ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 228

THE DEMAND FOR FARM CHILDREN: A THEORETICAL AND EMPIRICAL ANALYSIS

Mark R. Rosenzweig

April 1975

THE DEMAND FOR FARM CHILDREN: A THEORETICAL AND EMPIRICAL ANALYSIS

Mark R. Rosenzweig

Yale University

April 1975

*This paper embodies a portion of my Ph.D. dissertation, Columbia University, 1973. I am grateful for the comments and criticisms of Jacob Mincer, James Heckman, James McCabe and members of the Workshops on Labor Economics and Human Resources at Columbia University and on Applications of Economic Theory at the University of Chicago.

ABSTRACT

The household model of fertility behavior is extended to make it applicable to rural-agricultural settings in which the pecuniary returns from children are significant. Empirically testable implications regarding the influence of parameters pertaining to the market for agricultural labor and to farm outmigration, including technical change, wage rates, farm value, and non-farm wage and unemployment rates, are derived from the static, multi period model formulated. These are tested on U.S. data covering the period 1939 to 1970 and the estimated coefficients are utilized to quantify the important determinants of movements in farm birth rates from 1925 to 1965. The empirical results appear to be consistent with the 'predictions' of the model and indicate the importance of the reduction in the value of children as productive assets in agriculture in the decline in the farm-non-farm birth rate differential.

I. Introduction

Economists and demographers[1] have long recognized that a major factor in the secular decline in fertility associated with the development process is the movement of populations out of the high-fertility rural-agricultural sector. A primary cause of the anti-natalist impact of this 'urbanization' process is commonly thought to lie in the reduction in the pecuniary value of the returns from children associated with the disappearance of opportunities for children to perform non-household productive work in the modern urban sector. In the United States, such a phenomenon has also been accompanied by a secular decline in the fertility of the population remaining in rural-agricultural areas where such opportunities were still important even during periods when non-farm fertility was stable.[2] The movements in U.S. farm and non-farm fertility have in general been dissimilar up to the 1960's, as displayed and discussed in the Appendix. All fertility measures indicate that 1) from 1920 to 1970 the farm birth rate has declined at a considerably more rapid pace than the non-farm rates and 2) the differential fertility behavior of the pre-and post-war years has been significantly different, with the "baby boom" much less pronounced in the agricultural sector.

These differential patterns have for the most part been ignored by economists interested in modelling family fertility bahavior. Recent developments in the economic theory of fertility,[3] which have been formulated in the context of an urban or developed country environoment[4], abstract from the productive contribution of children and, while their predictions have been for the most part verified using cross-sectional data restricted to urban populations, or in regressions controlling for 'rurality'[5], they have failed to account for any of the behavioral differences in the farm and non-farm populations with respect to fertility.[6]

This paper thus has a twofold purpose: First, to modify and extend the theory of the household by explicitly considering two roles of children, as durable commodities which yield psychic as well as pecuniary returns over time.[7] The second focus of the paper is to use the theoretical framework developed to interpret and analyze the time pattern of movements in farm birth rates in the United States from 1925 to 1970.

In section II, a model of farm family fertility is formulated in which children are treated as commodity outputs derived from household production activities and as factor inputs in an agricultural production function whose cost and productivity characteristics change over the life-cycle. It is shown that price and income effects differ from those derived from 'urban' fertility models and a number of empirically verifiable implications concerning parameters pertaining to the market for farm labor and farm-non-farm migration are derived. In section III, the model is tested on a pooled series of quinquennial cross-sections covering the period 1939 to 1960 and on state cross-sectional data from the 1960 and 1970 population censuses. Two criteria are used to verify the predictions of the model--conventional t-tests and predictive power, the latter tested by utilizing the pooled-data parameter estimates to track movements in aggregate farm birth rates from 1925 to 1965. Both tests are generally successful. In section IV, the contribution of the farm birth rate determinants implicated in the analysis to the change in agricultural birth rates from 1925 to 1940 and over the period 1945 to 1965 are assessed. It is concluded that the more rapid decline in farm compared to non farm fertility is due both to increases in child cost components and to reductions in the pecuniary returns from children in agriculture. Evidence is obtained consistent with the hypothesis that agricultural technical change has,in part, been responsible for the latter and that prior to the 1960's farm children have been net assets when mature. These phenomena are shown to underlie an economic linkage between the reduction in farm birth rates and farm outmigraion, both of which are reflections of the decline in the demand for and supply of manpower in agricultural production. The result of these dynamic processes is that farm and non-farm fertility should display similar patterns of behavior in the future.

II. A Model of Farm Family Fertility

The crucial characteristic of the household production fertility model in its many variants is that children are viewed as durable consumption commodities which yield utility and are produced in the household by the parents' application of their time and market goods resources. To more accurately depict the situation of families in rural agricultural areas, however, two fundamental modifications are incorporated in this basic framework: 1) All family members, including the children, are assumed to contribute to farm output; their contributions are described by a farm profit function relating the quantitites and prices of family and other inputs to net farm income. Thus, children's contribution to real family income is assumed to be significant in the farm context and correlated with farm production parameters. It is implicitly assumed that, although children may contribute to household production, (are inputs in the household production functions), the elasticity of substitution of child and parental time is much greater in farm than in household production. 2) Because farm children are therefore both durable consumption and production commodities, to capture the empirical implications of the change in the productivity and cost characteristics of farm children as they age, the model is formulated in a multiperiod context.

To construct a model suitable to the rural-agricultural context whose implications are tractable, it is additionally assumed that all household and production decisions are made jointly by the parents on a farm of fixed size in the initial period of some relevant decision range of T periods and that the future is faced with perfect foresight. Utility is maximized with respect to two commodities, the stock of children N--the discounted flow of child services[8] in each period j, n_j--and S--the present value of the stream of services per period of the alternative commodity s_j.

$$U(N,S) \tag{1}$$

where

$$N = \sum_{j=0}^{T} \frac{n_j}{D^j} \quad , \quad S = \sum_{j=0}^{T} \frac{s_j}{D^j}$$

and $D^j = (1 + r)^j$ the discount factor in the j^{th} period. (Market and subjective rates assumed equal)

The household production of each consumption commodity i is described by a linear homogeneous production function g_{ij} in each period j whose inputs are the relevant goods vector X_{ij} and the time of the parents T_{ijp}:

$$n_j = g_{nj}\ (X_{nj},\ T_{njp}) \qquad s_j = g_{sj}\ (X_{sj},\ T_{sjp}) \tag{2}$$

Marginal and average input coefficients are thus equal, i.e.:

$$n_j t_{nj} = T_{nj} \qquad s_j t_{sj} = T_{sj}$$

$$n_j x_{nj} = X_{nj} \qquad s_j x_{sj} = X_{sj}$$

where t_{ij} and x_{ij} are the input coefficients T_j and X_j per unit of commodity i in the j^{th} period.

To further simplify the model, it is assumed that the husband specializes in farm production (his contribution to home production is zero), that the wife allocates her time between household and farm production exclusively (she does no non-farm work),[9] and that she is a perfect substitute for a hired agricultural worker in farm production. The latter assumption implies that the wife's value of time is equal to the hired agricultural laborer market wage if hired workers are used on the farm; her marginal value of household production time will be equal to the marginal value of her time at work. When no labor is purchased, however, the relevant imputed price of the wife's time becomes endogenous and this condition no longer holds. The implications of the latter case are discussed in section IV.

In each period j the wife spends an amount T_{wj} in farm production, $T_{nj} = n_j t_{nj}$ in child-services production, and $T_{sj} = s_j t_{sj}$ in the production of s so that under the assumption of linear homogeneity, the wife's time constraint in the j^{th} period can be expressed as

$$\Omega_j = t_{nj} n_j + t_{sj} s_j + T_{wj} \tag{3}$$

where Ω_j is the per period amount of time which, if allocated solely to farm production, would maximize family income.

The services from children are also inputs in the j^{th} period farm profit function Γ_j along with the labor of the wife, T_{wj}, hired workers, ℓ_j, and capital services, k, where f( ) is a twice-differentiable, decreasing-returns-to-scale production function.[10]

$$\Gamma_j = pf\ (n_j,\ l_j,\ T_{wj},\ k) - \pi_\ell \ell_j - \pi_k\ k \tag{4}$$

Also entering the profit function are the exogenous price parameters p, the price per unit of farm output, π_{ℓ}, the price per unit of hired labor (and the shadow wage of the wife's time), and π_k, the rental price of capital services. Γ_j will not correspond to reported net income if the shadow prices (in terms of the value of goods consumed) of the productive services of farm children and the wife not netted out by the farmer.[11] In any case, Γ_j is not equivalent to the farm household full income constraint.

It is assumed further that both the initial stock of child services n and of capital K are delivered in period 0 so that n and k are constant for all j. However, there is 'depreciation' of the stock of children. Relation (5), which can be considered a life table generating function, in which n is analogous to the radix, the initial cohort, of a life table, describes the T-period profile of the child-stock depreciation, where A_j represents the proportion of the initial stock of children remaining on the farm in the j^{th} period:

$$n_j = nA_j = A_0 \prod_{i=0}^{j} \mu_i n = A_0 \theta_j n \tag{5}$$

where A_0 = the proportion of the stock of children surviving the first period.
= 1 - infant mortality

$1-\mu_i$ = the proportion leaving the farm in period i.

In each period, a_j is a productivity factor for the farm child in farm production and is assumed to be less than one up to some period m, defined as the age of maturity; for $j \geq m$, $a_j \geq 1$. The goods and time components of the price of children do not affect a_j but may be positively correlated with its value. Thus the j^{th} period production function becomes:

$$f\ (A_0 \theta_j a_j\ n,\ \ell_j,\ T_{wj},\ K) \tag{6}$$

Absent farm children are assumed to provide no contributions to family income; the contributions to family utility of children off the farm will depend on the assumption made about the value of the utility discount factor ψ. To accomodate all cases, $0 \leq \psi \leq 1$, the farm family utility function (1) generalizes to:

$$U\ (\ \Sigma\ \frac{A_0 n[\theta_j\ (1 - \psi) + \psi]}{D^j}, S) \tag{7}$$

The implications of assuming different values for ψ are discussed in section III.2.

The second constraint on farm family decisions is that all money expenditures must not exceed total income:

$$V_j + pf\ (\ ) = p_n x_{nj}\ n_j + p_s x_{sj} S + \pi_\ell \ell_j + \pi_k K \tag{8}$$

where the p_{ij}'s are the price indices of the composite goods used in the household production of the commodities in the j^{th} period, x_{ij} is the marginal composite-good coefficient of the i^{th} commodity in period j, and V_j is the j^{th} period flow of non-farm income.

Constraints (3) and (8) can be combined, under the assumption that the shadow price of the wife's time is π_ℓ, the wage of agricultural labor, and summed over all T periods to yield the intertemporal full income constraint:

$$\sum_{j=0}^{T} \frac{\Omega\pi_\ell + V_j + pf(\ ) - \pi^c_{nj}\, n_j - \pi^c_s\, S - \pi_\ell(t_{wj} + \ell_j) - \pi_k K}{D^j} - \pi_b \qquad (9)$$

where $\pi^c_{nj} = p_n x_{nj} + \pi_\ell t_{nj}$

$\pi^c_s = p_s x_{sj} + \pi_\ell t_{sj}$

π^c_{nj} and π^c_s are defined here as the "consumption" prices of commodities n_j and s, as they are equivalent to the shadow commodity prices derived in 'consumption' fertility models. π^c_{nj} is not the true shadow price of n_j on the farm, however, as will be demonstrated in the next section. π_b is an additional cost of children restricted to the first period (cost of "birth").

1. Optimization

The optimal stock of the two consumption commodities, children surviving infant mortality, $n^* = A_0 n$, and S, the optimal investment in capital for the total planning period, and the best utilization of hired labor and the wife's work time in each period are found by maximizing the utility function (7) subject to (9) and the relevant non-negativity constraints on the control variables with respect to n*, S, $\ell_j + t_{wj}$, and K. There are thus T+3 first order conditions excluding the income constraint:

$$U_n \quad \Sigma \frac{\theta_j(1-\psi)}{D^j} + \lambda \left[\Sigma \frac{a_j\theta_j pf_n - \theta_j\pi^c_{nj}}{D^j} - \frac{\pi_b}{A_0} \right] \leq 0 \text{ or } A_0 n = 0 \qquad (10)$$

$$U_s + \lambda[- \Sigma \frac{\pi_s^c}{D^j}] \leq 0 \qquad \text{or } S = 0 \qquad (11)$$

$$pf_{(\ell_j + t_{wj})} - \pi_\ell \leq 0 \qquad \text{or } \ell_j + t_{wj} = 0 \qquad (12)$$

$$pf_k - \pi_k \leq 0 \qquad \text{or } K = 0 \qquad (13)$$

Assuming internal solutions[12] (ineffective non-negativity constraints) expressions (10) and (11) can be combined to form (14) and (15):

$$\frac{U_n}{U_s} \Sigma \frac{\theta_j(1-\psi)}{D^j} = \frac{\Sigma \frac{\theta_j(\pi_{nj}^c - a_j pf_n)}{D^j} + \frac{\pi_b}{A_0}}{\pi_s} \qquad (14)$$

$$\Sigma \frac{\theta_j \pi_{nj}^c}{D^j} + \frac{\pi_b}{A_0} - \Sigma \frac{a_j \theta_j pf}{D^j} = \frac{U_n + \Sigma \frac{\theta_j(1-\psi)}{D^j}}{\lambda} \qquad (15)$$

From expression (14) it can be seen that the appropriate shadow price of farm children contains an endogenous component related to the value of child productivity on the farm, which offsets the pre-determined 'consumption' price,[13] component, π_N^c (= $\Sigma \frac{\theta_j \pi_{nj}^c}{D^j} + \frac{\pi_0}{A_0}$). Expression (15) shows that the farm family produces children to the point where the present value of farm child marginal revenue is less than capitalized cost (including the opportunity cost of the wife's time input) by the value of the marginal utility of the stock of children. This result is consistent with Becker's insight (1960, p. 213) that "... the (net) marginal cost of children must be positive in families receiving marginal psychic income from children; otherwise they would have...additional children." Only if the productivity of children is so high that it is physically impossible to produce enough children so as to equate the total marginal costs and returns of children, will expression (15) not hold. Becker cites evidence showing that even in 1850 the actual number of children born was less than the potential quantity. The presence of children in the utility as well as the profit function is a sufficient condition for characterizing the family farm as non-profit maximizing; profit maximization is insufficient for utility maximization.[14]

Conditions (12) and (13) are the familiar profit maximizing ones; laborers are hired in each period such that the contribution to income of the last laborer equals the price of his services, or none are hired; capital is purchased up to the point where the capitalized cost of the marginal unit of capital services just offsets the discounted marginal contribution to income associated with that unit of capital.

Figure 3 depicts the farm fertility model diagrammatically. Quadrant I displays the pre-determined cost and the production relations (G_0G_0' = gross income, (V= 0) line TC = total cost) with respect to the stock of children N on a farm of fixed size, all other production variables adjusted according to the first order conditions (12) and (13). Thus for N=0, gross and net farm income (G_0TC_0) are positive because hired labor, capital, etc. are utilized. Also, increases in N raise total cost less than proportionally to the rise in total child costs ($N\pi_N^c$) because of the possibilities of input substitution--line TC has a gentler slope than the child (consumption) price line π_c. Line P_0P_0' translates the juxtaposition of the cost and production functions into profit; in quadrant III, $E\pi_s$ is the shadow price of S, and quadrant IV is a utility surface with respect to S and the stock of children, utility increasing as the indifference curves travel southeast. The profit function in I and II and the price line for S map a transformation curve B_0B_0' into quadrant IV relating S to N. Utility is maximized at the point of tangency between the indifference and transformation curves, in accordance with the algebraically derived first and second order conditions--the (marginal) rate of transformation is equated with the rate of substitution of S and N at the optimum (see expression (14)).

Figure 3 demonstrates the case in which children make positive, but declining, contributions to profit initially.[15] However, the quantity of children demanded at the utility-maximizing optimum exceeds the profit-maximizing quantity --$N_{opt} > N_{max}$--since second order conditions constrain the indifference curves to be convex at the optimum and the profit-maximizing point on the transformation curve must have a slope equal to zero.

To ascertain the response of the stock of children demanded to changes in the parameters specified in the model in part one, and to formulate a farm-child demand function, the first order conditions (10) through (13) are totally differentiated and the relevant partials for n*, child services per period of children surviving the initial period, are calculated.[16] To reduce mathematical complexity and to highlight the important implications of the analysis, the model is further simplified by collapsing the T periods into two corresponding to those prior to and following the age of maturity (j=m).

The parametric fertility effects derived from the farm model differ in two principal respects from those coming out of the household production framework which describes urban fertility behavior: the usual price of time and pure income relationships differ qualitatively as is shown in the next section and a vector of variable relationships is implicated in the model which would be zero-valued in the non-agricultural context. The latter are described in sections 3 and 4.

2. Price of Time, Income Effects

In the farm model, where it is assumed that the price of time of the wife is equal to the agricultural wage, π_ℓ, the compensated substitution elasticity of children with respect to the value of wife's time ($\bar{\eta}_{n^*,\pi_\ell}$) can be shown to be equal to(16)

$$\bar{\eta}_{n^*,\pi_\ell} = \bar{\eta}_{n^*,\pi_N^c} (\alpha_N - \alpha_s[1-\gamma]) + \tau \tag{16}$$

where $\bar{\eta}_{n^*,\pi_N^c}$ is the own compensated 'consumption' price elasticity of children,

$\alpha_N = \Sigma \dfrac{\theta_j t_{nj} \pi_\ell}{D^j} / \pi_N^c$, $\alpha_s = \Sigma \dfrac{t_s \pi_\ell}{D^j} / \pi_s$ and $\gamma = \Sigma \dfrac{pf_n \theta_j a_j}{D^j} / \pi_N^c$. The α_is correspond, in present value terms, to the time-value intensities of N and S in a similar price of time expression derived by Ben Porath (1973) from an 'urban'-type fertility model.[17] As in that framework, if $\alpha_n > \alpha_s$, if farm children are time-value intensive with respect to consumption prices, an increase in the wife's price of time will reduce the demand for farm children (if the substitution in farm production between hired laborers, the wife, and children τ is not strong) since $\bar{\eta}_{n^*,\pi_N^c}$ is constrained by second-order conditions to be negative. However, because the consumption price overstates the true shadow price of farm children (by the value of the marginal productivity of the stock of children), this condition is sufficient but not necessary for a negative effect in farm areas. Even if $\alpha_N = \alpha_s$, an increase in π_ℓ

still results in a diminution in the desired stock of farm children, the magnitude of the effect being proportional to the ratio of child marginal value product to the consumption price(γ).

$$\bar{\eta}_{n*,\pi_\ell} = \gamma\alpha_N \, \bar{\eta}_{n*,\pi_N^c} + \tau \tag{17}$$

If the additional restriction is made that the marginal product of farm children is some proportion b_j of that of hired agricultural workers (and the wife), i.e. $pf_{nj} = b_j\pi_\ell$, (16) becomes

$$\bar{\eta}_{n*\pi_\ell} = \left[\frac{\Sigma \frac{\theta_j(t_{nj}-b_j)}{D^j}}{\pi_{N*}} - \frac{\Sigma \frac{t_{sj}}{D^j}}{\pi_s} \right] \pi_\ell \, \bar{\eta}_{n*} \, \pi_N^* \tag{18}$$

where $\pi^*_{N*} = \Sigma \dfrac{\theta_j(\pi^c_{nj} - pf_n a_j)}{D^j}$

Since the productivity component is now exogenous, the relation is expressed in terms of the <u>full</u> child shadow price π_N*. The necessary condition for the compensated elasticity of farm children with respect to the hired laborer wage having a negative sign is that the <u>net</u> time-value intensity of n exceed that of S.

The existence of an endogenous component in the full shadow price of children also produces a discrepency between the true and observed income elasticities of farm children. An exogenous increase in non-earnings income (wife's time-value constant) would not directly affect the productivity of a given stock of children: however, if the quantity of children increases as a result of the rise in income, the marginal productivity component of child price diminishes,as long as the husband's supply of work effort to farming is negligibly reduced by the rise in income,and the full shadow price of children rises. Thus if the true income elasticity of farm children is greater than zero, under these conditions the observed non-earnings income elasticity <u>understates</u> the true elasticity. This is so because the full price of farm children relative to the price of S is dependent upon the <u>absolute</u> quantity of children or, more precisely, on the amount of N relative to the collection of production inputs, not on the ratio of N to S. If farm children are inferior commodities, alternatively, the observed income elasticity is biased upwards.

Figure 3 depicts these considerations graphically on the assumption that the farmer's labor supply is constant. The slopes of the transformation curves B_0B_0' and B_1B_1', where B_1B_1' represents the new allocative possibilities arising from an increase in non-farm income, are identical along vertical lines drawn from the N-commodity axis. This propostion is made intuitively more clear by considering N_{max}, the profit maximizing quantity of the stock of children. At N_{max} the slope of the transformation curve is zero, and, as increases in non-farm income have no effect on the most profitable allocation of production inputs, the slope of transformation curve B_1B_1' must be zero-valued at the same N_{max}. Ray EE' is the line representing the quantities of N and S produced if the true income elasticity of N and S equalled one. As can be seen from the diagram, extreme points a and c have different slopes because N has increased. Only if all the additional non-farm income were spent on S (ε_{NI}=0), at point b, would the shadow price ratios be unaltered.

This bias in the observed income elasticity of farm children resulting from the use of farm children in production is distinct from and in addition to that due to the dependency of the shadow price of child quantity on the amount of child quality, discussed by Becker and Lewis (1973). In that analysis, if the true income elasticity of quantity is less than one the observed quantity income elasticity also understates the true elasticity, since Q rises relative to N.

3. Migration, Technological Change

The full horizon-period cost to the parents of farm children is importantly related to the expected migration of either the children or the parents themselves and thus parameters influencing the movement of manpower from agriculture will have effects on agricultural fertility. The effect of a change in the proportion of children migrating from the farm upon reaching maturity (j=2 in the two-period model) depends on the profile of the net productive value of farm children over the planning period. If it is assumed that θ_j the proportion of non-migrating children is a function of some expected opportunity wage π_0 in non-farm employment such that an increase in this wage induces children (or parents) to leave the farm, i.e.:

$$\begin{aligned} \theta_j &= h(\pi_0) \quad j = 2 \quad h' < 0 \\ &= 1 \qquad\quad j = 1 \end{aligned} \tag{19}$$

then the compensated non-farm opportunity wage elasticity of the demand for farm children can be written as:

$$\bar{\eta}_{n*,\pi_0} = h'\left[\frac{\pi_0}{\pi^c_{N*}} \left(\frac{(1-\psi)U_{n*}/\lambda + a_2 p f_{n2} - \pi^c_{n2}}{D^2} \right) \right] \bar{\eta}_{n*,\pi^c_N} \tag{20}$$

The sign of the expression depends on the net marginal value product of farm children only in the second (mature) period. While over the whole planning horizon the net pecuniary value of farm children is negative (see expression (15) derived from the first order conditions in part 1), it is not unreasonable that farm children may have been net assets <u>when mature</u>, i.e., $a_2pf_{n2} - \pi^c_{n2} > 0$. An increase in expected non-farm wage rates would therefore diminish the demand for farm children by reducing the anticipated "harvest" of positive pecuniary returns derived from farm production in the 'mature' period.[18]

The necessity of the restriction that net profitability be positive for $j \geq m$ depends upon the value chosen for the discount utility factor ψ. If $\psi = 0$, absent children provide no utility to the farm household, then it is only necessary that the sum of the values of marginal utility and productivity exceed the consumption price in the mature periods:

$$\bar{\eta}_{n*\pi_0} = -h' \left[\frac{\pi_0}{\pi^c_N} \left(\frac{U_{n*}/\lambda + a_2pf_{n2} - \pi^c_{n*}}{D^2} \right) \right] \bar{\eta}_{n*\pi^c_N} \qquad (21)$$

For all values of ψ, $0 \leq \psi \leq 1$, it is sufficient that farm children be profitable in farming when mature.

Similar conclusions can be derived for the effect of the non-farm unemployment rate U. If this parameter is a proxy for the probability of employment of the prospective migrant in the non-agricultural sector, then the higher the expected non-farm unemployment rate U, the less likely the farm children (or the family) are to migrate and the less the expected lifetime cost of farm children.

Let $\theta_j = k(U) \quad k' > 0$

then $$\frac{\delta n}{\delta U} = \frac{\delta n}{\delta \theta_j} k' > 0 \tag{22}$$

By the same reasoning as for (19), an increase in expected urban unemployment should increase the desired stock of farm children.

Another influence on the expected horizon-period productivity of farm children, and hence on expected child cost, is technological change. One way to capture in the model the labor-saving nature of technological progress that has been said to have characterized the agricultural sector of the United States in the Twentieth Century[19] is by computing the effect of a decrease in the rental price of capital. The direction of the change in the optimal stock of farm children resulting from a reduction of π_k is not constrained by the second order conditions. If, however, it is assumed that capital and children are competitive farm production inputs, then the model predicts that, ceteris paribus, compensated decreases in the price of capital diminish the demand for farm children.[20] The income effect of a change in the real price of capital, assuming that children are non-inferior commodities, is, however, positive. This latter result comes out of the partial equilibrium framework of the model--output price is held constant, since the individual farmer faces a perfectly elastic demand schedule, so that a reduction in π_k lowers total costs and raises net income.[21]

4. <u>Infant Mortality, Product Price, Farm Value</u>

Differentiating the first order conditions with respect to A_0, the complement of infant mortality, yields the result that the magnitude and sign of the uncompensated elasticity of surviving child demand with respect to the proportion of children born surviving into the first period depends on the size of π_b, the cost of birth, relative to the horizon-period consumption price and on the expected profitability of the stock of children:

$$\eta_{n^*,\ A_0} = - \frac{\pi_b}{\pi_N^c} \bar{\eta}_{n^* \pi_N^c} + [n \Sigma \frac{A_0 \theta_j (a_j p f_n - \pi_{nj}^c)}{D^j} / I] \epsilon_I \qquad (23)$$

An increase in A_0, holding real full income I constant, increases the demand for n* because it lowers the cost of producing an "effective" stock of children - the compensated substitution elasticity is positive. As A_0 is the complement of infant mortality, it can be concluded that the demand for surviving children is negatively related to infant mortality.[22]

A rise in the price of farm output, ceteris paribus, increases farm fertility because the value of the marginal product of farm children increases, resulting in a reduction in the relative price of farm children, and because total income rises (normality assumed):

$$\eta_{n^*,\ p} = - \gamma \bar{\eta}_{n^*, \pi_N^c} + \frac{\Sigma \frac{Pf(\ )}{D^j}}{I} \epsilon_I \qquad (24)$$

Thus a change in farm income arising from an alteration in farm output price produces both substitution and income effects which work in the same direction, if children are normal commodities. The strength of the total elasticity of farm children with respect to farm product price depends on the ratio of the value of farm-child marginal productivity to the predetermined component of child cost (consumption and birth cost) and on the share of farm in full income.

Similarly, an increase in the scale of the farm, a factor implicitly held constant in the previous analysis, raises the demand for children by both lowering child full shadow price if child labor and land are complements and by enhancing total resources. Thus a positive relationship between farm value or farm income in a multivariate regression analysis (wife's imputed price of time held constant) is not conclusive evidence that farm children are non-inferior commodities -- ε_I can be negative and $\varepsilon_{SCALE} > 0$ if the positive compensated substitution effect outweighs the pure income effect.

5. Interaction Effects

The previous results concerning income, scale, and product price effects were derived under the dual assumptions that the farm purchased labor in the market and that the wife was a perfect substitute for hired labor in farm production. Thus the wife's imputed price of time could be identified (and controlled) as the wage of agricultural workers, and as a consequence the analytical separation of income and substitution effects was made feasible. More than half of farms in the United States, however, do not utilize hired laborers.[23] The value of the wife's time in a model describing family behavior on these farms is endogenous, positively related to farm size and income. An increase in farm size raises the wife's imputed time value by increasing her marginal productivity in farm and home production as both more land and more goods (purchased out of the additional farm income) are applied to the fixed quantity of time she can allocate to both activities.[24]

The demand for farm children will be negatively associated with farm size or income if 1) $(\alpha_N - \alpha_S[1-\gamma]) > 0$ (where π_ℓ is the endogenous marginal value of the wife's time), and the increase in farm scale does not enhance the productivity of farm children at a much greater rate than it raises the wife's productivity and 2) the negative compensated substitution effect (expression(16)) outweighs the presumed positive income effect, as it seems to in the urban sector. None of the other implications derived under the regime of an exogenous price of time are altered.

Because compensated price and income effects may differ qualitatively on farms according to the composition of the labor force employed on each farm, as a first approximation, it could be theorized that the aggregate fertility behavior of a heterogeneous sample of farm families can be represented by a weighted average of the two models, where the weights are the proportions of farms which hire laborers or which utilize only family members. These weights are, of course, not themselves exogenous but may be a function of some of the parameters affecting farm fertility directly.

Let a proportion ρ of farms be characterized by model 1 (hired-labor using), where the number of children is negatively related to the hired laborer wage, π_ℓ, = the value of the wife's time, and a positive function of farm size or income, F, and non-farm parental earnings, Y. In the linear representation of the models below, $a < 0$, $b > 0$, and $c > 0$.[25] For $1 - \rho$ farms, the stock of children is probably negatively correlated with farm size and non-farm income or, what is sufficient, $e < b$ and $f < c$. On these farms the optimal number of children may be positively related to the market labor wage as a proxy for the marginal value product of children or if the farmer anticipates expansion and the future need for more workers, $d > 0$:

$$\rho: \quad n^* = a\pi_\ell + bF + cY \tag{25}$$

$$1 - \rho: \quad n^* = d\pi_\ell + eF + fY \tag{26}$$

ρ itself is correlated with F; that is, a "demand" function for hired laborers can be specified in which the proportion of farms purchasing labor in the market is positively related to farm size ($\beta > 0$):

$$\rho = \beta F \tag{27}$$

Equations (25), (26), and (27),in these arbitrary linear specifications, can be combined to yield the aggregate child demand function:

$$\bar{n}^* = \rho[a\pi_\ell + bF + cY] + (1-\rho)\ [d\pi_\ell + eF + fF]$$

$$= \beta F\ [a\pi_\ell + bf + cY] + (1-\beta F)\ [d\pi_\ell + eF + fY]$$

collecting terms $\bar{n}^* = \phi F^2 + \psi\pi_\ell F + §FY + eF + d\pi_\ell + fY$

where $\phi = \beta(b-c) > 0$, $\psi = \beta(a-d) < 0$, $§ = \beta(b-e) > 0$

Under the assumptions made previously, the demand for children is positively related to the wage rate of hired agricultural workers and farm size or value, negatively related to the product of these two parameters, negatively related to non-farm earnings and positively related to the product of farm value and non-farm earnings. Thus the total effect of a change in π_ℓ on n* depends on the size of farms,

$$\frac{\delta\bar{n}^*}{\delta\pi_\ell} = d + \psi F$$

the larger farm size the less positive is the effect of the market wage as more farms utilize hired laborers. Similarly, the effect of farm size or income on fertility depends on the level of the agricultural market wage and non-farm earnings:

$$\frac{\delta\bar{n}^*}{\delta F} = 2\phi F + \psi\pi_\ell + §Y + e$$

Finally, the relationship between farm fertility and income earned off the farm by the parents depends on the size or value of farms in an aggregate sample:

$$\frac{\delta\bar{n}^*}{\delta Y} = e + §F$$

Integrating the appropriate differentials under the usual assumptions, and adding the interaction terms to capture the above relationships yields an equation relating fertility to the variables specified in the model capable of being utilized in an empirical analysis of farm fertility:[26]

$$N = \beta_1\pi_\ell + \beta_2 F + \beta_3\pi_\ell F + \beta_4 YF + \beta_5 Y + \beta_6 T + \beta_7 U + \beta_8\pi_0 + \beta_9 M + BX$$

$$\beta_1, \beta_2, \beta_7 > 0$$

$$\beta_3, \beta_4, \beta_5, \beta_6, \beta_8, \beta_9, < 0$$

where π_ℓ = agricultural wage

F = farm income, value

Y = parental non-farm earnings

T = technological change

π_0 = non-farm opportunity wage

U = non-farm unemployment

M = infant mortality

and X is a vector of policy and other variables which may influence the productivity and production of farm children and hence farm fertility: B is the associated vector of coefficients.

III. Empirical Analysis

In this section the farm fertility model is applied to three data sets which provide aggregate cross-sectional period measures of U.S. rural-farm birth rates on a quinquennial or decadal basis extending over the period 1939 to 1970. Because the model was formulated in terms of the demand for the stock of surviving children, and thus measures of completed family size are more appropriate counterparts to the theoretical control variable, attempts are made to adjust the fertility measures available in each set so that they reflect cross-sectional differences in desired family size rather than short-run stock adjustments. Cohort measures of completed fertility, available for the later data sets, are not used because many of the variables implicated by the model are not available on an age-specific basis or are, like the expected farm worker and opportunity wage rates, environmental or market parameters whose temporal relation to completed family size is unclear. Thus the empirical results should be interpreted with caution because any statistically significant economic relationship obtained from the data may reflect some stock-adjustment in addition to completed family size decisons.

1. Pooled Cross-Sections 1939-1960

Since 1920 the Department of Agriculture has made estimates of the size of and the important components of changes in the farm population on an annual basis for the nine geographical divisions of the United States. Fertility measures were constructed from this series by dividing the total number of births in years t to t+4 of division i by 5 times the average of the total farm population i in years t to t+4.[27] These birth rates are thus averaged over five-year periods to purge the variables of short-term components and attribution errors and were centered, with a lead of two years, on the Agricultural Census years. Because of the lack of many of the independent variables necessary for a complete specification of the farm fertility model, for purposes of multivariate regression analysis the pre-1938 data were not utilized. Thus the sample consists of a time-series of five quinquennial cross-sections for the nine geographical divisions from 1939 to 1960, 45 observations.

Because the averaged crude birth rate is not standardized for the age-sex composition of the population,two demographic variables were included on the right-hand side of the regression equation--the percentage of farm operators aged 25-49 (AGE), corresponding roughly to the child-bearing ages of women, and the average age of farm operators (AVAGE) from the U.S.D.A. Censuses. These variables were selected because the age-composition of farm women is not available on a quinquennial basis and because the Population Census definition of the "farm" population prior to 1960 differs appreciably from that of the Department of Agriculture; data from the two sources in the same year are thus not compatible.

Two of the most problematical economic variables implicated in section II with respect to an econometric analysis of agricultural birth rate determination are 'full' farm income and technological change. With regard to the former, it can be shown that reported net farm income, the most readily available variable, is not independent of (exogenous to) numbers of children and thus its use as a proxy for farm income would contaminate the coefficients of the OLS and GLS regression equations and provide a biased estimate of the farm income-fertility relationship.[28] A variable representing potential farm income would be statistically permissable and more theoretically appropriate. Fortunately such a proxy is available for the farm sector--farm value (VAL), a datum collected by the Department of Agriculture by states quinquennially since 1920. The price of the farm should reflect the best (most profitable) employment of the farm land and is therefore independent of the actual net income foregone or gained by the farmer in his "purchase" of children. The value of the farm is also a good proxy for permanent income, being less affected by business and climatological fluctuations than is annual income, which makes it more applicable to consumer durable decisions, of which family size is one. Since the fertility variables are averaged over a five-year period, the exclusion of transitory phenomena should improve the empirical results.

A more serious problem, however, is that data on the earnings of farm families derived from off-farm employment, which ranged from approximately 22 to 38 per cent of total net farm income over the period,are not available prior to 1964 on a divisional basis. The magnitude and direction of the specification errors imparted to the pooled sample parameter estimates, however, can be assessed on the basis of the 1960 and 1970 cross-sectional results.

Technological change has played a major role in the farm sector in the United States since its concomitant, agricultural productivity growth, combined with price and income inelasticities of farm output demand, has necessitated a secular decrease in the number of people contributing to farm production. In an econometric specification in which potential farm income is one of the independent variables, technical progress will reduce the demand for labor on a farm, and hence the optimal stock of children, as long as the income and expansion effects of technical progress are totally embedded in farm value. Employment change is used as a proxy for the decline in labor (and hence family worker) demand in the farm sector due to technical change as well as other factors. Those leaving agriculture are also, of course, responding to income differentials between the farm and non-farm sectors; that is, a ceteris paribus increase in non-farm opportunities should decrease employment in the absence of any change in the demand for agricultural labor. For employment change to be a proxy for alterations in the <u>demand</u> for farm manpower, opportunities in the two sectors must be controlled (entered in the regression); viz, farm income, agricultural wage rates, and non-farm wages. At the same time, the analytical framework developed in Section Two suggests that these same parameters which act as control variables, influence farm fertility directly through their effect on the "depreciation" of the stock of children--farm child migration.

The percentage total employment decline (EMP) was constructed by dividing the difference between the total employment in year t and t+1 by the total employed in year t. Thus a decrease in employment would be represented by a positive number. These per-cent differentials were then averaged over five-year periods, again centered on U.S.D.A. Census years. If technological change over the period 1939 to 1960 has not been too labor biased, the coefficient of this variable should be negative; a decrease in employment due to reductions in the demand for labor should decrease the demand for farm children if the farmer expects the reduction in labor demand to continue. To the extent that farm value and the opportunity wage do not control for farm employment supply changes, the employment change variable may also act as a parameter which influences the farmer's expectation of the likelihood of his children's or his own migration.

Employment change is thus utilized as an economic rather than as a demographic variable. However, employment change may be correlated with migration, which has a demographic effect on fertility in the same direction; a net increase in the outflow of farmers, because younger age groups are more mobile, would reduce the aggregate unstandardized farm birth rate (such as the farm crude rate) even in the absence of the postulated economic relation by diminishing the farm population of high fertility.[29] To the extent that the average age and age distribution variables capture these demographic effects, the employment change variable will reflect the impact of technological progress on the demand for children.

The expected opportunity non-farm wage (OPW), which acts both on farm fertility directly by attracting children away from the farm and thus raising their lifetime shadow price and indirectly as a control for the farm labor demand proxy (employment change), is represented in the pooled sample by the wage rate of common laborers in selected non-agricultural industries. This wage corresponds to the payment level that most farm migrants would receive initially, although it may not be the appropriate proxy for the expected income stream in the non-agricultural sector to which the prospective migrants respond.

The wage rate of hired farm laborers (HW) enters the regression as the price of the wife's time on farms which purchase labor, as the price of the substitute production factor for farm children, and as a proxy for agricultural worker farm opportunity. The variable used in the pooled regressions is the composite hourly wage as reported by farmers as paid to farm workers, averaged over five-year periods centered on the Agricultural Census years. This parameter, average farm value (VAL), and the opportunity wage were divided by the index of prices paid by farmers for consumption goods in the appropriate years.

The infant mortality variable used is the death rate of infants less than one year of age for the population in cities of less than 10,000, again averaged over five-year periods centered on the agricultural census years. These data suffer from two major shortcomings for the purposes of this study: 1) the data are not reported on a residence basis prior to 1960 so that if women in the farm population bore their children in cities rather than in rural areas the rural mortality rate may be inappropriate and 2) the infant mortality rates, even when defined on a residence basis, are not allocated between the farm and rural-nonfarm populations. To the extent that the relationship between the mortality rate in the two groups differs significantly among divisions or states in a way not uncorrelated with farm fertility, the coefficient of this variable may be biased.

The impact of changes in infant mortality rates on the birth rate measure used in this section is ambiguous. If infant mortality were costless, among parents who desired the same number of surviving children those who experienced or anticipated high levels of child mortality would be observed to have higher birth rates (replacement effect). Given, however, that infant mortality does increase the cost of achieving any desired number of surviving children as was shown in section II, the net influence of the infant death rate on birth rates will depend upon the relative strengths of the positive replacement and negative cost effects.

The human capital embodied in the farm parents may also play an important and multifaceted role in farm fertility decisions. Because there are a variety of channels through which parental educational attainment (as one proxy for human capital) may affect fertility in the analytical framework adopted here no attempt will be made to predict the signs of the coefficients of these variables.[30] In this sample, the median years of schooling of men and women aged 25 years and over (EDM,EDF), taken from the decennial population censuses and linearly interpolated for the intercensal years are used.

Once the basic fertility structure is specified, other variables which have been hypothesized to or may affect fertility can be added to assess their independent importance. The percentage of non-white farm operators (NONW) is entered to see if there are racial differences in farm fertility not accounted for by age, education, and income as found by Gardner (1972) using 1960 census farm data.

Another possible influence on the farm birth rate, not previously tested, is compulsory schooling legislation.[31] To measure the impact of these laws on farm fertility, the lawful minimum age of school leaving (EDLAW), every quinquennium, by divisions, is entered. Compulsory schooling laws, if effective, should have a negative effect on farm fertility for two reasons: 1) they may (initially) reduce the productivity of farm children in farming, and hence increase their full price, by requiring their absence from the farm beyond the point deemed optimal by the parents and 2) in the fertility models of Becker and Lewis (1973) which consider both quality and numbers of children as separate commodities, the relative price of quantity is positively related to the amount of quality; an effective compulsory education law would exogenously increase quality and hence lower the demand for numbers of children. One problem with testing the effects of laws, however, is that they are, in part, the product of the optimizing decisions of the affected groups. However, since the farm population makes up such a small percentage of the total population it is likely that compulsory schooling legislation has not been influenced to a significant extent by it. The exogeneity of the laws is less questionable in the context of rural-farm fertility. Thus, to the extent that the compulsory schooling variable coefficient is statistically significant, the coefficients of the other variables can be interpreted as measuring the effect of a variable change on birth rates, holding constant child quality.

Table 1 reports the coefficient estimates obtained by the application of ordinary least-squares (OLS) to the levels of the variables and from generalized least-squares (GLS) regressions in which the variables were transformed and the coefficients estimated according to the two-stage procedure suggested by Nerlove (1971).

In the OLS equation (column 1), the variables implicated in the model, in combination with the relevant controls, account for over 80 per cent (adjusted) of the divisional variation in agricultural crude birth rates over the period 1939 to 1960. All the coefficients display signs predicted by the model and are significant at the five per cent level (two-tailed test) except for that of the linear VAL term. The net effects of farm value and the agricultural wage rate on the birth rate, evaluated at the sample means, are negative and positive respectively, a result consistent with the numerical dominance of non-labor-hiring farms. Thus, on average in the sample period the value of the time of farm women appears to be endogenous and positively related to farm value. The hired wage rate effect on average reflects, in part, the value of children rather then the price of the farm wife's time.

The signs and significance of the coefficients of OPW and EMP are both consistent with the hypothesis that the demand for and the supply response of farm labor were important influences on the fertility of the rural agricultural population. The negative OPW coefficient, interpreted within the framework of the model, indicates that farm children were net assets when mature during the period—expected outmigration therefore raised the anticipated cost of farm children.[32]

On the demand side, the significant negative effect of employment decline on farm fertility is consistent with the hypothesis that technological change reduced the demand for children within the agricultural sector during the sample years. Such a result, however, may also reflect the demographic impact of the exodus of the younger age cohorts in the farm population. In order to assess the magnitude of the demographic relation, if any, average net migration (MIGR) was used in place of the EMP variable (col. 2). It was expected that the migration variable, since it is defined over the same population as the dependent variable,would be more likely to directly influence the age distribution of that population than would the change in the number of persons employed in agriculture and thus would have a significant and negative impact on the crude birth rate <u>if</u> neither AGE or AVAGE adequately controlled for age distributional effects. The insignificance of MIGR, however, appears to support the hypothesis that the employment change variable is acting more as a proxy for the decline in the demand for agricultural manpower than as a demographic variable in the equation.

Infant mortality has a significant and positive influence on the farm crude birth rate indicating that the mortality replacement effect dominates the cost effect on surviving children. NONW also has a significant and positive coefficient, which is consistent with the hypothesis that non-white farm families during this period had more children than white farm families, controlling for age, education, income and mortality. This variable may, however, be picking up regional price differentials not otherwise accounted for in the regression specification.

The coefficient on compulsory schooling laws has the predicted negative sign, but is not significantly different from zero. Neither of the parental schooling coefficients are statistically significant; however, this latter result appears to be due to multicollinearity--removal of both schooling variables significantly diminishes the explanatory power of the equation (F-test, 5 per cent level).[33]

The GLS coefficient estimates are displayed in columns three and four. Approximately 73 per cent ($\hat{\rho} = .7245$) of the variance of the disturbances obtained in the OLS estimates are attributed by this technique to errors specific to regions. Thus these equations give a relatively large weight to the time-series dimension of the pooled data.

The model appears to perform less well when this regression procedure is utilized. Although all the coefficients display the theoretically specified signs, only those of VALHW and EMP are significant (10 per cent level) and only the infant mortality variable retains its original level of significance. The parental schooling and EDLAW coefficients are significantly increased, however, with those of EDF and EDLAW attaining significance at the 5 and 10 per cent levels respectively. The coefficient of NONW is no longer significant.

The GLS results appear to suggest that the OLS cross-sectional estimates, which strongly confirm the predictions of the model, would provide a misleading picture of the importance of the economic variables derived from the model in explaining the behavior of farm fertility over time. An alternative interpretation, however, is that the reduction in coefficients of the economic variables resulting from the use of the GLS estimating procedure is due simply to errors in-variables. The transformation of the variable levels in the GLS technique, because of the high value of $\hat{\rho}$, approaches first-differencing which has been shown by Taubman and Friend (1966)to result in downward-biased coefficients if the level variables are measured with error.

To directly assess the ability of the OLS and GLS equations to track the temporal movement in farm fertility, sample means of the independent variables in the Agricultural Census years were used in the two equations to compute predicted values of the crude birth rates. These estimates were then compared with the actual agricultural crude birth rate averages for both the five sample years and for the extra-sample years, 1925, 1930, and 1965,for which aggregate values of the independent variables and the birth rates are available.

Table 2 reports the results of these computations, figure 4 plots the actual and predicted crude birth rate values for the 9 periods. They indicate that the performance of the OLS regression equation in tracking the time-pattern of average farm crude birth rates from 1925 to 1965 is clearly superior to that of the GLS regression--the root-mean-square error, based on the 9 observations, (.0369) is almost 1/2 that for the GLS predictions (.0627). Moreover, as figure 4 shows, the OLS equation successfully "predicts" the crude birth rate "baby boom" (turning point and amplitude); the GLS equation does not.

2. Cross Sections 1960, 1970

While the pooled sample OLS regression results appear to verify the predictions of the model, the coefficient estimates may be biased since an important constraint on the demand for farm children, income earned off the farm, is omitted from the equations. The availability of this data by state in 1964, however, enables a full specification of the model for both the 1960 and 1970 regressions.

Another problem with the pooled sample results, despite the insignificance of the migration variable, is that AGE and AVAGE may not have completely controlled for the demographic components of the movements in averaged crude farm bir rates, some of which may have been correlated with the economic variables. The Census of Population, however, provides data for 1960 and 1970 on the number of children under age 5 by 5-year age groups of farm women on a state basis, making it possible to construct fertility measures which are standardized for the age-composition of married women.[34] The use of this fertility measure, however, because it is based on the number of living children will result in a downward biased estimate of the effect of infant mortality on births since in those areas where child death rates are relatively high, the stock of surviving children will be reduced in size. Aside from this effect, none of the other variable coefficients should differ qualitatively from the coefficient estimates obtained from the pooled sample provided that the age variables in the latter adequately controlled for demographic influences.[35,36]

In addition to the off-farm income variables (NFY, NFYVAL), the unemployment rate of urban males aged 20-29 (U), as a proxy for the probability of off-farm employment, is added to the set utilized in the pooled sample regressions and an index representing the change in total factor productivity since 1950 (TFP), constructed by Evenson and Landau (1971) was tried as an alternative measure of technical change in agriculture.

The results of the 1960 OLS regressions are reported in columns 1 through 4 in Table 3. In the first column, the specification corresponds to that used in the pooled sample except that the urban unemployment variable is added. All the variable coefficients display the same signs as in the pooled sample equations and all but the infant mortality, employment change, and opportunity wage variables are significant, although the latter two approach significance and the insignificance of the IM coefficient can, in part, be explained by the nature of the fertility measure used. The coefficient of U is significant and displays the correct sign.[37]

Both the parental schooling variables are significant at the 5 per cent level, with male schooling exerting a positive and female schooling a negative influence on the birth rate measure. These latter results are consistent with those obtained from 1960 Census data for the farm population by Gardner (1972) and for the total population by DeTray (1973). However, when the off-farm income and interaction variables are introduced (col. 4) the coefficients on the education terms lose their significance. The coefficient on EDLAW is of the correct sign and approaches statistical significance in all specifications.

The TFP variable used in place of EMP produced no improvement in results. Thus the 1960 evidence fails to confirm the negative impact of technological change on the demand for children that was obtained from the pooled sample covering an earlier period. Whether this result is an indication that the productive contribution of farm children had become less significant by 1960 or whether it indicates that the EMP variable in the crude birth rate equations was not completely purged of demographic influences cannot be ascertained from the data.

When NFY and NFYVAL are entered in the equation the coefficients on these variables display the signs predicted by the model; the coefficient of the interaction term is significant at the 5 per cent level. Equally important, however, none of the signs or significance levels of the coefficients of the other variables implicated in the theoretical analysis are changed except for the opportunity wage coefficient. Thus, it appears that the omission of the off-farm income variables from the pooled sample regressions imparted a serious bias only to the coefficient of OPW. To the extent that off-farm income was a less important component of farm family earnings during the period 1939-1960, however, the alteration in the size of the OPW coefficient in the 1960 equation overstates the magnitude of the specification bias.

The 1970 regression results, cols. 5-7, appear, however, to be greatly improved by the inclusion of the off-farm income variables (col. 7). In the complete equation the NFY, NFYVAL, VALHW, and HW coefficients all achieve significance and display signs consistent with the analysis of section II.

The explanatory power of the equation is also from 30 to 40 per cent higher than in the 1970 regressions excluding those variables. This greater sensitivity of the 1970 regression coefficients to the exclusion of the off-farm income variables relative to the 1960 results is not surprising, however, in view of the significantly greater importance of off-farm income as a proportion of the total income of families in the agricultural sector in the late 1960's (almost 50 per cent by 1970) compared to earlier periods.

Another distinctive feature of the 1970 results consistent with the changing character of U.S. farming is the positive sign of the coefficient of the opportunity wage variable and the lack of significance of the urban unemployment variable coefficient. The prediction that OPW would negatively and U positively affect farm fertility, was predicated on the assumption that farm children were net assets when mature, thus farm parents faced the prospect of higher priced children as the anticipated 'depreciation' of the stock of children increased. If, however, by the late 1960's farm technology had reached the point where few farms could profitably employ any full-time worker (other than the operator and his wife) then the predictions of the model must be revised with respect to migration-related variables. If farm children are now net absorbers of resources every year of their lives, as in the urban sector (they may consume less per year, however), then these parameters would have little or perhaps the opposite effect on farm family fertility decisions, as is suggested by the 1970 results.

Thus the 1970 regression estimates, when analyzed in the context of the results obtained from data relating to prior years, appear to indicate that by 1970 the farm sector had become significantly urbanized: off-farm income had begun to play a significantly more important role in farm fertility decisions than in the past and an important qualitative change in the fertility-related productive nature of farm children resulting from a switch in the net value of <u>mature</u> farm offspring from positive to negative appears to have occurred in the 1960's.[38]

IV. Components of Change in U.S. Farm Fertility 1925-1965

In this section the estimated (pooled sample) farm fertility model is used as an instrument to identify the principal factors accounting for the trends in farm fertility from the second decade of the Twentieth century to 1965. In the introduction it was noted that the movements in the crude farm birth rate could be usefully divided into two periods on the basis of the 1920-1968 annual CBR series--the 1920-1940 period, when the fertility rate of the farm sector declined at a much less rapid pace than that of the non-farm population, and the 1945-1968 years when the farm crude birth rate fell, more or less continuously, at a greater rate than in the preceding period and at a faster pace than the non-farm rate within the period. The <u>predicted</u> average quinquennial farm crude birth rate series is similarly divided so that the components of the changes in fertility within each period can be examined to assess the importance of the role of the economic variables highlighted here in the secular decline in the farm crude birth rate.

Table 4 column 1 contains the changes in the variables affecting crude birth rates from 1925 to 1940; the second and third columns report the contribution of each to the predicted change in fertility according to the coefficients estimated by the OLS and GLS techniques respectively. As the OLS equation appears superior in its ability to track the movement of the average crude rate over time, only the OLS results are discussed.

The OLS predicted fall in this period is 3.8 births per 1000 in the farm population, a decline of 15 per cent, and the actual decline was 2.6 births or 10.2 per cent. The most important determinants of the fall in the farm birth rate in these years appear to be the decline in the proportion of women of child-bearing age, the relatively greater outmigration of non-whites, who had, ceteris paribus, larger families than farm whites, and the decline in infant mortality. The combined changes in these "demographic" variables (including AVAGE) would have decreased the farm crude birth rate over this period by 15.9 per cent in the absence of alterations in any of the other parameter values.

Except for the employment change decline, the net effect of changes in the economic variables in these years is to predict, ceteris paribus, a rise in farm fertility, as real non-farm opportunities and the real value of farms actually declined in the period. The increase in the reduction in farm employment, however, depressed the farm birth rate. Thus, it appears that, controlling for the effects of changes in demographic variables, the attenuation of the crude birth rate decline in the farm sector relative to that in the non-farm population during the depression is related to the economic situation of those years and the unique economic structure of the farm family: The imputed price of the farm wife's time, and hence the shadow price of farm children, decreased during this period because of the fall in real farm income; the relative decline in non-farm opportunities meant that the probability of the migration of productive farm children or the farm family was reduced, thus further lowering farm child price. The decline in farm labor demand, however, as represented by the employment change variable, raised the relative price of children somewhat.

A quite different picture emerges in the post-war period component changes, cols. 4-6. In these years the effects of the economic parameters dominate the demographic influences. The predicted farm birth rate fall from 1943-47 to 1963-67 is 6.3 births per 1000 compared to the actual decline of 6.8 births per 1000 (26.9 per cent). The net effect of changes in VAL, HWVAL, HW, OPW, and EMP is to predict a decline in post-war farm fertility of 6.5 births per 1000, or 25.8 per cent, all other parameters unchanged. The set of demographic variables, defined above, would have, in the absence of any other changes, reduced fertility by only 12.0 per cent. Thus, the greater farm fertility decline, as measured by the crude birth rate, in the post-war period relative to that of the pre-war years is due to the larger increases in farm value and the opportunity wage and the greater decline in farm labor demand in the later years.

The decrease in the farm relative to the non-farm crude birth rate in this period can also be partly attributed to the effects of the economic variables since the depressive influence of increases in OPW and the decline in farm labor demand presumably do not affect non-farm fertility. If these variables had no influence on farm birth rates, or if in the 20-year period their values remained constant, the farm crude birth rate decline would have been 67 per cent less than that predicted. It appears that the rise in farm value during the post-war period decreased farm fertility because of a positive correlation in the aggregate between the farm wife's time value and farm size or income due to the fact that a relatively small proportion of farm wives work in the market for a constant wage rate and a relatively small number of farms utilize hired labor on a regular basis. The rapid rise in the income of the farm sector relative to that of the non-farm population during the post-war years thus appears also to have contributed to the reduction of farm relative to non-farm fertility and the attenuation of the "baby boom" in the farm sector.

V. Conclusion

A static, non-sequential, multi-period model of farm family fertility behavior was formulated in which both the utility and income-generating roles of children are explicitly considered. The model represents a first and preliminary step towards attaining a generalized theory of the household that is not restricted to the socioeconomic environonment of an urbanized society. It is shown that not only do the price of time and income effects of such a framework differ from those implicated in 'consumption' household models, but that parameters pertaining to the market for agricultural labor are important determinants of farm family fertility. Movements in these variables appear to have contributed significantly to the changes in farm population birth rates in the United States in the post-war years and explain, in part, the differential dynamic behavior of farm and non-farm fertility over the period 1925-1965.

Evidence was obtained indicating an economic linkage between agricultural ou migration and reductions in family size within the farm sector in the period 1939-1960. On the demand side, technological improvements in agriculture have reduced the demand for farm manpower resulting in both migration from farms and a diminution in the demand for fa mily labor. On the supply side increases in non-farm relative to farm opportunities have induced farm children to leave agriculture; the prospective outmigration of farm children or the farm family when the children would be income providers increases the net cost of children and lowers fertility in the farm population. Multivariate regressions on 1970 data, however, provide evidence of the transformation of <u>mature</u> farm children in the U.S. from production to consumption commodities as a result of the continuous decline in the demand for full-time farm labor over the past decades. This phenomenon combined with the increased importance of off-farm income in farm family income imply that the dynamic behavior of farm and non-farm fertility will be more similar in the future, although farm families will probably remain larger.

Because of the aggregate and crude nature of the data, the empirical results are suggestive rather than conclusive. Further work is needed both on analyzing (and collecting) micro data on and modelling the time allocation of children and other family members in farm, household, and market activities over the life-cycle in order to better understand the role of and motivation for children in rural agricultural areas.

References

Becker, Gary S. "An Economic Analysis of Fertility." in Demographic and Economic Change in Developed Countries. Universities-National Bureau Conference Series 11. Princeton, N.J.: Princeton Univ. Press, 1960.

Becker, Gary S. and Lewis, Gregg H. "On the Interaction between the Quantity and Quality of Children." J.P.E. 81 no. 2, suppl. (March 1973, Part II): 279-288.

Ben-Porath, Yoram. "Economic Analysis of Fertility in Israel: Point and Counterpoint." J.P.E. 81 no. 2, suppl. (March 1973, Part II): 202-233.

David, P.A., and Khendert, Theovander. "Biased Efficiency Growth and Capital-Labor Substitution in the United States 1899-1960." A.E.R. (June 1965): 357-94.

DeTray, Dennis. "Child Quality and the Demand for Children." J.P.E. 81, no. 2, suppl. (March 1973, part II): 70-95.

Easterlin, Richard A. Population, Labor Force, and Long Swings in Economic Growth The American Experience. General Series 86. New York: Nat. Bur. Econ. Res., 1968.

Freedman, Ronald. "Fertility," in the International Encyclopedia of the Social Sciences, Volume 5, New York: Macmillan, 1968.

Gardner, Bruce. "Economic Aspects of the Fertility of Rural-Farm and Urban Women." Southern Econ. J. 38 (April 1972): 518-24.

Gardner, Bruce. "Economics of the Size of North Carolina Rural Families," J.P.E. 81, no. 2, suppl. (March 1973), part II): 99-122.

Griliches, Zvi. "Comment," J.P.E. 82, pt. 2, suppl. (March/April 1974): 5219-5221.

Hathaway, Dale, Beegle, J.A., and Bryant, W.K. People of Rural America. A 1960 Census monograph, U.S. Gov't Printing Office, Washington, D.C. 1968.

Hayami, Yujiro and Ruttan. "Factor Prices and Technical Change in Agricultural Development: The United States and Japan, 1880-1960." J.P.E. (September 1970): 1115-1141.

Leanos, Theodore P. "Relative Share of Labor in U.S. Agriculture, 1949-1968." A.J.A.E. (August 1971):

Michael, Robert T. "Education and the Derived Demand for Children." J.P.E. 81, no. 2, suppl. (March 1973; part II): 128-164.

Nerlove, Marc. "Further Evidence on the Estimation of Dynamic Economic Relations from a Time Series of Cross Sections." Econometrica 39 (March 1971): 359-82.

Nerlove, Marc, and Schultz, T. Paul. Love and Life between the Censuses: A Model of Family Decision Making in Puerto Rico, 1950-1960. RM-6322-AID. Santa Monica, Calif.: RAND corp., September 1970.

Radoje, Nikolitch. "The Individual Family Farm." in Ball, A.G. and Heady, E.O. Size, Structure and Future of Farms. Ames: Iowa State Univ. Press, 1972.

Rosenzweig, Mark. "The Economic Determinants of Population Change in the Rural and Urban Sectors of the United States," Ph.D. dissertation, Columbia University, 1973.

________. "Economic Aspects of the Fertility of Rural-Farm Women: Comment," S.E.J. 40, (April 1974): 675-679.

Schultz, T. Paul, "Explanation of Birth Rate Changes over Space and Time: A Study of Taiwan." J.P.E. 81, no. 2, suppl. (March 1973, part II): 238-276.

Schultz, T. Paul. "The High Value of Human Time: Population Equilibrium," J.P.E. 82, pt. 2, suppl. (March/April 1974): 52-510.

Stolnitz, George J. "The Demographic Transition: From High to Low Birth Rates and Death Rates," in Population: The Vital Revolution, edited by Ronald Freedman, Garden City, N.Y.: Anchor Books, 1964.

Taubman, Paul and Friend, Irwin. "The Aggregate Propensity to Save: Some Concepts and their Application to International Data," Rev. Econ. and Statis. 48, (May 1966), 113-123.

Willis, Robert J. "A New Approach to the Economic Theory of Fertility Behavior." J.P.E. 81, no. 2 suppl. (March 1973): part II, 14-64.

Footnotes

*I am grateful for the comments and criticisms of Jacob Mincer, James Heckman, James McCabe and members of the Workshops on Labor Economics and Human Resources at Columbia University and on Applications of Economic Theory at the University of Chicago.

[1]Stolnitz (1964) and Freedman (1968) are examples. Easterlin (1968) has computed that in the United States during the period 1895-99 to 1925-29, the proportion of the decline in native-white fertility accounted for by rural-urban migration was 51 per cent.

[2]Easterlin (1968) has shown that between 1915-19 and 1925-29 the reduction in U.S. rural fertility was approximately 10 per cent, almost double that for urban fertility.

[3]For instance Willis (1973), Ben-Porath (1973), DeTray (1973), and Michael (1973). Becker (1960) has a more general framework which is consistent with the model developed here.

[4]T.W. Schultz (1974) has noted this.

[5]Examples based on U.S. data are Gardner (1972), Willis (1973), DeTray (1973), and Cain and Weininger (1974).

[6]Gardner (1972), applied a regression specification derived from the 'urban' household model to aggregate data on the U.S. farm and urban populations and concluded that his farm fertility equation was misspecified. Using a micro sample of rural North Carolina families, Gardner (1973) also found that none of the variables which appeared to contribute successfully to explaining the variation in rural non-farm fertility, could explain any of the differences in the fertility behavior of families headed by farm operators and other families in the sample. Similar differences were obtained by Hathaway et al. (1968).

[7]Thus, the model represents, in part, a rudimentary step towards more closely examining the motives for having children, as suggested by Griliches (1974).

[8] Child services can be considered the product of child numbers and some quality index, Q, as in Willis (1973) and Becker and Lewis (1973). Here it is assumed that Q is unity and that the qualitative relationships between parameters affecting fertility (child quantity) and child quality are identical. The relationship between child quantity and quality is taken up briefly in section III.

[9] In the context of U.S. Agriculture, this assumption does not appear to be grossly inconcistent with reality. In 1959, the proportion of married, spouse-present farm women employed outside of agriculture was 15.9 per cent, rising only to 19.7 by 1965. (Source: U.S. Department of Labor, Bureau of Labor Statistics, "Special Labor Force Reports," Washington D.C., No's 2 and 64). Moreover, computations based on the <u>1964 Census of Agriculture</u> reveal that, at most, 0.5 percent of these women worked full-time off the farm, (see Rosenzweig (1974)). Theoretically it is less probable that farm women will be employed away from the farm than married non-farm women will be employed in the market since farm production represents an outlet for time that is not available to non-farm women.

[10] Second-order conditions constrain f( ) to be subject to decreasing returns to scale since in this partial-equilibrium framework all market supply and demand schedules are perfectly elastic. Farm scale is assumed fixed.

[11] The econometric implications of this in analyses of farm family fertility are discussed in Rosenzweig (1974).

[12] The non-negativety constraint most likely to be binding is that pertaining to the utilization of hired labor, which varies between periods according to

the changing productivity and size of the stock of children. However, labor will be more likely purchased when the child vintage is recent ($j \leq m$) and the wife's time is an important component in farm child cost; when full productivity is reached ($a_j = 1$, $j \geq m$), ℓ_j may be replaced entirely by the children and the farm wife if child depreciation is not great.

[13] Thus, it can be seen that differences in the cost of farm (f) and non-farm (n-f) children that may account for differences in completed family size levels between the f and n-f populations are composed of four components--differences in the price of time of f and n-f mothers, differences in the prices of f and n-f child goods inputs, difference in costs of birth, and the magnitude of the marginal value product of farm children.

[14] The assumption that the farm wife contributes to the production of utility-yielding commodities is also a sufficient condition

[15] It is not necessary to assume that intra-marginal children be profitable for these conclusions to hold.

[16] All derivations are presented in Rosenzweig (1973)

[17] An increase in π_ℓ, however, also diminishes full income, the strength of the income elasticity depending on the share of hired labor costs in full income.

[18] An additional implication derived from the assumption of the positive net worth of mature farm children is that the longer the period m to T, the lower the expected net cost of the stock of farm children. An increase in T, perhaps resulting from reductions in parental mortality, would, therefore, cet. par. result in an increased demand for children. Thus, computations

of the net value of children should be focussed on the mature years instead of only on earlier periods, as in Mueller (1975), for purposes of obtaining direct evidence on the value of children as productive assets or as sources of old age support.

[19]See Loomis and Barton (1961), David and Khendert (1965), Hayami and Ruttan (1970) and Leanos (1971).

[20]Neutral technological progress would also result in a decline in the demand for farm children, holding farm output constant.

[21]In the aggregate market for agricultural products, decreases in marginal cost, unless particularized to individual farms, would lead to an aggregate expansion of output and a lower product price. Since aggregate agricultural product demand is highly price inelastic, total revenue would fall.

[22]The effect of changes in the infant death rate on births is discussed in section III.

[23]The percentage of farms reporting the use of both hired and family labor in the 1959 census week was 13.4; most of the rest of farms used only farm workers. Evidence in Radoje (1972) indicates that the percentages were higher prior to that year and have been declining since 1940.

[24]See Willis (1973) for a mathematical proof of this proposition.

[25]The other variables implicated in the model are suppressed here since their coefficients do not differ between the two models.

[26]The squared F term, which emerges from the arbitrary assumption of linearity, is dropped to avoid problems of multicollinearity.

[27]The dependent variable is thus equivalent to the child-woman ratio except that the numerator is unaffected by child mortality and the denominator is

not restricted to fecund women.

[28]See Rosenzweig (1974) for a mathematical proof and empirical evidence.

[29]Nerlove and Schultz (1970) use migration as a demographic control variable.

[30]For a detailed discussion of education in the context of a non-farm fertility model, see Michael (1973).

[31]Becker (1960) suggests that these laws might have been an important determinant of the fertility decline in the United States.

[32]An alternative interpretation is that the non-farm opportunity wage is a proxy for the value of the farm wife's time and thus the negative OPW coefficient reflects the price of time effect. However, in Rosenzweig (1974) it is shown that when the computed wage of farm women in non-farm employment is entered in the equation, run on 1960 state data, OPW retains its significant and negative coefficient. The coefficient of the price of time variable does not attain significance. All these results are consistent with the low off-farm labor-force participation rate of farm women.

[33]Several interaction terms involving the schooling variables were tried on these and all subsequent regressions, but the coefficients of the variables never attained statistical significance. See Rosenzweig (1973) for a detailed description of these tests.

[34]The dependent variable is the total child woman ratio defined in the Appendix.

[35]AVAGE, the average age of farm operators, is retained as a regressor in the 1960 and 1970 equations. The coefficient of the variable should therefore reflect the impact of lengthening or shortening the time-period of

(pecuniary and non-pecuniary) returns from children and should display a negative sign.

[36]VAL is taken from the 1954 and 1964 Agricultural censuses. IM, HW, and EMP are state averages over the decades prior to 1960 and 1970. OPW is the hourly wage rate of production workers on manufacturing payrolls, averaged over each decadal period.

[37]The positive effect of urban unemployment on the farm birth rate also is obtained when EMP is replaced by the migration variable. U is therefore not acting as a proxy for farm-urban outmigration .

[38]This phenomenon is not due to the disappearance of the relatively small scale family farm, where family farm is defined as any non-institutional farm not operated by a paid manager on which the number of man-hours of hired labor does not exceed that of the family labor of the average farm. (See Radoje (1972)). In 1969, 95 per cent of all U.S. farms were family farms, the same percentage as in 1949, and these farms accounted for 63 per cent of the value of all products sold.

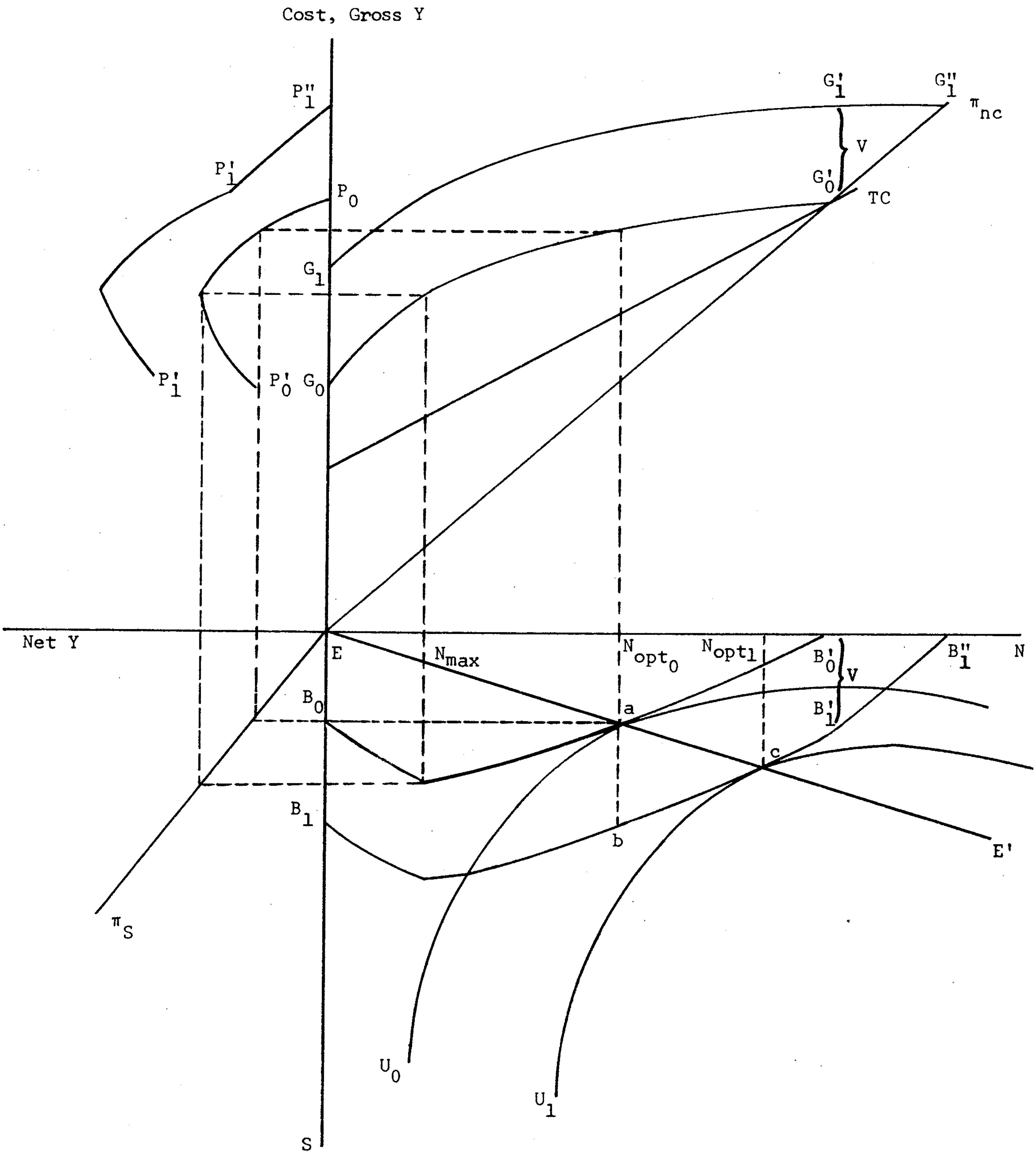
Cost, Gross Y
P''1
P'1
P0
G1
G'1
G''1
πnc
V
G'0
TC
P'1
P'0
G0
Net Y
E
Nmax
Nopt0
Nopt1
B'0
V
B''1
N
B0
a
B'1
c
B1
b
E'
πS
U0
U1
S

Figure 1

TABLE 1

REGRESSION COEFFICIENTS - POOLED CROSS-SECTIONS

GEOGRAPHIC DIVISIONS

QUINQUENNIA 1939-1959

Average Births Per Thousand, U.S.D.A. Farm Population

	Variable Levels	Variable Levels	Transformed Variables	Transformed Variables
HW	20.3785 (3.380)	24.7229 (3.327)	.20622 (0.276)	.97551 (1.199)
VAL	.000264 (1.146)	.000311 (1.187)	.000130 (0.641)	.000161 (0.761)
VALHW	-.001339 (2.123)	-.001365 (1.830)	-.000624 (1.752)	-.000592 (1.012)
OPW	-10.1644 (2.901)	-9.8086 (2.492)	-6.4468 (1.418)	-7.3530 (1.474)
MIGR		-.014260 (0.767)		-.00739 (0.449)
EMP	-.36746 (2.784)		-.22220 (1.685)	
EDW	1.2711 (1.561)	.33982 (0.412)	2.1721 (2.936)	1.9781 (2.594)
EDH	.11067 (0.078)	1.11290 (0.688)	-1.4078 (1.036)	-1.3521 (0.942)
NONW	.22641 (3.067)	.24131 (2.440)	.10052 (1.207)	.08903 (0.989)
AVAGE	.71793 (1.185)	.84810 (1.265)	.34328 (0.534)	.41472 (0.618)
20-44	.65504 (2.793)	.74953 (2.918)	.10527 (0.384)	.08076 (0.280)
IM	.08023 (2.163)	.10828 (2.744)	.08958 (2.467)	.09022 (2.437)
EDLAW	-.46800 (0.677)	-.85656 (1.118)	-1.13025 (1.734)	-1.3164 (1.935)
$\bar{R}^2$	.8074	.7637	.7717	.7532
S.E.E.	1.0305	1.1415	.8445	.8778

Note: t-values in parentheses.

Sources--Crude birth rates: U.S.D.A., Farm Population estimates 1950-59, AMS-80, February 1960, Farm Population: Migration to and from Farms 1920-1954, AMS-10, December 1954, pp.8-14; HW: Agricultural wage rate: U.S.D.A., Crop Reporting Board, Farm Labor, December 11, 1950, p. 9, Farm Labor, February 1961, pp. 6-7; VAL: Average farm value, U.S.D.A., Census of Agriculture, Volume II, 1920, 1925, 1930, 1935, 1940, 1950, 1954, 1959; OPW: Opportunity wage, U.S. Department of Labor, Monthly Labor Review, April 1926, July 1930, January 1941, December 1953, October 1955, October 1959; EDM, EDF: Median years of schooling, males and females aged 25+, U.S. Bureau of the Census, Census of Population, 1940, 1950, Volume II, part 2-50, Census of Population, 1960, PC(1)2D-52D, Table 103; AVAGE: Average age of farm operators: U.S.D.A. Census of Agriculture, 1940, Table 11; 1950, Table 11, (1954), Table 12, (1959), Table 14; NONW: Proportion of non-white farm operators: U.S.D.A., Census of Agriculture, 1940, Table 19; 1950, Table 18; (1954), Table 21; 1959, Table 22; EMP: Per-cent employment change: U.S.D.A., Crop Reporting Board, Farm Labor, February 10, 1954, Farm Labor, December 12, 1961; IM: Infant mortality rate, U.S. Bureau of the Census, Vital Statistics Rates in the United States 1900-1940, (1943), Table 28, Vital Statistics, "Special Reports--National Summaries," 1940-1960; EDLAW: Compulsory education laws: U.S. Office of Education, The School Census, Compulsory Education and Child Labor Laws--State Laws and Regulations, Bulletin No. 1, (1945), U.S.O.E., Ward Keesecker, Compulsory School Attendance and Minimum Educational Requirements in the United States, Circular No. 440, U.S. Department of Health, Education, and Welfare, Office of Education, Alfred Allen, Compulsory School Attendance and Minimum Education Requirements in the United States, Circular No. 278, September 1950, Carl Sokolowski, State Laws on Compulsory School Attendanee, Circular No. 793 (1966).

TABLE 2

AVERAGE PREDICTED AND ACTUAL CRUDE FARM BIRTH RATES 1925-1965

Period	Birthrate Averages			Per-cent Predicted Error	
	Actual	Predicted			
		a. Levels	b. Transformed	a. Levels	b. Transformed
1923-1927*	25.43	25.91	26.28	+1.44	+3.34
1928-1932*	23.89	24.11	25.22	+0.92	+5.57
1933-1937*	22.15	23.46	24.54	+5.89	+10.79
1938-1942	22.84	21.91	23.33	-4.07	+2.15
1943-1947	25.18	25.24	23.43	+0.25	-6.95
1948-1952	24.13	22.39	23.11	-7.19	-4.23
1953-1957	22.49	22.54	21.59	+0.23	-4.00
1958-1962	20.53	21.23	21.58	+3.41	+5.11
1963-1967*	18.40	18.22	20.41	-0.98	+10.92

Note: All monetary values deflated by farm consumption goods price index.
Predicted values derived from equations without EDLAW.
* Denotes extra-sample observations, education values extrapolated.

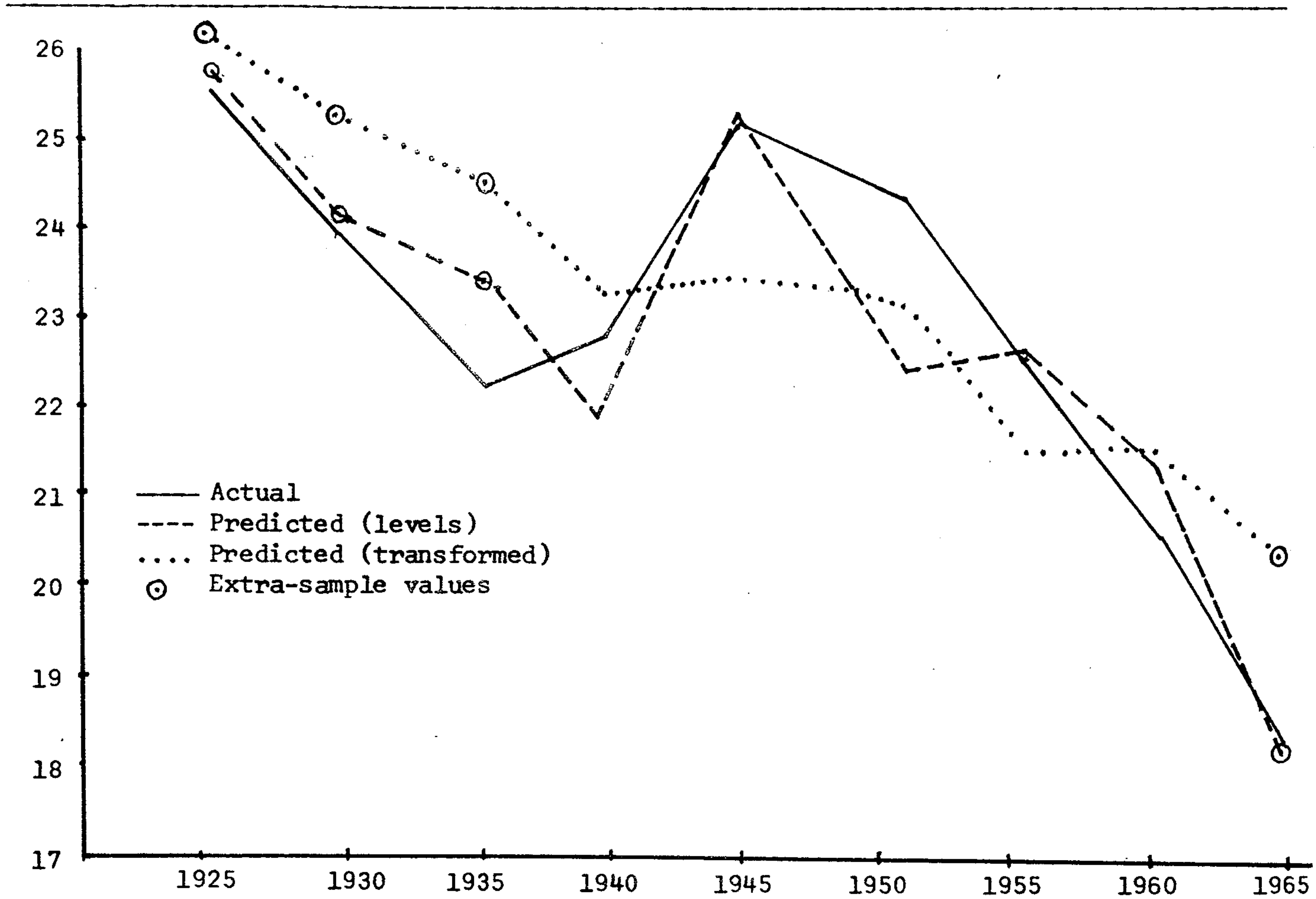

Figure 2

TABLE 3

REGRESSION COEFFICIENTS - CROSS SECTIONS

STATES

TOTAL CHILDREN 0-5 PER WOMAN, AGE-SPECIFIC

15-49[1]

	1960				1970		
HW	4696.73 (3.819)	4718.59 (3.843)	4773.06 (3.839)	4344.37 (3.623)	871.690 (1.014)	800.081 (0.859)	.664.96 (2.178)
VAL	.11102 (3.334)	.11046 (3.300)	.10940 (3.232)	.07658 (2.156)	.01313 (1.605)	.01256 (1.445)	.0044 (0.559)
VALHW	-.13069 (3.446)	-.12772 (3.305)	-.12840 (3.288)	-.14484 (3.862)	-.01257 (1.753)	-.01231 (1.670)	-.0284 (4.107)
NFY			.21918 (0.632)	-.79468 (1.429)		.04225 (0.222)	-.6286 (2.910)
VALNFY				.00003 (2.240)			.0000 (4.330)
OPW	-686.950 (1.612)	-740.781 (1.657)	-848.644 (.759)	-170.522 (1.318)	96.1572 (0.293)	86.8192 (0.259)	561.915 (1.953)
U	153.831 (2.493)	158.057 (2.520)	171.523 (2.657)	137.694 (2.275)	30.4880 (0.455)	26.8256 (0.383)	22.2008 (0.400)
EMP	-34.2122 (0.578)						
TFP		-3.8904 (0.581)	-4.0302 (0.595)	-.22739 (0.034)	-2.0621 (0.438)	-1.8807 (0.388)	-1.7948 (0.467)
EDW	-259.372 (2.446)	-256.464 (2.401)	-225.047 (1.894)	-43.962 (0.330)	90.6639 (0.232)	107.891 (0.267)	406.992 (1.242)
EDH	356.241 (2.395)	246.919 (2.331)	296.134 (1.737)	172.746 (1.047)	-79.1694 (0.321)	-90.9329 (0.355)	-75.854 (0.374)
NONW	24.8679 (1.647)	23.9695 (1.587)	20.9249 (1.308)	18.8992 (1.244)	6.8276 (0.441)	5.0969 (0.291)	14.5369 (1.033)
AVAGE	-136.342 (3.288)	-144.115 (3.325)	-164.396 (3.029)	-159.536 (3.123)	-171.000 (3.139)	-183.968 (2.289)	-125.661 (1.930)
IM	-.83146 (0.048)	-1.9123 (0.112)	-3.6419 (0.208)	-4.8919 (0.295)	10.2489 (0.292)	12.0866 (0.330)	25.5999 (0.878)
EDLAW	-42.7281 (1.490)	-45.5983 (1.570)	-49.3539 (1.648)	-41.5547 (1.447)	-76.9571 (0.707)	-83.8628 (0.730)	31.1702 (0.329)
C	8525.98	9424.47	10667.9	9652.57	12094.5	12723.1	4313.996
$\bar{R}^2$	.5766	.5766	.5824	.6259	.4470	.4479	.6646
S.E.E.	418.3	418.2	422.5	400.8	404.7	411.0	325.83

Note: t-values in parentheses

1. Defined in the Appendix.

Sources -- TC-W: U.S. Bureau of the Census, Population Census 1960, PC(1)2D-52D, Table 114, Population Census 1970, "Detailed Characteristics," Parts 2-52, Table 163; AVAGE: Average age of farm operators, U.S.D.A., Census of Agriculture 1959, Volume Two, Table 24, p. 12, Census of Agriculture 1964, Volume Two, Table 8, p. 527; EDF, EDM: Median years of schooling, females, males aged 25+, U.S. Bureau of the Census, Population Census 1960, PC(1) 2D-52D, Table 103; Population Census 1970, "Detailed Characteristics," Parts 2-52, Table 148; VAL: average value of land and buildings, U.S.D.A., Census of Agriculture 1964, Volume Two, Table 12, p. 25; HW: Agricultural wage rate, U.S.D.A., Crop Reporting Board, Farm Labor, February 1961, pp. 6-7, December 12, 1968, pp. 23-29; OPW: Hourly earnings of production workers on manufacturing payrolls, U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings Statistics for States and Areas 1939-1967, Bulletin No. 1370-5, August 1968; IM: Infant mortality rates, U.S. Bureau of the Census, Vital Statistics, "Special Reports--National Summaries," 1950-68; NONW: Proportion of farm males non-white, U.S. Bureau of the Census, Census of Population 1960, PC(1)2D-52D, Table 103, Census of Population 1970, "Detailed Characteristics," Parts 2-52, Table 148; EDLAW: Minimum school-leaving age, U.S. Department of Health, Education, and Welfare, Office of Education, Carl Sokolowski, State Laws on Compulsory School Attendance, Circular No. 793, (1966); U: Urban male unemployment rate, age 20-29, U.S. Bureau of the Census, (1960), PC (1)2D-52D, Table 176, Census of Population 1970, "Detailed Characteristics," Table 164; NFY: Off-farm income per farm, U.S.D.A., Census of Agriculture 1964, Volume Two, Table 25, p. 568.

TABLE 4

COMPONENTS OF CHANGES IN PREDICTED FARM BIRTH RATES

Variable	1925-1940[1] Variable Change	1925-1940[1] Contribution to Change in Crude Birth Rate a. Level	1925-1940[1] Contribution to Change in Crude Birth Rate b. Transformed	1945-1965[2] Variable Change	1945-1965[2] Contribution to Change in Crude Birth Rate a. Level	1945-1965[2] Contribution to Change in Crude Birth Rate b. Transformed
HW	.0038	0.071	0.009	.0351	0.715	0.007
VAL	-1794.7	-0.072	0.040	12492	3.300	1.626
VALHW	-67.28	0.055	0.027	4012.9	-5.375	-2.504
OPW	-.0046	0.033	0.018	.2960	-3.009	-1.908
U	n.a			n.a		
EMP	-2.272	-0.891	-0.630	-5.839	-2.146	-1.297
TFP	n.a.			n.a.		
EDW[4]	1.0	1.329	2.441	2.5	3.178	5.430
EDH[4]	0.9	-0.299	-1.687	1.6	0.177	-2.252
NONW	-8.42	-1.515	-0.845	-3.20	-0.725	-0.322
AVAGE	3.0	2.135	-0.841	2.60	1.867	-0.893
20-44	-5.83	-3.221	-0.371	-7.07	-4.631	-0.744
IM	-25.16	-1.442	-1.265	-11.9	-0.955	-1.066
EDLAW	n.a			0.1	-0.047	-0.113
Predicted Change		-3.82	-3.10		-6.25	-3.020
Actual Change[5]		-2.59	-2.59		-6.78	-6.78

1. Derived from pooled cross-section equations estimated without EDLAW variable.
2. Derived from coefficients reported in Table
3. Derived from 1960 state cross section, Table
4. 1925 values extrapolated from 1940-1965 trends.
5. Derived from sample averages of birth rates.

NOTE: All monetary values deflated by the price index of goods purchased by farmers for consumption purposes (1914-17 = 100).
n.a = not available.

Figure 3: Births Per Thousand, 1920-1968 (Farm —, Total ---)

Sources: U.S. Department of Agriculture, Farm Population: Migration to and from Farms 1920-1954, AMS-10 (1956), Farm Population Estimates, AMS-80 (1960-1968); U. S. Bureau of the Census, Vital Statistics Rates in the United States 1900-1940 (1943), Vital Statistics (1940-1968).

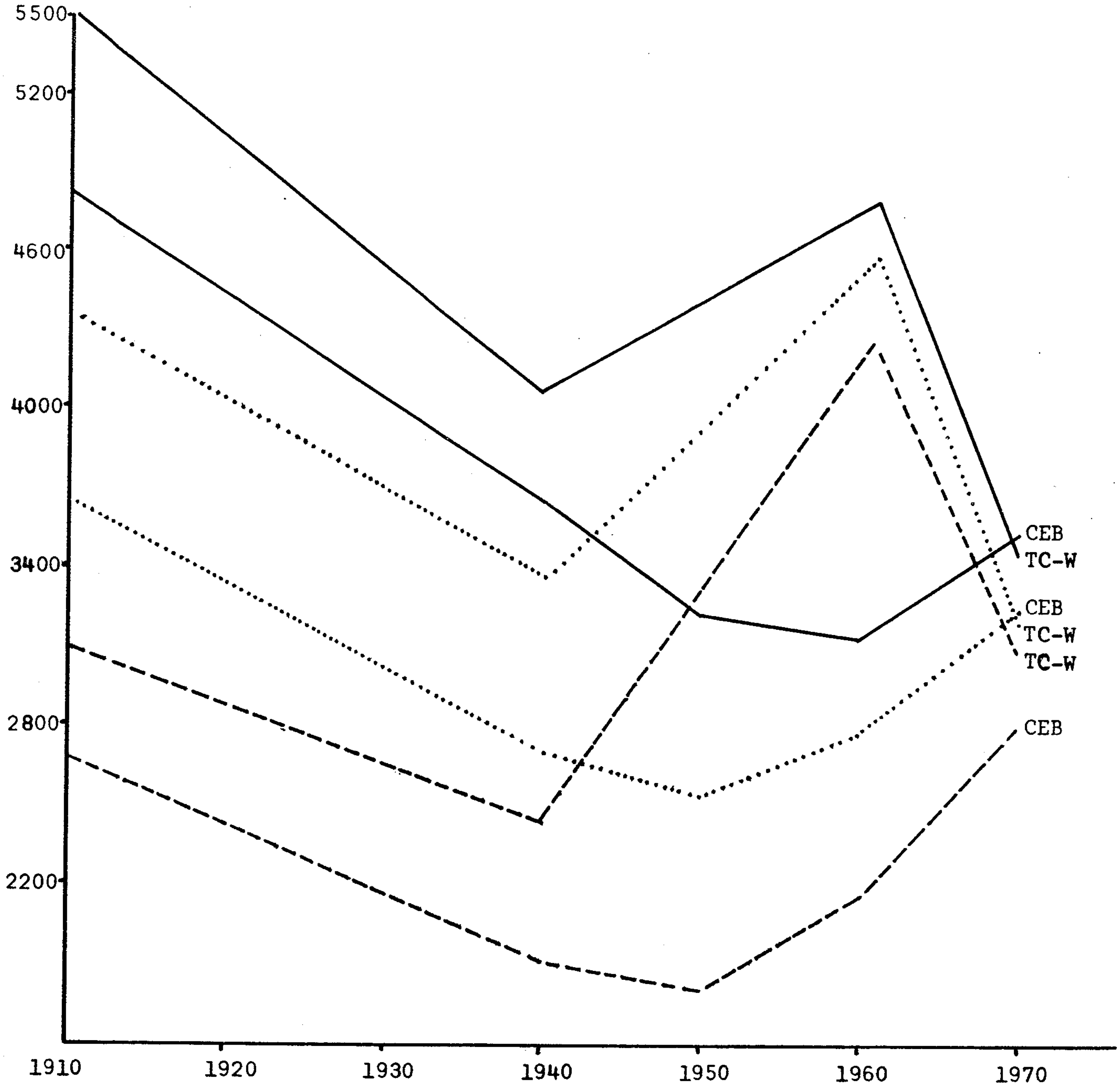

Figure 4: Children Ever Born per 1000 Women 40-44 (CEB), Total Children 0-5, Age-specific per 1000 Women (TC-W)[1], Native-white Farm——, Rural Nonfarm...., Urban---1910-1970

---

[1]Defined in Appendix.

Note--1920, 1930 values not available.

Sources: Bureau of the Census, Special Report, "Differential Fertility 1940 and 1910," (1945), Census of Polulation 1950, Special Report, "Fertility," PE-5C (1954), Census of Polulation 1960, Final Report, PC(1)D, Special Report, "Women by Children Ever Born," PC(2)-3A (1964); Census of Population, 1970 Final Report.

Appendix

Farm and Nonfarm Birth Rate Movements in the United States, 1910-1970

Three measures of fertility in the farm and non-farm populations in the United States covering the period 1910 to 1970 are available. Each birth rate series, however, has shortcomings with respect to depicting changes in the demand for children in the component populations, although all display similar differential patterns.

Annual U.S. farm and total population crude birth rates--births per thousand in the population--from 1920 to 1968 are displayed in figure 3. While the crude birth rate has the most tenuous relationship to completed family size, as it is influenced bv the age-composition of women in the population and the influx of the foreign-born, the rates are serially consistent in that the definition of the farm population over the period remained virtually unchanged.

The series show a marked dissimilarity in the behavior of farm and non-farm fertility within and between periods. From 1920 to 1935, the non-farm crude rate falls by 36.0 per cent while the farm rate only drops 17.0 per cent. (One reason for this phenomenon is the sharp fall in the birth rates of the foreign-born in the non-farm areas, as shown by Easterlin (1968)). From 1935 to 1945 birth rates in the farm and non-farm sectors rise at approximately the same rates but in the 1945-60 period farm fertility, as measured by the crude rate, falls by 18.5 per cent while the urban rate remains relatively stable. The sectoral crude fertility rates actually cross in 1950, the farm crude rate falling and staying below the non-farm rate.

The differential pattern of the crude birth rates in the two populations may be accounted for by differences in age-distributions, particularly since this may be due to the mortality trend. These series also display the "narrowing" of birth rates between farm and non-farm populations and indicate that the 1950 crude birth rate cross-over is most likely due to the demographic impact of the outmigration of the younger cohorts in the farm population.

The T-CW and crude fertility rates are period measures, measures of events in particular years which do not explicitly take into account the reproductive histories of the women involved, and thus may give misleading pictures of family-size choice in the sub-populations. That is, fluctuations in period rates could occur because of differential child-spacing decisions even in the absence of alterations in desired family size. The number of children ever born to historical cohorts of women who have completed their family size is also available from the Population Censuses over the period, although the data are not serially consistent within population sub-groups. The retrospective fertility of native-white women 40-44 for the years 1910, 1940, 1950, 1960, and 1970 is also displayed in figure 4, where it is assumed that women in the age group 40-44 in year i completed their fertility in that year.

The movements of cohort fertility appear to be consistent with those observed in the two period measures for the years 1920 through 1960. The corresponding period for comparative purposes with respect to the cohort rates is 1930 to 1970 since it is likely that fertility decisions are made at least ten years prior to the completion of family size. Thus while period birth rates begin to rise around 1940 this behavior is reflected in larger completed farmilies in 1950. For the 1950-60 period, completed farm cohort the farm sector experienced large rates of outmigration in the period considered. A more refined measure of period fertility, which is purged of the influence of the fertility of the foreign-born and is standardized for the age-composition of women, can be constructed from the Census of Population for the years 1910, 1940, 1950, 1960, and 1970, which report the number of children less than 5 years of age by five-year age groups of native-white women. These age-specific child-women ratios were summed to create 'total' child-women ratios (TC-W), and this series is displayed in figure 4 for the rural-farm, rural-nonfarm, and urban populations. Two shortcomings plague these series. Prior to 1960, the Census of Population definition of the farm population differs from that used by the Department of Agriculture so that the T-CW rates prior to that year are not compatible with the crude birth rates in figure 3 or the T-CW rates for 1960 and 1970. As the pre-1960 farm population definition is on a residential basis, including all families residing on farms whether or not they were engaged in agricultural production, and the more recent data pertain to families primarilly connected with agricultural operations on farms of minimum size and product value, it would be expected that the farm series understates the secular decline in the demand for children in families engaged in farming. A second problem, creating an upward bias in the trend of all three population TC-W rates, is that the TC-W rates are affected by the decline in infant mortality since they are computed from data on surviving children.

Despite these differences in fertility measures, the T-CW rates show a similar pattern to that displayed by the crude birth rate series. Farm fertility declines at a more rapid pace over the whole period 1910-1960. The urban T-CW actually shows an increase over the whole period, although fertility still falls, however, while that of the nonfarm cohorts rise. Over the 30-year period 1940-70 the cohort patterns depict farm fertility declining, while urban and rural non-farm fertility rise.