THE EFFECT OF RESOURCE INVESTMENT PROGRAMS ON AGRICULTURAL LABOR EMPLOYMENT AND FARM NUMBERS*

James C. Cato and B. R. Eddleman

Investments in natural resources usually are for the expressed purposes of conserving, developing, or managing the nation's supply of soil, water, timber, minerals, and marine resources. Many public investment programs in natural resources have also contained explicit development objectives. Any explanation of employment and income changes occurring within a region requires analysis of many interacting variables because the effects of natural resource investments may be masked by counteractions.

Changes in investment levels that shift the supplies of critical resources often occur concurrently with changes in the demands for products, supplies of other resources, firm production possibilities, and the number of firms. An important element is the consideration of how equilibration in product and factor markets is affected by programs designed to change the supplies of resources and, in turn, how changes in product and factor prices affect the level of output, resource employment and income within the recipient region. Differences among regions also need to be considered. These differences could exist in either the resource base or industrial structure. Knowledge concerning the relationships between natural resource investment and the other important stimuli and changes in employment is vital for any assessment of priorities among investment alternatives.

THEORETICAL MODEL

Tolley and Schrimper [1] developed a model to explain the rate of change in farm numbers. That is, farm number changes as well as changes in the exogenous variables were measured as percentage changes from a common temporal base. Using the Tolley-Schrimper model, Eddleman [2] developed a model to explain the rate of change in employment. The general regional model used for this paper consists of three basic types of components.[1] These are (1) product supplies and factor demands for all firms in individual types of industries, (2) aggregate product demand and factor supply functions, and (3) the number of firms in each industry. The theoretical model was developed to examine temporal changes in employment as the result of changes in exogenous shifters that affect labor employment. Variables were selected that represent each type of shifter.

The two-equation model used in this paper was developed from the more general model to explain simultaneously the absolute changes in both agricultural employment and farm numbers. The first equation of the model expresses changes in agricultural employment as a function of exogenous changes in product demand (agricultural product price), factor price or prices of factors having perfectly elastic supplies (agricultural wage rate), factor supply or shifters of the supply of factors assumed to have other than perfectly elastic supply functions for the region (investments in education, crop allotments, and projects of the Corps of Engineers, Soil Conservation Service, Agricultural Stabilization and Conservation Service, and Farmers Home Administration), shifters of firm production

James C. Cato is assistant professor of food and resource economics and B. R. Eddleman is director of the Center for Rural Development at the University of Florida.

*This research was supported in part by the Soil Conservation Service and Economic Research Service, U.S. Dept. of Agriculture. Florida Agricultural Experiment Station Journal Series Number 5438.

[1] The complete model is presented in Cato's Ph.D. thesis [3] along with empirical analyses for several other types of industries.

possibilities (agricultural technology), and changes in the number of farms. The second equation of the model expresses changes in the number of farms as a function of these same exogenous variables and changes in exogenous shifters of farm operator supply functions (agricultural wage opportunity, agricultural employment opportunity and farm operator age).

STUDY AREA

The four-state region of Mississippi, Alabama, Georgia, and Florida was chosen as the study area. The area was divided into two groups of homogeneous sub-areas containing 91 urban-oriented counties and 284 nonurban-oriented counties. Discriminant analysis and judgments of research scientists in the four states were used in the division process.

EMPIRICAL RESULTS

A two-equation model was estimated for all 375 counties (1.1 and 1.2), the urban-oriented counties (2.1 and 2.2), and the nonurban-oriented counties (3.1 and 3.2).[2] Counties were used as units of observation. Trends were downward during 1960 to 1970 in both the number of agricultural employees and the number of farms. Each model contains the same variables to represent variables in the theoretical model. Nonsignificant variables were retained so that equations could be compared for the different groupings. Improvement in the degrees of freedom also would have been minimal from variable elimination since the degrees of freedom were large.

All counties

$$(1.1)\ E = -8.69 - .148\ X_1 - .003\ X_2 - .074\ X_3 \quad (.291)\ (.004)\ (.100)$$
$$- .567\ X_4 - .053\ X_5 + .158\ X_6 \quad (.095)\ (.031)\ (.075)$$
$$+2.448\ PP - .007\ FP + 1.918\ Z + .801\ N \quad (3.903)\ (.009)\ (1.418)\ (.125)$$
$$+ 297.410\ GRP \text{ and} \quad (58.270)$$

$$(1.2)\ N = 14.63 + .206^{*}\ X_1 - .001\ X_2 + .031\ X_3 \quad (.107)\ (.001)\ (.031)$$
$$- .388^{***}\ X_4 - .060^{***}\ X_5 \quad (.028)\ (.011)$$
$$+.076^{***} X_6 + 7.433^{***}\ PP - .003\ FP \quad (.027)\ (1.379)\ (.003)$$
$$- 1.021^{*}\ Z - 1.168\ WW - .419\ WE \quad (.540)\ (2.606)\ (1.011)$$
$$+1.605^{***}\ WA + 29.520\ GRP \quad (.074)\ (23.480)\ \ R^2 = .82$$

where:

- E = Change in county's agricultural employment for the period 1960-1970.
- X_1 = Change in federal and state expenditures per pupil for primary and secondary education in the county during the period 1960-1970.
- X_2 = Change in total construction expenditures in water development projects in the county in thousands of dollars by the Corps of Engineers during the period 1960-1970.[3]
- X_3 = Change in total construction expenditures in the PL-566 Small Watershed Program in the county in thousands of dollars by the Soil Conservation Service during the period 1960-1970.[3]
- X_4 = Change in total investment in the Agricultural Conservation Program (renamed the Rural Environmental Assistance Program in 1971) in the county in thousands of dollars by the Agricultural Stabilization and Conservation Service during the period 1960-1970.[3]

[2] Equations 1.1, 2.1, and 3.1 were estimated with two-stage least squares so probability levels of significance are not attached to the coefficients. Figures in parentheses for these equations are asymptotic standard errors. Equations 1.2, 2.2, and 3.2 were estimated with ordinary least squares. Standard errors are shown in parentheses. Significance levels are: * 10 percent, ** 5 percent, *** 1 percent.

The derived reduced form equations are not presented in this paper. The coefficient of determination does not represent a valid measure in those equations estimated with two-stage least squares.

[3] This investment variable was defined as the "change" in total investment in each county for the period 1960 to 1970. Each observation was actually the sum of annual investments in each county from 1960 to 1970. The definition is not intended to be interpreted as annual investment in 1970 less annual investment in 1960.

X_5 = Change in total loans and grants for community water and sewer systems and waste disposal systems in the county in thousands of dollars made by the Farmers Home Administration during the period 1960-1970.[3]

X_6 = Change in acreage of allotment crops due to reduction in allotments between 1959 and 1969 weighted by the proportion of the total value of the allotment crop to total value of crops and livestock in the county in 1959.

PP = Change in price index of agricultural commodity groups during the period 1959-1961 to 1969-1971 weighted by the proportion of the value of the commodity group to the total value of crops and livestock in the county in 1959.

FP = Change in the average annual wage per hired farm worker in the county during the period 1959-1969.

Z = Change in the Southeast index of agricultural output per man-hour for commodity groups during the period 1959-1961 to 1969-1971 weighted by the proportion of the value of the commodity group to total value of crops and livestock in the county in 1959.

GRP = Intercept shifter dummy variable with GRP = 1 when urban-oriented county and = 0 when rural-oriented county

N = Change in the number of farms in the county during the period 1959-1969.

WW = Change in total annual nonagricultural wage payments in the county during the period 1960-1970 per agricultural employee in 1960.

WE = Change in total nonagricultural employment in the county during the period 1960-1970 per agricultural employee in 1960.

WA = Change in the number of farm operators who were 55 or more years of age in the county during the period 1959-1969.

Urban-oriented counties

$$(2.1)\ E = 268.80 + .888\ X_1 - .006\ X_2 + .339\ X_3 - .841\ X_4 - .068\ X_5 + .184\ X_6 - 14.483\ PP + .034\ FP - 1.121\ Z + .070\ N \text{ and}$$
(.832) (.010) (.219) (.211) (.060) (.338) (9.598) (.043) (3.252) (.250)

$$(2.2)\ N = -78.21 + .399^{**}\ X_1 + .002\ X_2 + .080^{*}\ X_3 - .248^{***}\ X_4 - .031^{**}\ X_5 + .058\ X_6 + 4.935^{**}\ PP + .013\ FP - 1.136\ Z - .372\ WW + .135\ WE + 1.911^{***}\ WA.$$
(.162) (.002) (.043) (.043) (.012) (.069) (1.949) (.009) (.692) (2.529) (.782) (.097)

$R^2 = .93$

Nonurban-oriented counties

$$(3.1)\ E = -470.60 - .315\ X_1 + .001\ X_2 - .147\ X_3 - .266\ X_4 + .046\ X_5 + .082\ X_6 + 4.284\ PP - .006\ FP + 7.052\ Z + 1.364\ N \text{ and}$$
(.252) (.003) (.096) (.094) (.033) (.060) (3.591) (.007) (1.498) (.132)

$$(3.2)\ N = 58.59 + .125\ X_1 - .002\ X_2 - .011\ X_3 - .415^{***}\ X_4 - .080^{***}\ X_5 + .078^{***}\ X_6 + 8.590^{***}\ PP + .002\ FP - 1.480^{*}\ Z + .176\ WW + 9.098^{**}\ WE + 1.403^{***}\ WA.$$
(.131) (.002) (.048) (.035) (.014) (.029) (1.743) (.004) (.797) (4.139) (4.703) (.0947)

$R^2 = .80$

Exogenous Shifters

Education. Changes in per capita education

expenditures were not very important in affecting agricultural employment changes. A more skilled work force resulting from higher education levels would be expected to migrate to urban areas to realize their employment potential. This migration effect is indicated by negative coefficients for the all-county group and the nonurban county group. Somewhat different results were obtained for changes in the number of farm firms. Increases in per capita education expenditures were significantly associated with increases in farm numbers for both the urban group and all-county group. Higher educational attainments of potential farm operators enabled them to take advantage of alternative employment opportunities. The strong positive relationship for the urban counties indicates that higher educational expenditures in the urban counties coupled with greater nonfarm employment opportunities encouraged an increase in the number of rural residences classified as part-time farms.

Corps of Engineers. Investments by the Corps of Engineers showed a negative effect on agricultural employment changes for all groups except the nonurban group. A major portion of investments by the Corps in the four-state study area was for flood control. Effective flood control makes more land available for agricultural use. Expansion of farm size encourages the use of more efficient laborsaving techniques with resultant declines in agricultural employment. Displacement of some existing farms through consolidation also contributed to employment declines. Although it appears that this occurred for the two groups having negative coefficients, the effect on farm numbers was not statistically significant for any of the three groups. A priori expectations were for negative signs for this coefficient. Although coefficients were nonsignificant, most signs were consistent with expectations. This suggests that even though some variation remains unexplained, the movement is in the expected direction. In general, similar observations can be made with the other nonsignificant coefficients.

Examination of the geographical pattern of Corps investments may indicate why positive coefficients occurred for employment in the nonurban groups and for farm number changes in the urban group. A large proportion of these investments occurred in the delta area of Mississippi and in east-central Alabama which are predominantly nonurban areas. Large numbers of small farms have been predominant in these areas. Flood protection provided by Corps projects made available new land suitable for mechanized agriculture. This, apparently, created a movement to larger farms through both the effect of entry of new farm operators and farm consolidation. It follows that increased agricultural activity which may have resulted from the projects could have contributed to fewer farms employing a larger number of agricultural workers in these two areas.

Small Watershed Program. Investments by the Soil Conservation Service in the Public Law 566 Small Watershed Program yielded average investment levels per county that were fairly uniform in all groups. This program also showed the lowest average level of investment per county of any of the land- or water-related investments. The nonurban and all-counties groups both exhibited negative effects on employment with the standard error having a smaller value than its associated regression coefficient for the nonurban equation. Negative effects for these two groups could imply that farm expansion to larger and more efficient units occurred in these areas with a concurrent reduction in agricultural employment. A positive coefficient, but with a standard error slightly smaller than its value, resulted for the urban-oriented counties.

Positive coefficients were observed in the farm numbers equation for coefficients in the urban group and the all-county group. The urban group coefficient demonstrated low statistical significance. Since one of the major purposes of this investment program is to prevent floodwater damage, it appears that previously flood-prone land became available for farming operations in these groups. Declines in farm numbers occurred in the nonurban group as a result of farm size expansion and consolidation. Some of the lagged effects of flood control structures and waterways have not been measured over the 10-year period since investments in the actual construction of some projects began late in the study period. In these cases the impact on agricultural employment and farm numbers had not yet occurred.

Agricultural Conservation Program. Program investments in the Agricultural Conservation Program (ACP) provided the most uniform coverage over the four-state area of any of the investment programs analyzed. Only one county did not receive an investment, and the average investment per county did not vary greatly among the three groups. All three groups demonstrated a negative effect on changes in employment. Since this is a cost-sharing program with farmers and is intended to introduce various conservation measures, the negative effect on employment was expected, indicating that measures taken with regard to land stabilization, resource

improvement, and land retirement enabled the use of laborsaving production practices. The effect on farm numbers was also negative in each group with all groups having a high level of statistical significance. This may indicate that the more responsive operators of larger farms have taken advantage of the cost-sharing program to improve their production practices.

Simple correlation coefficients ranging from -.64 to -.68 existed between this variable and farm numbers for all three county groupings. A coefficient of -.56 also resulted with the agricultural wage opportunity variable for the nonurban equation. These coefficients should cause no estimation problem. Most coefficients for all variables and equations were below .5 with the majority less than .3. Multicollinearity was not an apparent problem.

Water and Sewer Programs. Investments by the Farmers Home Administration (FmHA) for community water and sewer programs represented loans and grants made during the time period under study. Additional grants for the projects made by other federal agencies were included, although data sources were inadequate to determine precisely the year of expenditure. Loans and grants made during the period resulted in negative employment effects for all counties and the urban group. Investments in this program were fairly widespread over the four-state region. Most program investments were in the nonurban county group which had a positive coefficient. Availability by community water and sewer facilities in rural communities may have resulted in attracting agriculturally related firms which stimulated agricultural output and agricultural employment. A significant level of association was found for changes in the number of farms in all areas. The effects were negative for each group. Improvement of water and sewer facilities in local towns and communities often result in an expansion of nonfarm employment alternatives for farm operators and their families and a subsequent movement away from the farm.

Allotment. Allotment reductions and agricultural employment moved in the same direction for each of the three groups. Positive coefficients for this variable indicate movement in a general downward direction, a result consistent with a priori expectations. Small standard errors were associated with the coefficients for the all-county group and the nonurban group. Allotment reductions were effective in reducing agricultural employment. Positive coefficients also were obtained for the allotment variable in the equations for changes in farm numbers. Significant levels of association occurred for both the all-county group and the nonurban group. These two groups are heavily weighted with nonurban counties where the major proportion of allotment reductions occurred.

Product price. Changes in product demand as measured by changes in the index of agricultural product prices were important in explaining agricultural employment changes. Increases in product prices resulted in increased agricultural employment in all groups except the urban group. Product price effects on farm numbers were positive in all three groups. The effect on farm numbers was important as indicated by the high level of statistical significance of the coefficients. Increases in product prices tend to reduce the rate of farm firm disappearance and reduce consolidation effects, since they are very important to small marginal farmers in maintaining their net income levels. The importance of the product demand variable points out the responsiveness of agricultural farm numbers to product price changes.

Factor prices. Changes in factor prices as indicated by increases in the agricultural hired wage rate did not seem important in influencing employment changes since the standard error was slightly larger than the coefficient for all three equations. Mechanization is the normal substitute for labor employment in agriculture. Increased mechanization is normally associated with increases in farm size and reductions in farm numbers. These expected results were not substantiated in the farm number equations.

Technology. Output per man-hour increases for agriculture was positively related to agricultural employment changes for all counties and the nonurban group. These effects appear to be important as examination of the standard errors for these two coefficients reveals. This most likely resulted from large output increases which in turn increased the demand for agricultural labor, particularly in the production of labor intensive commodities. An opposite effect occurred with respect to farm labor number changes. Technology advancements which increased output per man-hour caused a decline in farm numbers for all three groups. However, low levels of statistical significance were obtained. Output per man-hour increases would be expected to reduce farm numbers through two effects. First, larger farms are most able to take advantage of technological innovations and increase both output and farm size. Second, since the demand for agricultural commodities is inelastic, output increases by the larger producers may reduce immediate prices to such a degree that smaller farms are forced out of business with the resulting effect

that they are consolidated into larger farm units.

Farm numbers. Changes in the number of farms seemed important in influencing agricultural employment in both the nonurban counties and all counties since the standard error was much smaller than the regression coefficient for this variable. Decreases in farm numbers caused a decrease in employment.

Wage opportunity. Increases in the opportunity cost of remaining as a farm operator should influence operators making a low return on their farming investment to seek a higher income-earning alternative. Changes in nonagricultural wages were negatively related to farm number changes for all groups except the nonurban group. The positive effect for the nonurban group may be explained by the relative lack of alternative employment opportunities in the nonurban areas. In each group the coefficients for the wage opportunity variable were not statistically significant.

Employment opportunity. Changes in nonagricultural employment opportunities were positively related to changes in farm numbers in both the urban and nonurban groups. Negative effects on farm numbers were observed for the group containing all counties. The nonurban group coefficient was the only one that was statistically significant. These results indicate that increases in part-time farming operations have been associated with expansion of nonfarm employment opportunities.

Farm operator age. Changes in the ages of farm operators were significantly associated with changes in the number of farms. As deaths and/or retirements reduce the number of older farm operators, decreases will occur in the number of farms. The results indicate that farm consolidation occurred rather than operator replacement by younger farm operators.

Group differences. A zero-one intercept shifter was included in the model for all counties to determine if differences existed between the urban and nonurban counties. The nonurban group was used as the base group. The coefficient for group differences was not statistically significant for the farm number equation. However, the coefficient for this variable in the agricultural employment change equation was about five times the magnitude of its standard error.

CONCLUSIONS

The effects of changes in the exogenous variables on agricultural employment and farm numbers differed among the individual county groups considered. These variations indicate that changes in the exogenous shifters may result in different agricultural employment and farm number effects, depending on the type of shifter and the resource base and industry structure of the geographical area receiving the investments. Some resource investments were consistent in their effects among all groups, while others were important only in an urban or a nonurban location.

Certain implications became apparent from this research. Increases in ACP payments, FmHA loans and grants for water and sewer systems, and output per man-hour seemed to be important in influencing farm consolidation which resulted in reduced farm numbers and agricultural employment. Increases in education expenditures by state and federal governments seemed important in influencing positive changes in farm numbers and employment only in the urban-oriented counties. Decreases in crop allotments and changes in the number of older farm operators seemed important in reducing both the number of farms and agricultural employment in the nonurban-oriented counties, and in reducing the number of farms in the urban-oriented counties. None of the other shifters of operator supplies seemed important in influencing employment and farm number changes, except for changes in nonagricultural employment opportunities in nonurban counties.

Decreases in agricultural product prices were found to be consistently influencing the decline in farm numbers in both urban and nonurban counties. Water resource investments during the construction phases of projects were not influential in agricultural employment or farm numbers. It is possible that sufficient time has not elapsed to measure adequately the employment and farm number response in agriculture to water resource investments.

REFERENCES

[1] Tolley, G. S., and R. A. Schrimper. "Feasible Ways for Relating the Micro and Macro." *Price and Income Policies.* Agricultural Policy Institute Publication No. 17, North Carolina State University, pp. 141-152, April 1965.

[2] Eddleman, B. R. "Estimating the Effects of Resource Development Programs on Regional Employment." *American Journal of Agricultural Economics,* Vol. 51, No. 5, pp. 1434 - 1441, Dec. 1969.

[3] Cato, James Carey. "The Effect of Resource Investment Programs on Labor Employment." Unpublished Ph.D. thesis, University of Florida, Dec. 1973.