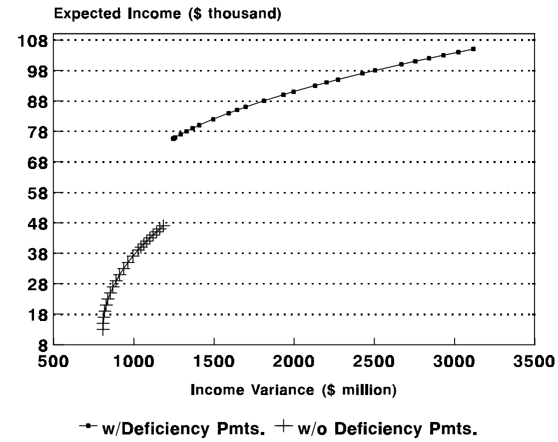

Figure 3. Efficient E-V Frontiers, with and without Cotton Deficiency Payments, 825 Acre Cotton and Soybean Farm, Red River Area, Louisiana, 1995.

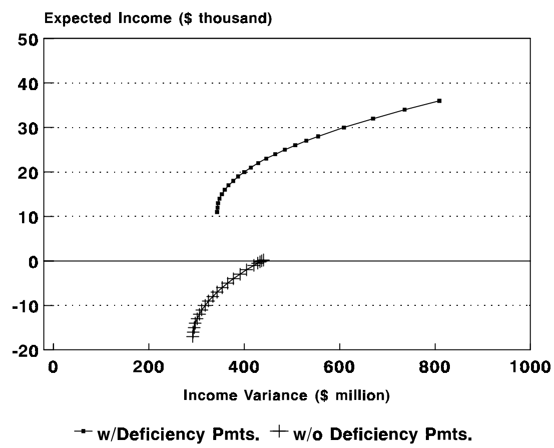

Figure 4. Efficient E-V Frontiers, with and without Cotton Deficiency Payments, 533 Acre Cotton and Soybean Farm, Macon Ridge Area, Louisiana, 1995.