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THE ECONOMIC DETERMINANTS OF SCHOOL ENROLLMENT AND EXPENDITURE IN U.S. AGRICULTURE

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Recent developments in the economic theory of household behavior[1] provide a useful framework for the study of the educational investment in children. While economists have in the past been concerned with the determinants of schooling and school expenditure[2], much of the previous empirical work has been characterized by a lack of attention to the economic structure of the family.[3] Moreover, most of the literature is concerned with behavior in urban rather than rural areas with some investigators, however, attempting to control for "rurality" by the use of a single control variable or intercept dummy. This technique has generally revealed significant, yet unexplained, differences in rural and urban behavior: Conlisk [1969] and Edwards [1971] concluded that, ceteris paribus, farm children have higher enrollment rates than non-farm children while DeTray [1973] found that farm families appear to spend more on education per enrolled child.

In this paper, the determinants of two parameters of child investment in an agricultural environment--school enrollment and expenditures--are analyzed within a modified household production framework in which education is treated as both a consumption and production good. In part I, a simple model of the farm family is formulated in which attempts are made to account for the complex economic structure of families in agriculture. The empirical analysis of part II derived from the theoretical discussion, based on U.S. state data, contains implications for the effects of agricultural technological change on the demand for rural schooling, the cost and returns of rural school consolidation, the interaction of school expenditures (quality) and enrollment, and the importance of compulsory schooling laws in rural areas.

I. Theoretical Framework

There are two principal characteristics of the farm population which necessitate a somewhat different theoretical framework than those utilized to analyze non-farm behavior: 1) all family members, including the children, may participate in income-generating activities--in farm production and 2) the dispersion of rural schools makes cost of schooling (travel) and the effects of school scale-economies of significant importance in child investment decisions. The significance of characteristic one is that decisions concerning the education of farm children may be influenced by conditions affecting farm production if children remain in the agricultural sector after finishing their formal schooling. Initially in this section it is assumed that no outmigration of children occurs. The relaxation of this assumption is discussed just prior to section II.

In order to formulate a model of farm family behavior which is tractable and which provides implications for the schooling components of child investment, it is assumed that the family is in a stage of its life-cycle such that the quantity of children has been determined, and thus fertility is exogenous in the model, and that the parental time components in child investment are relatively insignificant compared to the schooling inputs. The quality of children Q is thus assumed to be the product of the amount of schooling t (years of schooling, for instance) and of schooling expenditure X.

$$Q = tX \tag{1}$$

The total time of all children is equal to T, a function of the number of children (fixed), part of which ('raw' child labor) l may be allocated to farm production or to school, t. Both l and Q are inputs in the production function Γ, described in expression (2), which determines the agricultural

$$\Gamma = f(l, Q; edf, edm, \tau) \tag{2}$$

output of a farm of fixed size L.[4] Edf, edm, the schooling levels of the husband and wife, and τ, agricultural technological change, are "environmental" variables which influence the marginal products of raw and educated family labor. It is hypothesized that:

$$(\delta f/\delta Q)/\delta\tau > 0 \tag{3}$$

$$(\delta f/\delta l)/\delta\tau = 0 \tag{4}$$

These restrictions embody the "innovative ability" hypothesis of Welch (1970) that educated farm workers can more efficiently adopt new production techniques and is consistent with his finding that the returns to college-educated farm labor were higher in areas of more rapid technical progress. While the level of technology may affect the marginal products of all inputs (equally if Hicks-neutral), the rapidity with which technology changes is assumed to leave the marginal product of raw labor and other inputs unaffected.

The farm family is assumed to maximize its utility, given by function (5) which contains two arguments, child quality and S, a composite of all non-child-related commodities, and has the usual properties, subject to the constraint (6):

$$U(Q,S) \tag{5}$$

$$pf(1,Q;\ edF,\ edm,\ \tau) + V = S\pi_s + \pi_x X \tag{6}$$

income from farm production $p\Gamma$, where p is the price of agricultural output, and non-farm income V must just equal expenditures on S, $\pi_s S$, and on schooling, $\pi_x X$, where π_s and π_x are the relevant prices. Noting that $l = T - t - b$, where b is assumed to be the travel time to and from school, the Langrangian function may be written as:

$$\Lambda = u(tX,S) + \lambda[pf(T-t-b,\ tX;\ edf,\ edm,\ \tau) + V - S\pi_s - \pi_x X] \tag{7}$$

where t and X are assumed non-negative.

The Kuhn-Tucker conditions for determining the optimal amounts of school expenditures, time spent in school, and the amount of the commodity S are:

$$\frac{\delta\Lambda}{\delta t} = X\frac{\delta U}{\delta t} + p\lambda\left[\frac{-\delta f}{\delta(T-t-b)} + X\frac{\delta f}{\delta t}\right] \leq 0,\quad \frac{\delta\Lambda}{\delta t}t = 0,\quad t \geq 0 \tag{8}$$

$$\frac{\delta\Lambda}{\delta X} = t\frac{\delta U}{\delta X} + p\lambda\left[tp\frac{\delta f}{\delta X} - \pi_x\right] \leq 0,\quad \frac{\delta\Lambda}{\delta X}X = 0,\quad X \geq 0 \tag{9}$$

$$\frac{\delta\Lambda}{\delta S} = \frac{\delta U}{\delta S} - \lambda = 0 \tag{10}$$

$$\frac{\delta\Lambda}{\delta\lambda} = pf(T-t-b,\ tX;\ edf,\ edm,\ \tau) + V - S\pi_s - \pi_x X = 0 \tag{11}$$

If it is assumed that (7) has a regular local maximum where both t and $X > 0$, then conditions (8) and (9) may be rewritten:

$$X\left[\frac{1}{\lambda}\frac{\delta U}{\delta t} + p\frac{\delta f}{\delta t}\right] = p\frac{\delta f}{\delta(T-t-b)} \tag{12}$$

$$t\left[\frac{1}{\lambda}\frac{\delta U}{\delta X} + p\frac{\delta f}{\delta X}\right] = \pi_x \tag{13}$$

Expression (12) indicates that parents will "send" children to school up to the point where the values of the marginal utility and marginal product of schooling quantity just equal the opportunity cost of school attendance--the value of the marginal product of raw child labor. Similarly, from (13), the equality of the sum of the marginal values of utility and production of the expenditure component of child quality to the market price determines the optimal amount of school expenditure.

To derive some testable implications from the model, the total derivative of first-order conditions (8) - (11) is computed ($t, X > 0$ assumed satisfied).[5] The qualitative relationships between land size, school transportation time, technological change and the quantity of and expenditures on schooling can thus be ascertained.

Expression (14) is the compensated effect of an increase in land size L on the quantity of

$$\left(\frac{\delta t}{\delta L}\right)_{\bar{U}} = \frac{\lambda\left[\frac{\delta F}{\delta(T-t-b)\delta L} - X\frac{\delta f}{\delta t\delta L}\right]D_{11} + \lambda t\frac{\delta f}{\delta X\delta L}D_{12}}{D} \tag{14}$$

where $D < 0$, $D_{11} > 0$, $D_{12} \lesseqgtr 0$[6]

< 0 if $\frac{\delta f}{\delta t\delta L}$, $\frac{\delta f}{\delta X\delta L} \geq 0$

schooling and is unambiguously negative in sign if it is assumed that the complementarity between land and child quality is negligible. This result is intuitive; on farms with larger productive capacity the opportunity cost of schooling, the marginal value product of raw labor, is greater than on farms of lesser size. If farm size and the returns to child quality are unrelated there is more of an incentive to curtail schooling and to retain raw labor in production. The negative (compensated) substitution effect of land size on school expenditures, expression (15), is much weaker than

$$\left(\frac{\delta X}{\delta L}\right)_{\bar{U}} = \frac{\lambda\left[\frac{\delta f}{\delta(T-t-b)\delta L} - X\frac{\delta f}{\delta t \delta L}\right]D_{21} + \lambda t \frac{\delta f}{\delta X \delta L} D_{22}}{D} \lesseqgtr 0 \qquad (15)$$

that pertaining to land and the quantity of schooling since large land holdings are not associated with higher direct costs of schooling. The uncompensated effect of land size, assuming the normality of t and X, may thus be negative for school quantity and positive for school quality, given the relative strengths of the two substitution relations: the presumed positive income effect of land size may overpower the negative quality substitution effect but not the stronger quantity effect.

Expressions (16) and (17) show that given restrictions (3) and (4), a compensated increase in the pace of agricultural technological progress

$$\left(\frac{\delta t}{\delta \tau}\right)_{\bar{U}} = \frac{-\lambda X \frac{\delta f}{\delta t \delta \tau} D_{11} + \lambda t \frac{\delta f}{\delta X \delta \tau} D_{12}}{D} > 0 \qquad (16)$$

$$\left(\frac{\delta X}{\delta \tau}\right)_{\bar{U}} = \frac{\lambda X \frac{\delta f}{\delta t \delta \tau} D_{21} - \lambda t \frac{\delta f}{\delta X \delta \tau} D_{22}}{D} > 0 \qquad (17)$$

increases the demand for the quantity and quality of schooling. An increase in b, travel time to school, however, as shown in (18) and (19),

$$\left(\frac{\delta t}{\delta b}\right)_{\bar{U}} = \frac{\lambda \frac{\delta f}{\delta (T-t-b)} D_{11}}{D} < 0 \qquad (18)$$

$$\left(\frac{\delta X}{\delta b}\right)_{\bar{U}} = \frac{-\lambda \frac{\delta f}{\delta (T-t-b)} D_{21}}{D} \gtrless 0 \qquad (19)$$

reduces the amount of schooling but has an ambiguous compensated effect on school expenditures. This latter result is not surprising; exogenous increases in travel time to school raise the opportunity cost of time in school but do not directly affect the "price" of school quality.[7]

The model as formulated provides implications for the important elements of the demand for education in an agricultural setting on the assumption that the returns to schooling are derived from farming and are in part received by the parents. Given the high rates of outmigration characterizing the agricultural sector, however, it may also be true that the amount and quality of schooling is a reflection of the costs and opportunities in the non-farm sector. Enlarging the model to accomodate these additional factors would do little to increase the understanding of farm schooling since arbitrary assumptions concerning the pecuniary and psychic benefits of educated farm migrants accruing to the farm parents would have to be made. Moreover, the reformulation of the model is unnecessary if these considerations do not significantly alter the interpretation of the empirical structure derived from the model as given: For instance, to the extent that children do contribute to farm production, land size and distance from school will be positively correlated with the opportunity cost of schooling whether or not the children eventually leave the farm. However, the positive relationships between the pace of technical change and rural schooling, should they be empirically significant, can be given an alternative explanation--for a fixed agricultural output price, an increase in factor productivity will be reflected in a reduction in the demand for farm inputs, including children. Schooling may be one means of facilitating the escape from rural agriculture to the industrial sector; if so the pace of technological change and rural schooling may be positively correlated because of an increased desire on the part of farm children to leave agriculture as a result of the concomitant reduction in this demand for farm inputs. If this technological change demand-reduction hypothesis is the correct one, then it would be expected that the demand for the quantity of farm children would be negatively correlated with agricultural progress. These additional effects thus make it necessary that non-farm parameters enter the set of determinants influencing farm child investment and that some attention be paid to the relationship between farm parameters and numbers of farm children.

II. Empirical Implementation

To test the implications of the model formulated in section I, regressions were run on the state enrollment rates of 15-18 year olds in the farm population as reported in the 1960 Census of Population,[8] the proxies for the quantity of schooling, and on the current expenditures per pupil in average daily attendance less transportation expenses in rural districts from the Biennial Survey of Education, 1954-56.[9] The use of school enrollment rather than attendance rates, not available by state on a farm-non-farm basis, implicitly assumes that in modern agriculture classes are scheduled in conflict with farm work and that variation in school attendance is not an effective means of rendering schooling totally compatible with agricultural production. The state was chosen as the unit of observation because the indices which measure the pace of productivity growth, constructed by Evanson and Landau (1973) and which are used to test the innovative ability hypothesis, are only available on a state basis. While the model implies that both the quantity and quality of schooling are chosen jointly by the family, because the determination of the amounts expended on education occurs for the most part through the public sector, it is possible that school enrollment and expenditure may interact with each other, as found by Gustman and Pidot (1973) for urban areas. Attempts are thus made in section II.b to construct a simultaneous equation system to take into account the mutual dependence of these variables. Other than variables used to identify the system, discussed below, all variables serving as proxies for those parameters discussed in section I as affecting rural schooling were used in both the enrollment and expenditure equations, although it was shown that the qualitative effects of these parameters may differ. Tables I and II list the variables and their predicted effects and Table III provides the sources of these variables. The justification for the inclusion of each variable and its estimated effect on farm school enrollment and expenditures are discussed in the next section.

2a. OLS Regression Results

Table IV reports on the results of the OLS regressions. While the high explanatory power of these equations is evidence that the theoretical framework is useful--the set of parameters account for over 83 percent (adjusted) of the interstate variation in teen-age farm school enrollment rates and almost 95 percent (adjusted) of the variance in rural per pupil school expenditures net of transportation costs--the signs and significance of the variable coefficients are of more interest and are better indications of the power of the model.

The average value of the land and buildings of farms was used as an indication of the income potential of the farm, and thus is one important component of the opportunity cost of attending school. Net farm income was not selected as a regressor since it is itself a function of the quantity of children and the extent to which they are schooled; it is not an exogenous determinant of enrollment.[10] In the first section it was shown that farm size (or value) was negatively associated with time in school if the compensated substitution effect dominated the positive income effect, but that the relationship between school expenditures and land was more likely to be positive. The result of the OLS regressions show that this is indeed the case--those states with more productive and larger farms, cet. par.,are associated with lower teen-age school enrollment rates but with higher expenditures on schooling. The negative VAL coefficient cannot represent a negative income effect on enrollment since the coefficient of non-farm income in that equation, which does capture the "pure" income effect, exceeds zero. Thus it appears that increased land size results in the substitution of the quality of schooling for school quantity in agriculture.

No a priori statements about the influence of adult educational attainment on the schooling of farm children were made in section I simply because education plays such a multifaceted part in the household. To the usual roles of education as a proxy for contraceptive knowledge, market and non-market productivity, tastes, and perception must be added, in the agricultural context, the possible complementarity of adult human capital with that of children. Thus it is not particularly fruitful to interpret the coefficients of the parental schooling variables, except to point out that they differ from those schooling effects obtained by DeTray (1973), who found that female educational attainment was dominant.[11]

TFP, the index of the average change in total factor productivity in the decade 1950-59, a measure of the rapidity of agricultural technical change, is associated positively with the farm school enrollment rate. This result provides evidence of the role of education as a productive input whose productivity is enhanced in a dynamic environment: a 10 percent increase in the rate of technical change results in over a 6 percent rise in the school enrollment rate of the farm population. It is important to note that the significant effect of this variable on enrollment is obtained even though the potential income of the farm, VAL, which embodies the level of technology, is controlled for. In order to check whether the index of technical change was merely reflecting an additional income effect, the average value of farms for 1964 was tried in place of the 1960 variable on the supposition that the income gains from productivity increases over the 1950-59 period would more likely be reflected in the value of farms in the later years. No significant alteration in results was obtained. The insignificance of this variable in the expenditure equation may be due to the slow responsiveness of school budgets but requires further investigation.

To ascertain if the positive school enrollment-technological change relationship merely reflects a reduction in the demand for farm inputs and thus an increased demand for schooling on the part of farm children, as discussed in the first section, the number of children ever born to wives of farm operators 35-44 years of age (CEBF) was regressed on the same set of parameters as in the enrollment equation. If the technologically-induced input demand reduction is important, given that children do in part participate in farm production, farm family size and agricultural technological change should be negatively associated. However, the CEBF regression results, reported in (20), do not confirm that hypothesis--

$$\begin{aligned} CEBF = {} & \underset{(4.416)}{9211.93} - \underset{(2.283)}{.010834VAL} - \underset{(1.940)}{93.4382EDM} \qquad (20) \\ & + \underset{(1.466)}{125.7141EDF} + \underset{(0.717)}{2.86521TFP} + \underset{(1.424)}{.341233NFY} \\ & + \underset{(0.194)}{.464810EXP} - \underset{(0.329)}{2.945538TRAN} - \underset{(0.460}{60.01326FSR} \\ & - \underset{(4.271)}{139.1299AGE} - \underset{(0.254)}{4.76358EDLAW} + \underset{(1.377)}{44.7836U} + \underset{(2.172)}{19.81882} \\ & \bar{R}^2 = .785 \end{aligned}$$

the coefficient of TFP on completed fertility is not statistically significant.[12]

The use of school expenditure as a dependent variable implicitly assumes that parents are able to exert at least some control over school spending. However, parents may be less influential in determining the size and location of (travel time to) rural schools. Thus, for the purposes of this paper, these important aspects of rural schooling are assumed to be exogenous. The level of total rural spending per pupil, for given levels of transportation cost and school size, appears to show a strong positive impact on the enrollment rates of farm teen-agers in the OLS regression, a result which is consistent with Edward's (1974) findings for the whole U.S. population based also on OLS regressions. However, the equally strong positive relationship between enrollment and non-transportation school expenditure in the OLS expenditure equation may mean that these correlations may reflect reverse causation. The two-stage least squares procedures used in the next section may eliminate any biases in the coefficients resulting from the possibility of simultaniety.

Distance to school, as demonstrated in the model, should have a negative impact on rural school enrollment, as it is a component of the opportunity cost of schooling. The Biennial Survey of Education provides data not only on current expenditures per pupil in rural areas but also on transportation costs per student, TRAN. If it can be assumed that these costs are positively correlated with average distance to schools in rural areas and do not merely reflect differences in salaries paid to bus drivers, then the variable should have a negative impact on school enrollment. The transportation cost data do seem to reflect urban-rural differences in school travel time--the average annual per pupil transportation expenditure in urban school districts was \$4.16 in contrast to an average of \$25.68 in rural areas.

The coefficient of TRAN is negative in the OLS enrollment equation and is significant at the 10 percent level, one-tailed test. However, the interpretation of this result requires care. Attempts to use an expenditure variable less transportation costs along with TRAN resulted in a non-singular regression matrix. Thus because the level of total spending had to be included in the equation, the TRAN coefficient reflects the effect of increased transportation expenditures with a fixed level of total expenditures per pupil on enrollment and thus in part captures the effect of lowering school quality.

School size may also affect school enrollment and expenditure. Welch (1966) has shown that the quality of rural schools is negatively associated with scale and thus school size should be negatively correlated with school enrollment, for given levels of per-pupil expenditures. Moreover, the evidence of rural school scale economies[13] means that how much is spent on students may be in part a function of scale such that the smaller the school the more that must be spent to achieve the same level of quality. Using the same data as utilized here, Welch concluded that the faculty-student ratio (FSR) was a good correlate of school size--the higher the ratio the samller the school. This ratio was entered in both the enrollment and expenditure equations but it does not appear to exert a statistically significant influence on enrollment. However, the variable is strongly and positively associated with spending per pupil; for given levels of adult educational attainment, farm value, and other income, in those states in which schools are smaller, per-pupil school expenditures excluding transportation costs are at significantly higher levels.

The proportion of farm non-whites in the age group 35-44 (NONW) was included to test if, *ceteris paribus*, whites and non-whites in the farm population differ with respect to their child investment behavior. Conlisk (1969) found that non-whites have significantly lower enrollment rates and McMahon (1970), Gustman and Pidot (1973), and DeTray (1973) concluded that non-whites also spent less per child for educational purposes. All these results, however, were obtained from regressions of differing specifications run on either urban or total population groups. In the regressions run here, it appears that farm non-whites do not differ from their white counterparts with respect to school enrollment but appear to spend slightly *more* on schooling, for given levels of farm value, school size, distance, education, and income. This latter result is consistent with the hypothesis that non-whites of similar background and "tastes" as whites are likely to spend more on education to compensate for discrimination against non-whites with respect to the quality of schools; they must pay more to achieve the same level of school quality as whites.

It was suggested in section I that because of the importance of urban-rural migration, decisions concerning the education of farm children may be influenced by conditions in non-farm areas as well as by agricultural parameters.

To control for these effects, a set of urban wage and unemployment variables was entered in the farm enrollment regressions. The unemployment rate of urban youths 20-24 was used as a proxy for the non-farm opportunity cost of school enrollment--the higher this rate, the lower the probability of obtaining urban employment as an alternative to schooling, and thus the higher the rural enrollment rate. Unfortunately, because of the high degree of intercorrelation of most variables between age groups within states, this variable could not be entered with unemployment (or wage rates) pertaining to older age groups. Thus, the effects of urban opportunity costs and returns could not be disentangled. That the urban unemployment rate, or the set of urban variables, does have a significant effect on the school enrollment rates of farm teen-agers, however, confirms the hypothesis that both agricultural and non-farm influences are important in farm school enrollment decisions.[14]

The proportion of the school budget locally financed (FIN), in part determined by state revenue-sharing laws, and the proportion of the farm population of high-school age (HSP) were used as instruments to identify the school enrollment equation in the simultaneous system discussed in the next section. Both were found to be important influences on school spending by Gustman and Pidot (1973). It would be expected that the less schools are subsidized by state (and federal) governments, the less local areas will spend on education so that the coefficient of FIN should be negative, as is confirmed in the expenditure regression. Osburn (1960) has noted that high school education tends to be more expensive than that for lower grades and thus the proportion of the population in this age group may well influence the total amount expended on students; the coefficient of HSP did not attain significance, however.

Finally, both to control for the influence of compulsory education laws and to test for their effectiveness in raising teen-age farm enrollment rates within the framework of the farm family's demand for schooling, the minimum school-leaving age for each state was entered in the regression equations. The results provide evidence that, given other influences on the demand for schooling on the part of farm parents, these laws exert an insignificant independent effect on either rural school spending or on the enrollment rate of teen-agers in the agricultural population.[15]

II b. TSLS Regression Results

In order to ascertain the importance of any biases in the OLS results produced by the possible simultaniety between enrollment rates and school expenditures, a two-stage least squares procedure was used to restimate the equations.[16] Table V presents the results of these runs.

In the enrollment equation, because of a high degree of collinearity between the FSR, TRAN, and EXP variables, no inference can be made regarding the independent effect of school expenditures on school enrollment. However, the coefficients of the agricultural parameters--VAL, Edm, and TFP--and the non-farm unemployment rate retain their signs and significance.

The TSLS expenditure regression was less successful, possibly because of the weakness of the urban unemployment rate as the identifying parameter. The set of farm characteristics appears as a whole to be significant despite the insignificance of the individual coefficients.

III. Summary and Conclusion

Empirical tests based on an economic model of the educational investment behavior of farm families appear to confirm the importance of education as an agricultural production input. The results provide evidence that the school enrollment rates of farm children are greater in those areas in which agricultural technological change is most rapid, which is consistent with Welch's hypothesis that education enhances the innovative ability of farmers. The empirical analysis also indicates that school expenditure, a proxy for the quality of schooling, and school enrollment, representing the quantity of schooling, are determined jointly by the farm family but bear qualitatively different relationships to family farm characteristics--farm size, a component of the opportunity cost of the quantity of schooling, seems to be significantly negatively associated with teen-age school enrollment in the agricultural sector but bears a strong positive relationship to rural school expenditure.

Opportunities in the non-farm sector seem also to affect the enrollment rates of farm teen-agers but the size of rural schools appears to have no significant effect on enrollment. School scale , however, significantly influences rural school expenditures. One policy implication which is suggested by these latter results is that a school consolidation program, which both increases school size to exploit scale economies but which also necessitates increased spending on transportation and additional time lost from agricultural production may have ambiguous effects on the costs per unit of education and on the enrollment rates of farm children.

Table I: Variables Used in the Farm School Enrollment Regressions

Variable	Definition	Expected sign of coefficient
ENROL	School enrollment rate of the Census Rural-farm population aged 15-18	
VAL	Average value of land and buildings of farms	-
EDF	Median years of schooling of farm women 35-44	?
EDM	Median years of schooling of farm males 35-44	?
NFY	Average family income from non-agricultural sources	+
TFP	Total Factor productivity change index; 1950 = 100	+
U	Unemployment rate of urban population 18-24	?
AGE	Average age of farm operators in 1950	?
NONW	Per-cent non-white in farm age-group 35-44	?
TRAN	School transportation expenditures per pupil attending school in rural districts	-
EXP	Total current school expenditures per pupil attending school in rural districts	+
FSR	Ratio of instructional staff employees to pupils attending school in rural districts	-
EDLAW	Minimum lawful school-leaving age in state	+

Table II: Variables Used in the Farm School Expenditure Regressions

Variable	Definition	Expected sign of coefficient
NEXP	Current school expenditures per pupil attending school in rural districts net of transportation expenditures	
VAL	Defined in Table I	+
EDF	Defined in Table I	?
EDM	Defined in Table I	?
NFY	Defined in Table I	+
TFP	Defined in Table I	+
AGE	Defined in Table I	?
NONW	Defined in Table I	?
FSR	Defined in Table I	+
EDLAW	Defined in Table I	+
FIN	Proportion of school expenditures funded locally in rural districts	-
HSP	Proportion of the total school-age farm population, 5-18, of high-school age, 15-18	-

Table III: Sources of Variables Used in the Farm School Enrollment and Expenditure Regressions

Enrollment rate: U.S. Bureau of the Census, Census of Population 1960, PC (1) 2D-52D, Tables 101 and 102.

Farm value: U.S. Department of Agriculture, Census of Agriculture 1959, Volume 2.

Schooling: U.S. Bureau of the Census, Census of Population 1960, PC(1) 2D-52D, Table 103.

Urban unemployment: ______________, Table 176.

Average age of farm operators: U.S. Department of Agriculture, Census of Agriculture 1950, Volume 2.

Proportion non-white: U.S. Bureau of the Census, Census of Population 1960, PC(1) 2D-52D, Table 103.

Total current school expenditures: ______________, Chapter 3, Section IV, Table O for 38 states: Chapter 3, Section III, Table 3, for 6 states having county-unit systems, Tables 3 and 4, groups III-VI.

School transportation expenditures: U.S. Office of Education, Biennial Survey of Education in the United States 1954-56, Chapter 3, Section IV, Table Q for 38 states; Chapter 3, Section III, for 6 states having county-unit school systems, Table 4, groups III-VI.

Faculty-student ratio: __________, Chapter 3, Section IV, Table J for 38 states; Chapter 3, Section III, Table 3, for 6 states having county-unit systems, groups III-VI.

Compulsory schooling laws: U.S. Office of Education, Circular Number 793, State Law on Compulsory Attendance.

Proportion local revenue: U.S. Office of Education, Biennial Survey of Education in the United States 1954-56, Chapter 3, Section IV, Table S, for 38 states; Chapter 2, Table 25 for 6 states for which only total state averages are available.

High-school age population: U.S. Bureau of the Census, Census of Population 1960, PC(1) 2D-52D, Table 103.

Total factor productivity indices: Evenson and Landau (1973), Appendix C.

Table IV: U.S. Farm Regressions- 1960--OLS

	ENROLLMNT		NEXP	
	b	ε	b	ε
VAL	-.000013 (4.947)	.31	.092990 (2.771)	.128
EDM	.078546 (2.962)	.78	14.172830 (0.034)	
EDF	.043841 (0.929)		655.487305 (0.979)	.51
NFY	.000235 (1.780)	.213	.756510 (0.434)	.08
TFP	.005760 (2.617)	.652	-42.075786 (1.407)	
SCHL. EXP./ ENROLLMNT	.003162 (2.399)	.861	2195.93970 (1.957)	
FSR	-.025586 (0.356)		2872.48730 (4.981)	
TRAN	-.005949 (1.208)	.15		
AGE	-.101247 (5.645)		591.252441 (1.530)	
NONW	-.005094 (1.014)		113.269577 (1.989)	.02
EDLAW	-.000657 (0.064)		213.91236 (1.617)	
U	-.029727 (1.660)	.177		
LOCFIN			-70.329514 (2.443)	.133
HSP			-243.306976 (0.999)	
$\bar{R}^2$	.8324		.8674	

t-value in parentheses

n = 44 states, excl. Alaska, Hawaii, Connecticut, Rhode Island, Deleware, New Jersey

b = coefficient

ε = elasticity computed at population means

Table V: U.S. Farm Regressions 1960--TSLS

	ENROLLMNT		NEXP	
	b	ε	b	ε
VAL	-.000012 (2.603)	.29	.100219 (1.352)	
EDM	.078148 (2.925)	.78	-64.227310 (0.078)	
EDF	.052402 (0.744)		624.259277 (0.126)	
NFY	.000266 (1.146)	.241	.433382 (0.126)	.173
TFP	.005595 (2.308)	.633	-45.911407 (0.995)	
SCHL. EXP./ ENROLLMNT	.002575 (0.675)		3059.27417 (0.372)	
FSR	.000675 (0.004)		2796.28027 (3.090)	
TRAN	-.004123 (0.339)			
AGE	-.100262 (5.285)		656.504883 (0.979)	
NONW	-.004090 (0.516)		117.351929 (1.875)	.024
EDLAW	.000095 (0.008)		208.670120 (1.266)	
U	-.028347 (1.429)	.169		
LOCFIN			-70.240402 (2.433)	.132
HSP			-209.365067 (0.530)	
$\bar{R}^2$	.822		.8784	

t-value in parentheses

n = 44 states

Appendix

$$
\begin{bmatrix}
\left[X^2 - \lambda X \frac{\delta f}{\delta(T-t-b)\delta t} + \lambda X^2 \frac{\delta^2 f}{\delta t^2}\right] & \left[X + \frac{\delta U}{\delta X \delta t} + \frac{\delta U}{\delta X} + \lambda\, t\, X \frac{\delta f}{\delta X \delta t} + \frac{\lambda \delta f}{\delta X}\right] & X\frac{\delta U}{\delta S \delta t} & \left[\frac{-\delta f}{\delta(T-t-b)} + X\frac{\delta f}{\delta t}\right] \\
\left[\frac{\delta U}{\delta t} + tX \frac{\delta U}{\delta X \delta t} - \lambda t \frac{\delta f}{\delta(T-t-b)\delta X} + \lambda X t \frac{\delta f}{\delta t \delta X} + \lambda \frac{\delta f}{\delta t}\right] & \left[t^2 \frac{\delta^2 U}{\delta X^2} + \lambda t^2 \frac{\delta^2 f}{\delta X^2}\right] & t \frac{\delta U}{\delta S \delta X} & \left[t\frac{\delta f}{\delta X} - 1\right] \\
X\frac{\delta U}{\delta t \delta S} & t\frac{\delta U}{\delta X \delta S} & \frac{\delta^2 U}{\delta S^2} & -1 \\
\left[-\frac{\delta f}{\delta(T-t-b)} + X\frac{\delta f}{\delta t}\right] & \left[t\frac{\delta f}{\delta X} - 1\right] & -1 & 0
\end{bmatrix}
\begin{bmatrix}
dt \\ dX \\ dS \\ d\lambda
\end{bmatrix}
$$

$$
= \begin{bmatrix}
\lambda\left[\frac{\delta f}{\delta(T-t-b)\delta L} - X\frac{\delta f}{\delta t \delta L}\right] dL - \lambda\left[X \frac{\delta f}{\delta t \delta \tau}\right] d\tau & \lambda \frac{\delta f}{\delta(T-t-b)}\, db & \\
-\lambda + \frac{\delta f}{\delta X \delta L}\, dL \quad -\lambda t \frac{\delta f}{\delta X \delta \tau}\, d\tau & & \\
0 & 0 & \\
-\frac{\delta f}{\delta L}\, dL \quad \delta f & \frac{\delta f}{\delta(T-t-b)}\, db & -dv
\end{bmatrix}
$$

Footnotes

[1]See the articles in the Journal of Political Economy, 81, No. 2, Part II (March/April 1973).

[2]Notable examples are Conlisk (1969), Masters (1967), McMahon (1970), and Gustman and Pidot (1973).

[3]DeTray (1973) is an exception.

[4]The function Γ is therefore subject to decreasing-returns-to-scale.

[5]The set of differential equations is found in the Appendix.

[6]D denotes the bordered Hessian determinant; D_{ij} are the relevant co-factors.

[7]To the extent that transportation is financed out of school budgets, total spending on schooling may be importantly affected by average distance to school.

[8]This age group was chosen because the interstate variation in the school enrollment rates of persons below age 15 was negligible.

[9]This is the latest source of these data which differentiates between urban and rural areas. The use of 1960 Census data in conjunction with those from this source should not be econometrically troublesome because of the high degree of serial correlation characterizing the school expenditure data. See Welch (1966) for evidence of this phenomenon. Counties considered rural were those that had at least 85 percent of their inhabitants classified as living in rural areas (1950 Census definition). Only 38 states contained counties which met this criterion; of these, all but six--Maine, Massachusetts, New Hampshire, New York, Vermont, and Arizona--contained rural counties having 50 percent or more of their inhabitants classified as rural-farm. Six states with county-unit school systems were added to the sample. Expenditures and other school data from counties III-VI in these states, having, on average, 42 percent of the population classified as rural-farm, were used.

[10]See Rosenzweig (1974) for empirical evidence that family size influences net farm income.

[11]DeTray, however, combines both enrollment and school expenditures in his child quality dependent variable, making it difficult to compare his results with those obtained here.

Footnotes

[12]The use of a predicted value of EXP in the CEBF equation did not alter significantly the OLS regression coefficients reported in (20). The negative and significant VAL coefficient is consistent with the hypothesis that rearing farm children is a time-intensive activity. See Rosenzweig (1974) for a discussion of the fertility of farm women.

[13]See Cohn (1968), Hanson (1964), Osburn (1970), Riew (1966), and White and Tweeten (1973).

[14] None of the urban variables, together or separately, were significantly correlated with school expenditures when entered in the expenditure equation.

[15] Edwards (1973) tested the effectiveness of these laws in the aggregate population in 1960 and concluded that only the school enrollment rates of males were significantly affected. The results here appear to indicate that compulsory schooling legislation was only effective in raising the school enrollment rate of urban male teen-agers.

[16] The use of TSLS results in consistent estimates. However, because of the smallness of the sample utilized, the estimated OLS coefficients may be closer to the "true" parameters.

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