Education

1976

The Demand of Farm Families for the Quantity and Quality of Schooling for their Children in the United States

Mark R. Rosenzweig*

For presentation at the Agricultural Economics Association meetings, Pennsylvania State University, August 16, 1976

(Revised)

In recent years economists have become increasingly interested in the roles of education in the agricultural sector. The pioneering studies by Gisser (1965) and Welch (1970) on the relationship between education and farm employment and agricultrual production and the vast emerging literature on the importance of education in a dynamic context, summarized by Schultz, are notable examples. Economists have also been studying the determination of the level of human capital acquired by individuals as well as the returns to various dimensions of schooling which go beyond the most commonly utilized measure -- years of school completed. These latter studies, however, have primarily focussed on the non-agricultural population. In this paper an attempt is made to formulate and test on U.S. data pertaining to the early 1960s a model of the farm family which 1) integrates the schooling of farm children among the set of household production and consumption decisions and which 2) explicitly accommodates the roles of education in agricultural production while distinguishing between the quantity of schooling and school quality. It will be shown that this latter distinction is particularly important in the farm population.

Theoretical Framework

Two principal characteristics of farm families that differentiate them from their non-farm counterparts are that school-age farm children can readily participate in farm production and thus contribute to family income and that the level of schooling a child acquires directly influences the farm family's income to the extent that schooling enhances farm productivity. Moreover, schooling plays an important role in the migration of children from the family farm. In describing the demand for the schooling of children by farm parents in an optimizing framework, three functions are central to the analysis.[1] The farm family is assumed to maximize an intertemporal utility function whose arguments are the per-period flow of services from purchased commodities and the accumulated human capital of the farm children (child quality).

Parents can augment child quality in each period according to a schooling production function, which describes the relationships between gross investment in child human capital per period and the schooling inputs -- the time children spend in school

(measured in years, days, hours, etc.) -- school quantity -- and the total amount of school-related goods and services purchased in the market (teachers, books and other classroom materials) -- school quality. For simplicity it is assumed that the farm family is in the stage of its life cycle such that the total number of children, and hence the maximum amount of child time available for schooling each period, is predetermined and that all child investment occurs in school. Thus the possible interactions between decisions concerning the quantity of children and child schooling (quality) is excluded from the analysis as well as the important roles parents play in the pre-school years, as documented by Leibowitz and others.[2] To capture the latter in part, we shall assume that the educational level of the farm parents enhances the productivity of child time in school as well as the productivity of school-oriented expenditures.

The third function describes the intertemporal production possibilities of the farm family, assumed to live on a farm of pre-determined economic capacity as measured by the value of the farm assets owned by the farmer. Within the vector of farm production inputs are assumed to be the time of the ("raw") farm children devoted to farm production in the schooling periods and the services of the human capital of "skilled" farm children in the post-school periods. Child human capital is thus a production as well as a consumption commodity. A characteristic of schooling investment, however, is that it increases earnings capacities in both farming and other activities, thus enhancing the prospect of farm children obtaining non-farm jobs. The willingness of farm parents to finance investment in general skills thus may in part be explained by the declining nature of farming as an occupation -- farm parents anticipated that many of their children would have to leave agriculture and saw schooling as a means of increasing their welfare in the non-farm sector.

The optimal levels of school quantity and quality are determined where marginal costs equal marginal returns. The returns to, in contrast to the marginal costs of, both schooling inputs are similar -- the marginal product of the input in the schooling function multiplied by the sum of the marginal pecuniary and non-pecuniary benefits from schooling, the values of marginal product and marginal utility of child human

capital. The marginal cost of school quality is the market-determined price of the school quality inputs.

The cost of an additional unit of the quantity of schooling, the transfer of a unit of child time from farm to human capital production in school, however, is equal to the marginal value product of "raw" child labor in agricultural production. Thus the shadow price of the quantity of schooling in agriculture is dependent upon the allocation of production and consumption inputs by the farm family, while the cost of a unit of school quality is not.

To illustrate the importance of the differential shadow prices of school quantity and quality in agriculture as well as the consumption and production aspects of education, consider the influence on the demand for school quantity and quality of an increment in the economic capacity of the farm (value). The analysis suggests that increases in farm value will unambiguously raise the demand for school quality as long as child quality is a non-inferior consumption commodity. An increase in farm capacity will thus lead to a higher demand for schooling and therefore for the quality input because it both raises farm income and the marginal value product of "skilled" farm children.

The relationship between farm value and school quantity is not unambiguous, however. While the effects of an increase in farm productive capacity on the returns from the school quantity and quality inputs are similar, unlike in the former case the shadow price of school quantity also rises as increases in farm value raise the marginal value product of "raw" labor and thus the opportunity cost of time in school. Thus the analytical framework suggests that farms with greater potential productivity will demand higher levels of schooling but will also tend to substitute school quality for quantity -- the (positive) effect of farm value on school quality will be stronger than its effect on school quantity. Indeed, if the substitutibility between productive assets and unskilled child labor is high, a negative relationship between the quantity of schooling and farm value may be observed.

A general implication of the analytical framework is that parameters related to agricultural production, such as the cost of production inputs, the quality of land and the available technology will importantly (and differentially) influence the demand for the quantity and quality of schooling in agricultural populations. In addition if mature children participate in the allocative decisions on the farm we would expect the rate of technological change to increase the demand for child schooling if the farm parents perceive the usefulness of education in the adoption and use of new technologies. Farmers may also be sensitive to variables affecting the off-farm employment prospects of their offspring, since these variables will influence the expected pecuniary returns from school investment as well as the welfare of their migrant children.

Empirical Analysis

a. The Data

Demand equations for school quantity and quality relating the level of the two school inputs to the exogenous production and consumption variables discussed can be derived from the theoretical framework. To estimate these equations, U.S. state cross-sectional data are utilized, extracted mainly from 1960 census sources.[3] The two dependent variables representing respectively the quantity and quality of schooling are the natural logarithim of the non enrollment rate of rural farm teen-agers aged 15-18[4] and instructional expenditures per enrolled child in rural school districts and counties.

While micro data may be more appropriate for testing models of household behavior, data availability preclude the use of less aggregative variables. However, because expenditures on education are implemented for the most part by governmental units in the United States, the assumption of the theoretical analysis that the levels of school quantity and quality are jointly determined at the household level may be unrealistic, as all households, including those in other geographical areas and those without school age-children, participate collectively in the budgetary process. In considering the aggregate demand for school quantity and quality, the population demographic composition and fiscal structure

must therefore be taken into account as well as the possibility that the two aggregate schooling variables may interact. Accordingly, both ordinary least squares and two-stage least squares estimating procedures are utilized.[5]

Of the independent variables, listed with their means and standard deviations in Table 1, those central to the analysis are farm value, which represents potential agricultural income, total non-farm income, and a measure of total factor productivity change, constructed from the indices developed by Evenson and Landau and used as a proxy for the degree of disequilibrium. The wage rate of agricultural labor is used to represent the price of one farm input which varies significantly in the cross-section. The educational levels of adult farm males and females are included to capture schooling preferences and child schooling- adult schooling interactions. Representing the set of possible variables measuring non-farm employment prospects for farm children is the unemployment rate of 20-25 year old urban whites.

The state minimum lawful school-leaving age, the percent of non-white farm operators, the ratio of the school-age (5-18) to total population, the proportion of the school population of high school age, and the proportion of the local governmental budgets financed by superior governmental agencies are also added to the data set as control variables, the latter three to take into account the public expenditure aspect of the school quality proxy.

b. Results

The results obtained using ordinary least-squares (OLS) to estimate the enrollment equation, excluding the demographic variables, are presented in column 1 of Table 2. The independent variables together account for 84 percent (adjusted) of the interstate variation in the school enrollment rates of farm teen-agers. More importantly, all of the variables derived directly from the theory are statistically significant, indicating that parameters relating to agricultural production are significant determinants of farm school enrollment.

The negative sign of the coefficient of the farm value variable supports the hypothesis that the opportunity cost of school quantity, the marginal value product of teen-age children in farm production, is a significant deterrant to school attainment in the farm population. Moreover, the farm value coefficient cannot be interpreted as evidence of the inferiority of child quality, as the coefficient of non-farm income, which should provide a lower-bound estimate of the pure income effect, is significantly greater than zero.[6]

The positive coefficient of the productivity change variable suggests that farmers perceive that the returns to schooling are higher in settings where the pace of technological change is more rapid; the coefficient estimate indicates that a 10 percent increase in the rate of productivity change would be associated with a rise in the enrollment rate of farm teen-agers of 5 percent. However, an obvious plausible alternative hypothesis also consistent with this finding is that a high rate of technological change in agriculture may be associated with a lower demand for relatively unskilled labor, such as that of school-age children, since such technical change is likely to make the production process, in the U.S. context, more capital intensive.

The positive and significant coefficient of the wage rate of agricultural laborers suggests both that educated farm children and hired laborers are substitutes in farm production and/or that higher agricultural wage rates enable farm children to finance their schooling by working as unskilled paid laborers both inside and outside the agricultural sector during school vacations.

The coefficients of both schooling attainment variables exhibit positive signs, but only that of the schooling level of adult farm males is statistically significant, reflecting, perhaps, the predominance of males in agricultural production. Neither of the coefficients of the race or compulsory schooling variables attain statistical significance, however, suggesting respectively that the behavior of farm non-whites and whites do not differ with respect to school enrollment and that state compulsory schooling laws do

not significantly increase the school enrollment rates of farm teen-agers.

If at the aggregate level interactions between school quantity and quality are important, the specification in column 1 is not the complete reduced-form as it omits some of the exogenous variables influencing the supply of school quality. To test for the dependence of school enrollment on aggregate school expenditures in the farm population the school quality variable is added to the enrollment equation. However, because teen-age school enrollment may possibly influence total per-pupil public school expenditures, as found by Gustman and Pidot, two-stage least squares (2SLS) is used to obtain parameter estimates which are consistent. These estimates, displayed in column 2 of Table 1, do not differ appreciably in either sign or significance from those obtained using OLS techniques and excluding the exogenous influence of school expenditure except that the coefficient of the urban unemployment rate becomes statistically significant (10 percent level, two-tailed test), suggesting that decreases in employment opportunities in the non-agricultural sector significantly reduce the school enrollment rates of farm teen-agers. The school expenditure coefficient does not attain statistical significance.

Column 3 of Table 2 displays the OLS school expenditure coefficient estimates.[7] The set of independent variables explains approximately 72 percent (adjusted) of the interstate variance of rural per-pupil instructional expenditures although only the coefficients of farm value and the agricultural wage, of the variables implicated in the theoretical analysis, attain statistical significance.[8] The sign of the latter, consistent with that in the enrollment equation, suggests that the demand for both rural-farm schooling inputs, school quantity and quality, is greater in areas where agricultural wage rates are high.

The most important result, however, is the positive farm value coefficient, which indicates that a rise in farm value of 10 percent results in an increase in rural-farm school expenditure of slightly over one precent. In conjunction with the results displayed in columns 1 and 2, this finding supports the hypothesis that increases in child farm

productivity lead to the substitution of school quality for quantity in the farm population. However, the relative magnitudes of the mean elasticity estimates of farm value on the enrollment and school expenditure variables (-.2 and +1.0 respectively) and the evidence obtained by Johnson and Stafford and others that the rates of return to school attainment (quantity) and quality are approximately equal, suggest that increases in farm value on net raise the overall quality level of farm children despite their attenuating effects on school enrollment. Given that child human capital is non-inferior in an economic sense, this latter finding is also consistent with the theoretical analysis, in which the demand for school quantity and quality are derived from the demand for child quality.

Conclusion

The empirical results obtained based on U.S. state data generally support the theoretical framework. As a consequence of farm children's participation in farm production their marginal value product represents an important component of the cost of school quantity in the farm population such that increases in farm potential productivity reduce the enrollment rates of farm teen-agers. At the same time, however, rural-farm school expenditures, which are unaffected by this opportunity cost, tend to rise with increases in potential farm productivity such that farm child quality on net is enhanced.

Evidence was also obtained that the quantity of schooling in agriculture responds to both agricultural production and non-farm parameters associated with the returns to schooling. A strong positive correlation was found between the school enrollment rates of farm teen-agers and the rate of agricultural productivity change, a result consistent with the view that the returns to education in agriculture may be higher in situations characterized by disequilibrium because schooling increases the efficiency of technological adaptation. More research is needed, however, particularly on the direct contribution of the farm parents to the education of their children prior to, during, and after the schooling years, on the interplay of family size and education decisions, and on the the transfer of pecuniary assets from parents to children.

References

Edwards, Linda N. "The Economics of Schooling Decisions: Teenage Enrollment Rates," Journal of Human Resources 10 (Spring 1975): 155-173.

Evenson, Robert and D. Landau. "A Note on Productivity Growth in U.S. Agriculture." Mimeographed, New Haven, Ct: Yale University, 1973.

Gisser, M. "Schooling and the Farm Problem," Econometrica 33 (July 1965): 582-592.

Gustman, Alan and G.B. Pidot, Jr. "Interactions Between Educational Spending and Student Enrollment." Journal of Human Resources 8 (Winter 1973): 3-23.

Johnson, George and F.P. Stafford. "Social Returns to Quantity and Quality of Schooling." Journal of Human Resources 8 (Spring 1973): 139-55.

Leibowitz, Arleen. "Education and Home Production." American Economic Review 64 (May 1974): 243-250.

Rosenzweig, Mark R. "The Economic Determinants of School Enrollment and Expenditure in U.S. Agriculture." Yale Economic Growth Center Discussion Paper No. 218, 1973.

Rosenzweig, Mark R. "The Demand for Children in Farm Households," Journal of Political Economy, forthcoming, December 1976b.

Rosenzweig, Mark R. "Farm Family Schooling Decisions: Determinants of the Quantity and Quality of Education in Agricultural Populations." Journal of Human Resources, winter forthcoming, 1976a.

Schultz, Theodore W. "The Value of the Ability to Deal with Disequilibria." Journal of Economic Literature 8 (1975): 827-846.

Welch, Finis. "Eduation in Production." Journal of Political Economy 78 (January 1970): 35-59.

Footnotes

*Assistant Professor, Department of Economics, Yale University. I am grateful to T.W. Schultz for some perceptive comments on an earlier draft. Research support was provided by NICHD grant 1ROI HD 08687-01.

1. A formal two-period version of the model discussed here is found in Rosenzweig 1976a.
2. For an analysis of child quantity decisions by farm families, see Rosenzweig 1976b.
3. A detailed description of the variables employed and their sources are contained in Rosenzweig 1973 and 1976a.
4. For the rationale regarding the form of the enrollment variable, see Edwards.
5. Various tests for the existence of heteroscedasticity were all rejected and thus the regression equations are unweighted.
6. One component of off-farm income may be the earnings of children, which would impart a negative bias to the off-farm income coefficient in the enrollment equation.
7. Because no identifying restrictions based on the available data were considered plausible, it was not possible to estimate the impact of farm school enrollment rates on rural school expenditures using 2SLS.
8. The roles of the demographic and fiscal variables are discussed in detail in Rosenzweig 1976a.

Table 1- Variable Means and Standard Deviations: U.S. Rural Farm Population 1960

Variable	Mean	Standard Deviation
School enrollment rate of farm population 15-18	0.802	0.076
Per-pupil instructional expenditures in rural schools	168.2	44.07
Farm value	23955	16650
Non-farm income (1964)	907.0	330.4
Percent (+100) total factor productivity change (1950-59)	113.2	9.45
Hourly Agricultural Wage (annual average, 1954-1959)	0.73	0.17
Median years of schooling of farm males aged 35-44	10.0	1.82
Median years of schooling of farm females aged 35-44	11.0	1.49
Urban unemployment rate of white males aged 20-25	5.95	1.36
Percent of farm operators non-white aged 35-44	5.33	11.3
Minimum lawful school-leaving age	15.6	3.45
Percent of 5-18 farm population aged 15-18	31.1	2.80
Proportion of total farm population aged 5-18	0.263	0.022
Percent of local school budget locally financed	55.4	19.2

Notes: n = 44 states; Alaska, Hawaii, Connecticut, Rhode Island, Delaware, New Jersey excluded.

Table 2- School Enrollment and Expenditure Regression Coefficients: U.S. Rural Farm Population 1960

Independent Variable	Dependent Variable: School Enrollment[a]	School Enrollment	Per Pupil ($x10^2$) Instructional Expenditures
Farm value ($x10^{-3}$)	-.008 (3.97)	-.001 (2.18)	.095 (2.81)
Non-farm income ($x10^{-2}$)	.022 (2.24)	.028 (2.33)	1.42 (0.91)
Total factor productivity change (percent)	.005 (2.17)	.006 (2.31)	21.1 (0.59)
Agricultural wage	1.00 (3.60)	.609 (1.17)	11434.1 (2.32)
Male schooling attainment (35-44)	.091 (3.07)	.071 (2.39)	219.5 (0.49)
Female schooling attainment (35-44)	.024 (0.49)	.008 (0.15)	205.7 (0.21)
Urban unemployment rate (20-25)	-.021 (1.24)	-.038 (1.49)	-184.9 (0.61)
Percent non-white farm operators (35-44)	-.002 (0.40)	-.008 (0.96)	105.4 (1.38)
Minimum lawful school-leaving age	.011 (0.11)	.008 (0.55)	216.2 (1.27)
Percentage of 5-18 pop. aged 15-18			-53937.5 (1.98)
Proportion of total pop. aged 5-18			716.1 (1.87)
Percentage of budget locally financed			-89.1 (2.18)
Instructional Expenditures per pupil ($x10^{-2}$)[b]		.004 (0.91)	
Constant	4.29 (4.22)	4.12 (4.21)	41820.6 (1.76)
Estimation technique	OLS	2SLS	OLS
R^2	.837		.716

Notes: n = 44 states; Alaska, Hawaii, Connecticut, Rhode Island, Delaware, New Jersey, excluded. t-values in parentheses.

[a] ln(1 - enrollment rate of farm 15-18 year olds); coefficient signs displayed are reversed.

[b] Endogenous variable.