U.S. Agricultural Policy Effectiveness: An Analysis of Income and Capital Gain Returns Impacts

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ABSTRACT

This paper examines the effects of agricultural policy upon the first three moments (mean, variance, and skewness) of aggregate farm income distributions. For the income variables examined, the program period distributions were positively skewed relative to the nonprogram period. However, it appears that the significant impact of the programs on risk reduction encourages the asset and product markets to shift the distribution of total returns toward asset appreciation rather than income enhancement.

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Agricultural economists generally agree that the primary goal of agricultural policy since the Agricultural Adjustment Act of 1933 has been to raise farm incomes. A broad spectrum of policies have been implemented to achieve that goal. Examples include supply controls, storage subsidies, price and income supports, and subsidized credit. While it is likely that agricultural policies have succeeded in raising the level of farm income above its unregulated level, it is questionable whether such policies have raised the rate of return to farm assets.

Melichar (1984) and Phipps (1985) have argued that government programs cannot alter the total rate of return to farm assets. Their arguments are based on the assumption that the income-capitalization model determines land prices and that the total rate of return is determined by the collective product of investor behavior in asset markets. Based on these two assumptions, any increase in the level of farm income will be capitalized into the value of farm assets to the point where the rate of return on farm assets is unchanged. However, farm programs can alter the composition of the total return to farm assets, which is divided between an income and capital gains return. An example will help illustrate this effect. First, note that the capital gain return is equal to the rate of growth in the income return. Initially, assume the equilibrium total return is 4 percent and is composed of 0 percent capital gains and 4 percent income returns. Next, assume the government supports the level of income such that it grows 1 percent per year. This translates into a 1 percent capital gains return per year. If the market determined total return remains 4 percent, then income return must fall to 3 percent. Therefore, by increasing the level of farm income the income rate of return in fact may be reduced.

The above example is revealing conceptually, but is difficult to apply in reality. The reason is that government programs likely effect the shape of the entire distribution of returns, not simply the mean as was implicitly assumed. More specifically, policies such as price and income supports are likely to truncate at least the lower portion of the expected income return to farm assets. This may result in a complex change in at least the mean, variance, and skewness of the realized distribution as producers change their optimal production plans in response to the changed expectation of returns.

The previous discussion suggests the effect of government intervention in agricultural markets is reflected in changes in all moments of the distribution of returns to farm assets. We will examine this effect by comparing the first three moments (mean, variance, and skewness) of aggregate rates of return to farm assets previous to 1933 and after 1933. This particular period, concerning U.S. agricultural policy, marked the beginning of what now has been five decades of federal government intervention in agricultural markets. The first three moments are argued to be representative of the most important and economically meaningful effects. The results of the analysis should prove valuable to the debate concerning the effectiveness of farm programs. Following sections discuss utility maximization under uncertainty, procedures, results, and conclusions and implications.

THEORY

Farm programs were enacted to improve producers' income and economic well being. Therefore, to analyze the impacts of farm policy upon the rate of return on aggregate farm income, changes in producers' expected utility are examined. Traditionally, policy analysts have utilized the first two moments of farm income in producers' utility functions as a measure of policy effectiveness. But, as mentioned above, government policy affects more than the first two moments, it also changes the third moment of the distribution. Following is a brief discussion of producers' expected utility utilizing higher order utility functions which incorporate the first three moments.

An individual facing economic uncertainty (risk) will maximize his expected utility (U) generated from all activities entered. Utility (U) is defined to be a function of income (I) and is specified by:

1) $U = U(I)$

2) $U = E[U(I)]$

3) $U = \int_{-\infty}^{\infty} U(I)h(I)\, dI$

where equation (2) follows from equation (1) by virtue of the expected utility theorem and h(I) is the probability distribution of income.

Taking the expectation of a Taylor series expansion of the utility function, the expected utility function (3) can be expressed as a function of the moments of the income distribution. Thus,

4) $U(I) = f[M_1(I), M_2(I), M_3(I),\ldots]$

where $M_k(I)$ represents the kth moment of the income distribution and therefore,

5) $U(I) = f[E(I), V(I), S(I),\ldots]$

where E(I), V(I), and S(I) respectively denote the mean, variance, and skewness of the income distribution. The mean represents the expected return while variance and skewness measure the relative riskiness of returns.

Arrow states that the desirable properties for an individual's utility function are:

1) positive marginal utility for income, $U'(I)>0$;
2) decreasing marginal utility of income, $U''(I)<0$;
3) non-decreasing absolute risk aversion, $r'(I)<0$

where $r(I) = -[U''/U']$.

Arditti has shown that Arrow's condition (3) is a sufficient condition for $U'''(I)>0$, implying individual preference for positive skewness. For individuals with long term investment horizons, skewness becomes a relevant variable in their decision making criteria (Arditti and Levy). Risk averse individuals prefer positive skewness and dislike negative skewness (Anderson, Dillon, and Hardaker).

PROCEDURES

To examine policy effectiveness of federal government farm programs, aggregate farm income data from 1910 to 1985 are utilized (Melichar, 1986). These data series consist of income from all farm sources and have been converted to 1985 dollars using the Personal Consumption Expenditure (PCE) deflator. Income measures examined consist of income earned, real capital gains, and total returns on assets.

Melichar derived much of these income series from USDA sources, but did reconstruct one series. Consequently, income earned on assets differs from its USDA counterpart. In essence, in these data income earned on assets is gross income less operating expenses, capital consumption, and imputed labor costs.

The rates of return to assets were analyzed for two periods: 1910 to 1932, inclusive and 1933 to 1985, inclusive. Rates of return to assets were used to eliminate the scale effect of a growth in asset values. The period of 1910-1932 represents the period of limited and inconsistent government involvement, while 1933-1985 represents the era of government interventions. Policy effectiveness is examined by identifying differences in the first three moments (mean, variance, and skewness) of the three rate of return variables between the two periods. Clearly, other factors may have caused the changes, if any, in the distribution of returns after 1933. Possibilities include a change in investor preferences either in general or in the farm sector, the changed structure of farming, and increasing macroeconomic intervention by the government. We recognize the caution this suggests in interpreting the results.

The statistical tests included comparison of the sample mean, variance, and relative skewness between periods for each income variable. To statistically infer differences between the first two moments for the two periods, t and F tests were conducted on the sample means and variances, respectively, at the 95 percent confidence level. A standardized relative skewness for each income distribution for the two periods was also calculated and tested at the 95 percent confidence level.

RESULTS

The results show that federal farm programs have apparently benefited the aggregate agricultural sector. Increased expected producer utilities should have resulted from changes in the first three moments that occurred in the program period, 1933-1985. For all three variables investigated, the 1933-1985 income distribution shifted to the right relative to the 1910-1932 distribution. Alternatively, the 1933-1985 period distribution was either less skewed to the left, normal, or skewed right relative to the 1910-1932 period distribution. The statistical results for income, capital gains, and total returns are presented in Table 1. Figures 1, 2, and 3 illustrate the changes in distributions of the three variables between the two periods.

The mean ROR (rate of return) of income earned on assets is statistically higher for the nonprogram period although the variances are not significantly different. The nonprogram period averaged slightly over 4 percent while the program period averaged 3.2 percent. The program period distribution is skewed to the right while the nonprogram is normally distributed. Figures 1a and 1b show that the program period distribution is skewed to the right relative to the nonprogram period. Thus, with respect to income earned on assets the evidence on the impact of the post 1933 programs on producers' expected utility is inconclusive. Only the third moment (skewness) clearly moved in the desired direction.

The ROR (rate of return) of real capital gains on assets for the 1933-1985 period averaged 1.0 percent and is significantly greater than the 1910-1932 period at -2.13 percent. Both periods real capital gains are negatively skewed, but the program period is relatively less negatively skewed than the nonprogram period. Figures 2a and 2b depict this change in capital gains. Thus, the expected utility of producers as measured by real capital gains was improved as a result of federal farm programs. That is, both the mean (first moment of the producers' utility function) and the skewness (third moment) shifted significantly to the right while there was no significant change in the variances (second moment).

The ROR of total returns to assets for the 1933-1985 period averaged 4.19 percent and is statistically greater than the 1910-1932 period at 1.96 percent. The variances are not significantly different however, the post policy period distribution is normally distributed while the pre-policy period is skewed left. Figures 3a and 3b illustrate these changes in total returns on assets.

One should exercise caution in the interpretation of these results. The period of analysis, 1910 to 1985, presents some data limitations. The pre and post 1933 periods may not be comparable due in part to the differences in sample size. Both periods were also characterized by some rather dramatic economic events which may bias the capital gain and total returns comparisons.

TABLE 1. Statistical Summary of Rates of Return to Assets.
(Shown in Percentages)

Period		Net Income	Real Capital Gains	Total Return
1910 to 1932	mean	4.09	-2.13	1.96
	variance	5.21	17.60	25.21
	relative skewness[1]	0.335	-1.09	-1.20
	skewness type	normal	left	left
1933 to 1985	mean	3.20	1.00	4.19
	variance	3.13	24.93	30.00
	relative skewness	1.258	-0.99	-0.43
	skewness type	right	left	normal
	means < = > [2]	c	a	a
	variances < = >	b	b	b

1 The critical value for relative skewness is the skewness value divided by the standard deviation for relative skewness. The standard deviation for relative skewness is the square root of (6/n).

2 a = 1933-1985 > 1910-1932
b = 1933-1985 = 1910-1932
c = 1910-1932 > 1933-1985
One-side t-statistics test at the 95 percent confidence level.

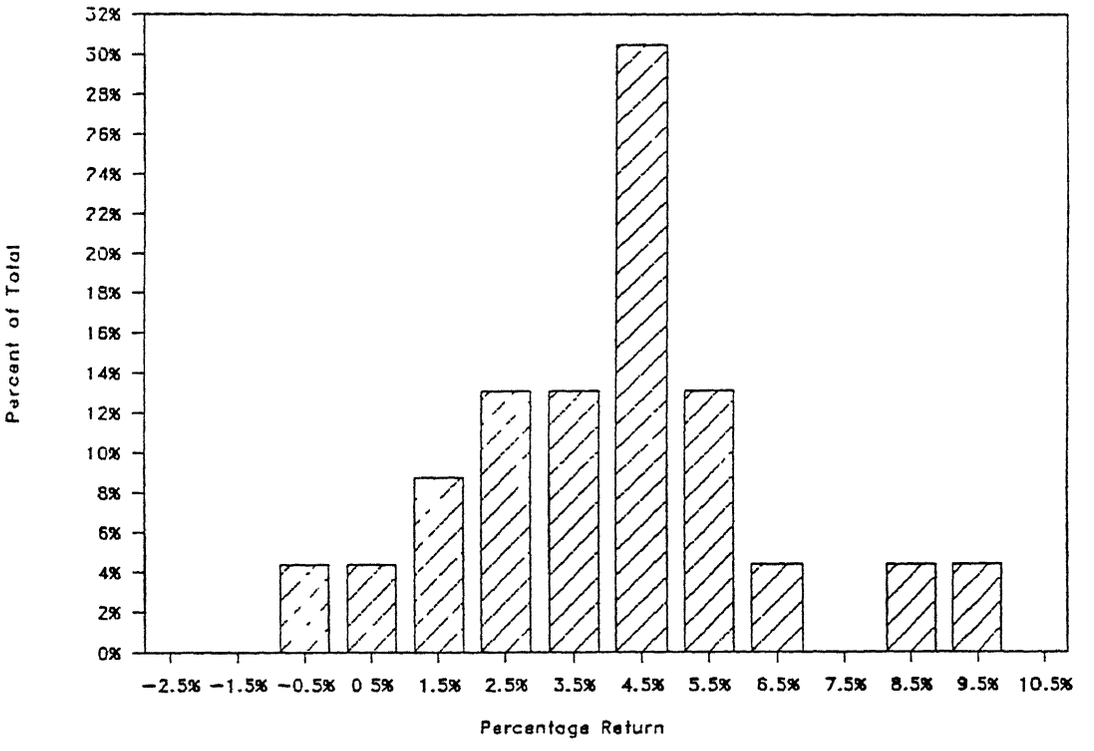

Figure 1a. Frequency Distribution of the Rate of Return of Income Earned on Assets, 1910 to 1932.

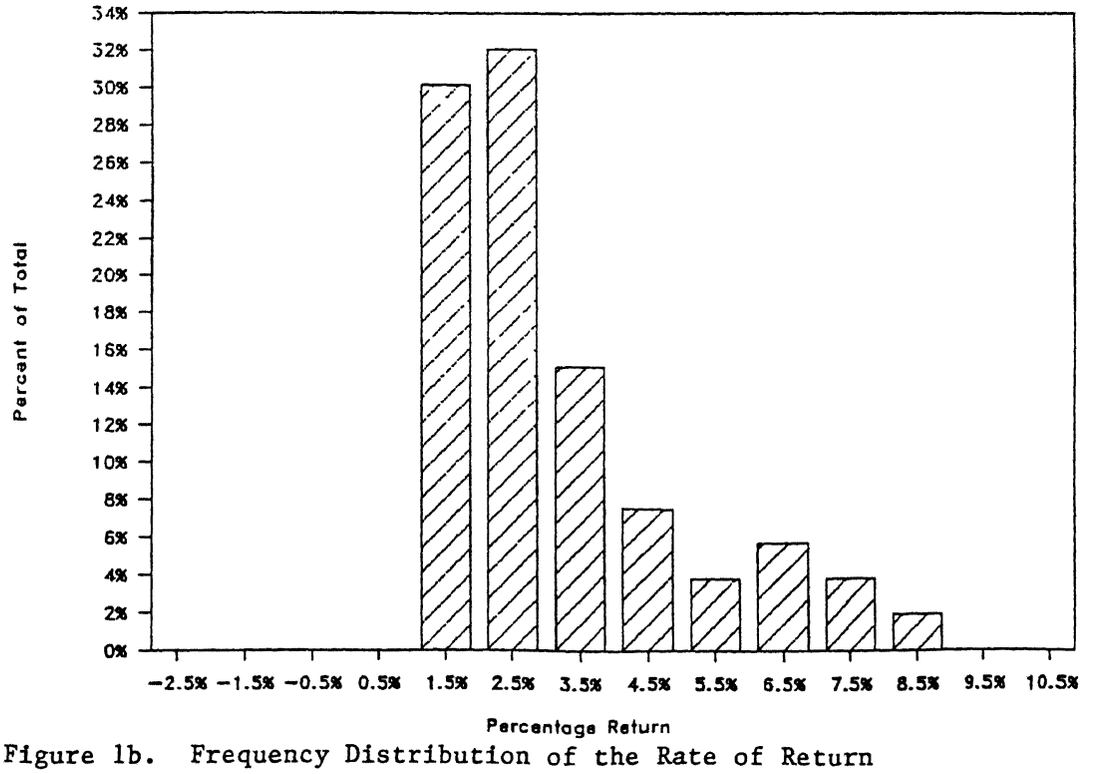

Figure 1b. Frequency Distribution of the Rate of Return of Income Earned on Assets, 1933 to 1985.

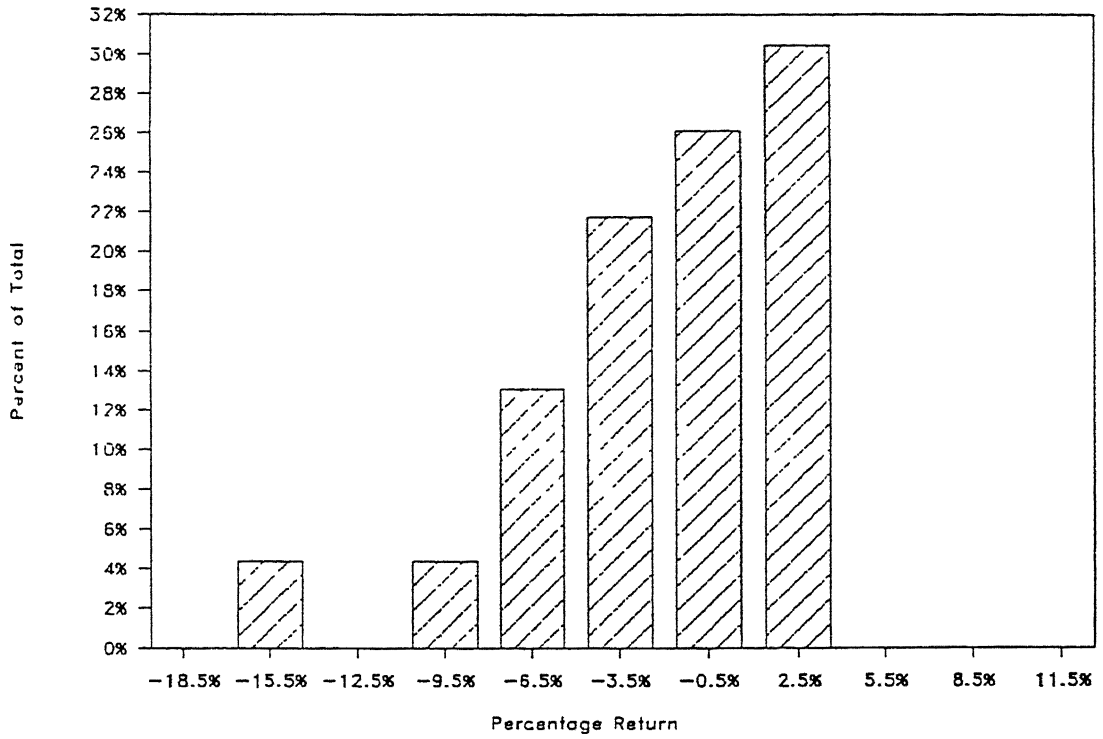

Figure 2a. Frequency Distribution of Real Capital Gains on Assets, 1910 to 1932.

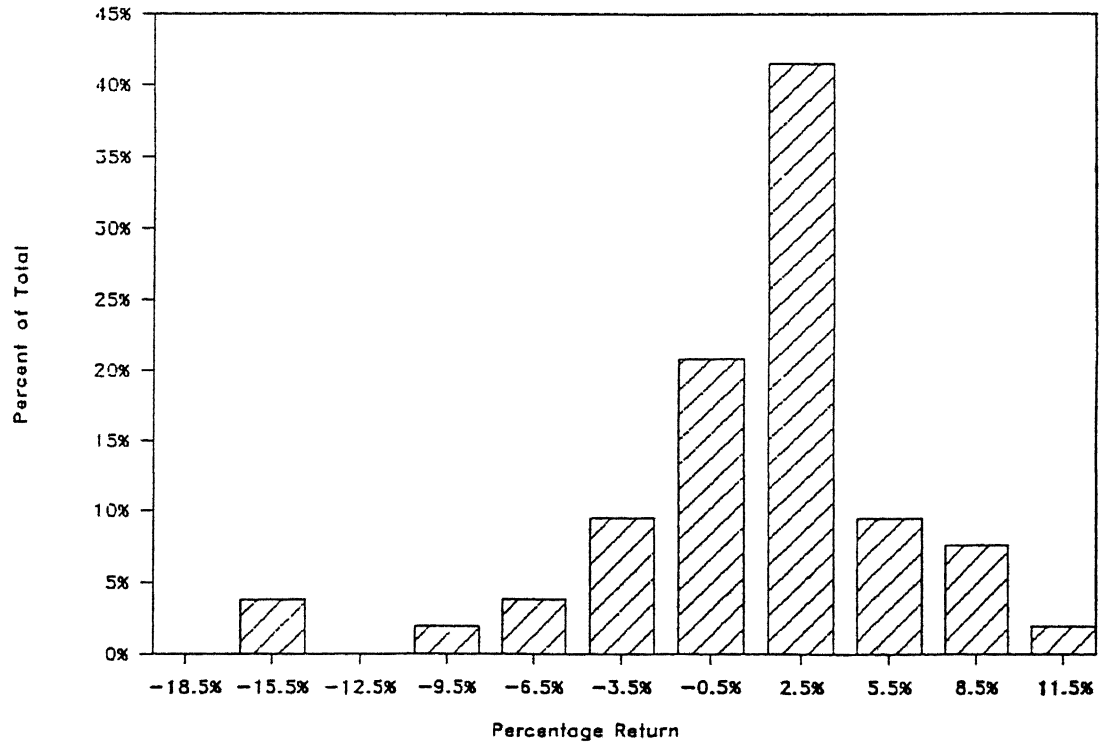

Figure 2b. Frequency Distribution of Real Capital Gains on Assets, 1933 to 1985.

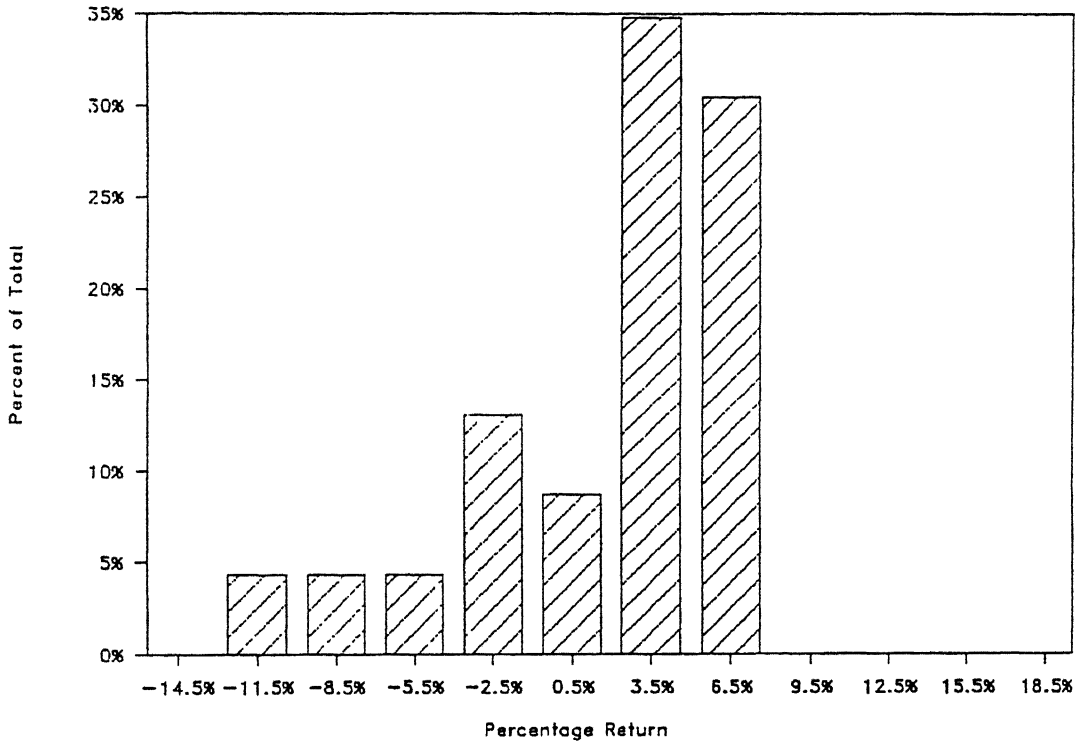

Figure 3a. Frequency Distribution of Total Returns to Assets, 1910 to 1932.

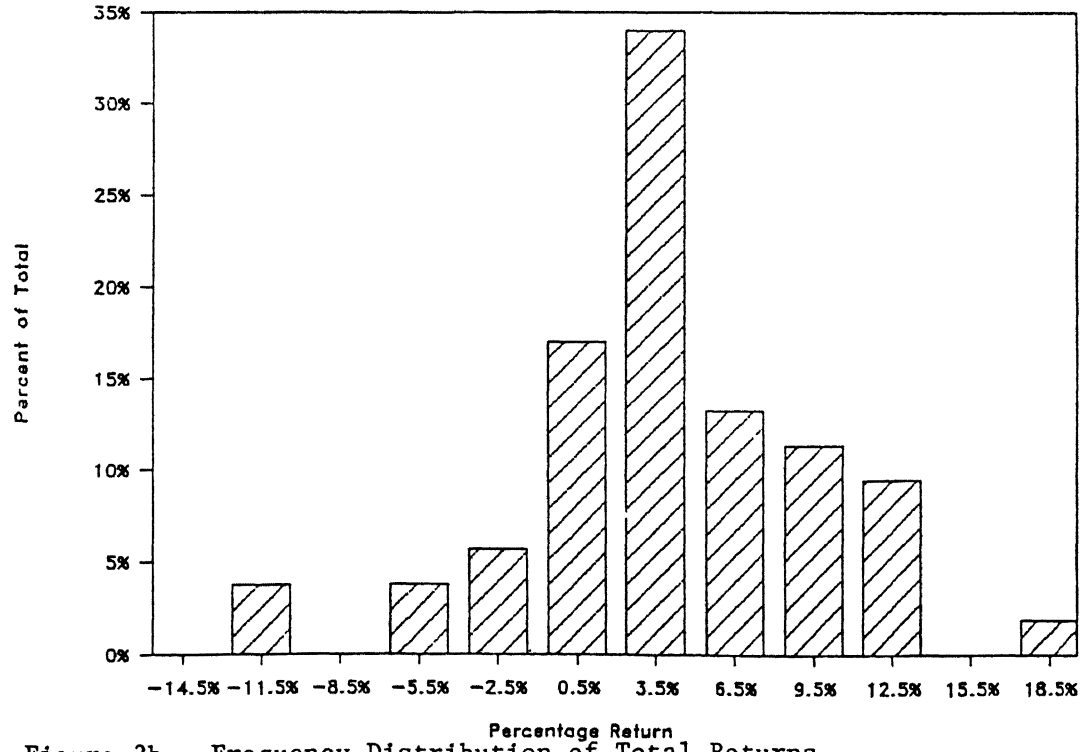

Figure 3b. Frequency Distribution of Total Returns to Assets, 1933 to 1985.

CONCLUSIONS AND IMPLICATIONS

Imposition of government farm programs, such as price and income support provisions for selected agricultural commodities, have been justified at least politically on the basis of the rationale that agricultural producers are better off as a result of these programs. However, it has been frequently observed that much of the gain to farm operative incomes have been capitalized into asset values, particularly farmland.

In this analysis, it has been argued that changes in producers' expected utility from economic gains associated with these programs is a relevant measure of program success. Contrary to traditional utility analysis which concentrates on the first two moments, mean and variance, this analysis has incorporated the third moment, skewness. Because one objective of farm programs has been to limit down-side price and/or income risk to producers, it is argued that a shift in skewness in the distribution of economic gains over time from the left to the right is a meaningful measure of program effectiveness. Such a shift is also consistent with the expected utility of risk-averse producers.

Three measures of economic gains were examined: (1) income earned, measured in terms of return on assets, (2) the rate of real capital appreciation, and (3) total return on assets. The first is representative of an income flow to farm operators; the second of gains that flow to landowners. Thus, the impacts of post 1933 government programs on operating income, capitalized asset values, and total returns were examined in the context of the first three moments of expected producer utility.

The results showed that, in terms of the second moment, variance, there were no statistically significant changes caused in each measure of economic gain by the imposition of post 1933 government farm programs. In terms of the third moment, skewness, there were statistically significant improvements in all three variables. Regarding the first moment, income, there was a statistically significant decrease for the income measure and a statistically significant increase in the asset value measure and total returns.

Overall, therefore, for five of the nine possible outcomes, changes occurred that are all indicative of an increase in expected producer utility as a result of the post 1933 programs while one outcome was indicative of a decrease (mean value of earned income) and the remaining three outcomes showed no significant differences between the pre and post 1933 periods. These results were fully consistent with the generally received view that economic gains associated with the post 1933 programs have been capitalized into asset (land) values rather than in increased operating incomes.

Indeed, operating incomes on average appear to have declined as a result of the post 1933 programs. The question is, was the increase in capital gains and total returns concurrent with shifts in income, capital gains, and total return skewness to the right sufficient to compensate producers for the lower income stream? While the evidence is not conclusive, these results suggest that the answer is yes: five of nine elements affecting expected producers' utility were improved, three were essentially unchanged and only one

decreased. In essence, it appears that the significant impact of these programs on risk reduction (shifting skewness to the right) encourages the asset and product markets to shift the distribution of total returns toward asset appreciation rather than income enhancement. This is to say, risk-reduction policies are differentially beneficial to asset owners.

Finally, caution must be exercised in the interpretation of these results. First, the pre and post 1933 period data is characterized by some dramatic economic events and differing sample sizes. Secondly, other factors, such as changing preferences of investors, may also have contributed to the observed changes in the distribution of returns to farm assets.

REFERENCES

Anderson, Jack R., Dillon, John L., and Hardaker, Brian. Agricultural Decision Analysis. Ames, Iowa. The Iowa State University Press, 1980.

Arditti, F. "Risk and the Required Return on Equity," Journal of Finance, 1986.

Arditti, F. and Hain Levy. "Portfolio Efficiency Analysis in Three Moments: The Multiperiod Case," Journal of Finance. Vol XXX, No. 3, June 1985.

Arrow, K. "Essays in the Theory of Risk-Bearing," Markham Publishing Co. 1971.

Melichar, Emanuel. Division of Research and Statistics, Board of Governors of the Federal Reserve System. Agricultural Finance Databook. Washington, D.C. June 1986.

Melichar, Emanuel. Farm Wealth: Origins, Impact, and Implications for Public Policy. A.E. Res. 83-40, Ithaca, New York. Cornell University, 1984.

Phipps, Tim. Farm Policy and Asset Returns in U.S. Agriculture. Working Paper at the Resources for the Future, National Center for Food and Agricultural Policy, Washington D.C. July 1985.