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THE OLD AGE SECURITY HYPOTHESIS AND POPULATION GROWTH

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SUMMARY

In traditional societies it is often argued that parents' desire for old age security in the form of transfers from their children provides an important motive for childbearing. Some doubt has been cast on this "old age security hypothesis" by recent estimates which suggest that the rate of return on investments in children tend to be negative in most developing countries.

This paper presents a theoretical model which integrates micro-level decision making about fertility and life cycle consumption into a dynamic macro-level model of overlapping generations in order to investigate the implications of this hypothesis. In this model, observation of a negative rate of return to children and positive population growth in a traditional society may imply (1) that the old age security motive for childbearing is, in fact, very strong; (2) that the rate of population growth is "too high" from a Paretian point of view; and (3) that each individual in current and all future generations could be made better off if the rate of population growth were lower and the level of old age consumption were increased, but that a reduction in population growth alone would reduce welfare. A social security tax and transfer policy could be devised to induce a Pareto optimal rate of population growth and distribution of life cycle consumption only if measures are taken to offset the divergence between the private and social rate of return to children created by the social security scheme.

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Introduction

It has long been hypothesized that an important and perhaps dominant motivation for childbearing in traditional societies stems from the economic returns that parents expect to receive from their children in the form of child labor and old age security.[1] With a few exceptions, there has been surprisingly little attention given to this hypothesis in the recent spate of microeconomic models of fertility.[2] To some extent this may be explained by the fact that most of the economic models have been directed toward explaining fertility in the United States and other advanced countries in which, presumably, economic motivations for childbearing are minor. Another part of the explanation for the neglect of the old age security hypothesis by economists may follow from evidence that the rate of return to investments in children is low or negative, even in traditional societies in which the elderly do appear to rely on their children for support.[3] Frequently, a low or negative rate of return from child investments is cited as evidence for the proposition that the economic motivation for fertility is weak.

In this paper, I present some results of a theoretical investigation of the old age security hypothesis as part of a longer theoretical study of population growth, fertility behavior and family structure in developing countries.[4] One of these results suggests that it may be inappropriate to infer that negative rates of return to children imply that the economic motivation for childbearing is weak. Rather, the combination of a negative rate of return and a positive rate of population growth may imply a very strong economic motivation for childbearing because parents need to have a large number of children in order to obtain a subsistence level of old age consumption. A further implication is that population growth in such circumstances is inefficiently high in the sense that each individual in current and future generations could be made better off if (a) the rate of population growth were lower and (b) the level of transfers to the elderly from the economically active segment of the population were increased. I show that an efficient rate of population growth implies that the rate of return to children must be equal to the rate of population growth. Other theoretical results, some of which are briefly described in this paper, include the effect on fertility behavior of variations in mortality; of the introduction of monetary savings, land markets or other non-human forms of asset holding; of investments in human capital and a theory of the determinants of the distribution of income among families and by age under conditions of Malthusian diminishing returns.

These results are obtained in a theoretical model that represents a significant departure from much of the recent literature on the microeconomics of fertility in two respects. First, the microeconomic model of fertility decisions assumes that children are treated purely as capital goods. That is, parents do not receive any direct utility from their children; their only motivation for childbearing stems from the expectation that children will support them in old age. This assumption is made for simplicity in order to highlight the implications of purely economic motivations for fertility. It will also help to identify the circumstances under which a direct preference for children or some other non-economic motivation for fertility is important. Second and more importantly, the micro model of fertility is embedded in a dynamic general equilibrium framework of overlapping generations of a type first suggested by Paul Samuelson (1958). With a few exceptions, the Samuelson model has not yet been applied to problems of demographic behavior; Samuelson and most subsequent users of the framework assumed that fertility is exogenous.[5] Yet, in my view, this framework provides an extraordinarily simple and powerful tool for analyzing the aggregate implications of micro behavior for population growth, economic welfare and the distribution of income. It is also suggestive of reasons why demographic behavior may be subject to a variety of normative restrictions on the pursuit of individual self-interest, a favorite theme of some sociological students of fertility.[6]

The plan of the paper is as follows. In the first section, I specify the overlapping generations framework for a simple agrarian society in which resources are abundant so that population growth is not limited by diminishing returns. In this section, I analyze the possible relationships between population growth and the age distribution of consumption and the evaluation of these possibilities in terms of the welfare of individuals in current and future generations. This analysis is deliberately non-behavioral and divorced from any consideration of the economic, social and institutional setting in which reproduction and the distribution of consumption takes place. However, the analytical framework and many of the results provide the basis for the behavioral analysis that is presented later. One of the main results of this section is the derivation of a square root formula for efficient fertility and a corresponding formula for an efficient consumption possibility frontier which shows the maximum level of adult consumption that is attainable for any given level of childhood and old age consumption. These formulas imply that the optimal rate of population growth is higher, the higher is the ratio of old age to childhood consumption. A second main result is the derivation of a Golden Rule of distribution and population growth and examination of other possible Pareto optimal and non-Pareto optimal distribution and fertility levels.

In the second section, I turn to an analysis of individual fertility and distribution behavior. Some of the main hypotheses that emerge from this analysis have been mentioned earlier in the introduction and will not be repeated here. In the third section, I briefly consider some policy issues. For example, I show that a mandatory social security tax and transfer scheme might be imposed that would increase the welfare of each individual in current and all future generations and reduce the rate of population growth. Paradoxically, I also show that self-interested voters might never vote to implement such a scheme.

Optimal Population Growth and the Optimal Distribution of Life Cycle Consumption

Consider a primitive agricultural society in which food, the only consumption good, is produced on family plots of land by an adult family head. Assuming that there is no technical change, no physical capital, that all adults are equally productive, and that land is abundant, an adult family head in any period t produces C_t units of food by using land up to the point at which its marginal product is zero. Output per adult or, equivalently, income per family is constant and aggregate output in any period is proportional to the number of adults in the population. Also assume that food is not storable across periods; it must be consumed in the period in which it is produced or it spoils.

Each individual is assumed to live for three periods of equal length as a dependent child, as a productive adult and as a dependent elderly person. For simplicity, assume that reproduction is asexual, that it occurs at the beginning of adulthood and that there exists an exogenous mortality regime in which the survival rate to adulthood is s_1 and the conditional survival rate from adulthood to old age is s_2. Thus, B_t births to an adult in period t will be expected to produce $s_1 B_t$ adults in period t+1 and $s_1 s_2 B_t$ elderly in period t+2. Also for simplicity, I abstract from the facts that the number of births is discrete and the number of survivors among the births to a given adult is random. Rather, I assume that B_t is a continuous variable and that $s_1 B_t$ and $s_1 s_2 B_t$ are deterministic.

The life cycle consumption of an individual born in any period t who survives through old age is C_t^1 units of food during childhood, C_{t+1}^2 units of food during adulthood and C_{t+2}^3 units of food during old age. I shall assume that each individual is perfectly selfish in the sense that his utility is a function only of his own current and future consumption and is independent of the consumption of others. I also assume, for now, that all individuals have identical tastes and face identical and constant mortality rates. The lifetime utility of an individual born in period t is

$$V_t = V(C_t^1, C_{t+1}^2, C_{t+2}^3; s_1, s_2). \qquad (1)$$

Since the survival rates s_1 and s_2 are assumed constant and identical for all individuals, they will be suppressed for notational simplicity. The lifetime utility of adults in period t may be written as

$$U_t = U(C_t^2, C_t^3) = V(\bar{C}_{t-1}^1, C_t^2, C_{t+1}^3) \qquad (2)$$

and the utility of the elderly in period t is

$$W_t = W(C_t^3) = V(\bar{C}_{t-2}^1, \bar{C}_{t-1}^2, C_t^3) \qquad (3)$$

where bars over the amounts of past consumption indicate that these quantities are not subject to choice and are therefore exogenous. Finally, I assume that an individual requires a minimum consumption level of I units of food per period to survive.

Any viable society must provide for reproduction and the nurture of its young. Moreover, if the unproductive elderly years are not to be foreshortened by starvation, society must also provide a mechanism by which the consumption of the elderly exceeds their productivity. Before considering how social institutions may arise to cope with the problems of reproduction and the distribution of income by age over the life cycle, it is useful to establish the nature of the technical possibilities open to our hypothetical society and to see how to evaluate these possibilities in terms of the welfare of individuals in current and future generations. The analysis of this section is therefore deliberately non-behavioral and divorced from any consideration of the economic, social and institutional setting in which reproduction and the distribution of consumption takes place. However, the analytical framework and many of the results in this section provide the basis for the behavioral analysis to be presented in the next section.

Consider stationary schemes in which the birth rate and mortality rates remain constant over an indefinitely long period of time and in which the distribution of consumption by age remains constant in each time period. Note that the assumption of constant vital rates implies a fixed age distribution and a constant rate of population growth. Also note that the assumption that the distribution of consumption by age remains constant in each period implies that the life cycle distribution of consumption for each individual also remains constant. That is, if the cross-section distribution of consumption by age is $C_t^1 = C^1$, $C_t^2 = C^2$ and $C_t^3 = C^3$

for all t, then the life cycle consumption of an individual born in period t who survives through old age is $C_t^1 = C^1$, $C_{t+1}^2 = C^2$ and $C_{t+2}^3 = C^3$.

Let B be the number of births per adult, s_1 be the survival rate to adulthood and s_2 be the conditional survival rate to old age and assume that all births occur at the beginning of adulthood. Assuming constancy of these vital rates over a long period of time, elementary stable population theory implies that the rate of population growth per generation, π, will be equal to the net reproduction rate, $NRR = s_1 B = \pi$. In addition, the age distribution will be stable such that for every adult in the population there will be $s_2/(s_1 B)$ elderly and B children. Since each adult produces C units of output, the distribution of consumption by age in each period must satisfy the constraint

$$C = \frac{s_2}{s_1 B} C^3 + C^2 + BC^1. \tag{4}$$

It is now possible to derive an expression for the efficient level of fertility using the following definition of efficiency: the efficient level of fertility is defined as that level of births per adult that maximizes adult consumption, holding constant the level of consumption of children and adults at any arbitrary level. Rewriting (4), this definition corresponds to the maximization problem

$$\max_B C^2 = C - \frac{s_2}{s_1 B} C^3 - BC^1 \tag{5}$$

where C, C^3 and C^1 are treated as constants. The necessary condition for a maximum is

$$\frac{dC^2}{dB} = \frac{s_2}{s_1 B^2} C^3 - C^1 = 0 \qquad (6)$$

Solving (6) for the efficient level of fertility, we obtain the expression

$$B = (C^3/C^1)^{\frac{1}{2}}(s_2/s_1)^{\frac{1}{2}} \qquad (7)$$

Note that the efficient level of fertility is higher, the higher is the ratio of old age consumption to child consumption. The intuition behind this result is that higher fertility, and hence more rapid population growth, shifts the age distribution so as to reduce the fraction of elderly and increase the fraction of children relative to productive adults. As the consumption of the elderly is increased relative to the consumption of children, the burden of support is reduced by having relatively more adults per elderly person. This is accomplished by increasing the birth rate.

Assuming that the level of fertility is efficient, we may substitute (7) back into the constraint (4) to obtain the efficient consumption possibility frontier

$$C = C^2 + 2(C^3C^1)^{\frac{1}{2}}(s_2/s_1)^{\frac{1}{2}} \qquad (8)$$

This expression tells us the maximum level of adult consumption, C^2, that is attainable for any given level of old age and child consumption.

The efficient consumption possibility frontier in (8) is illustrated diagrammatically by the curved line AB in Figure 1

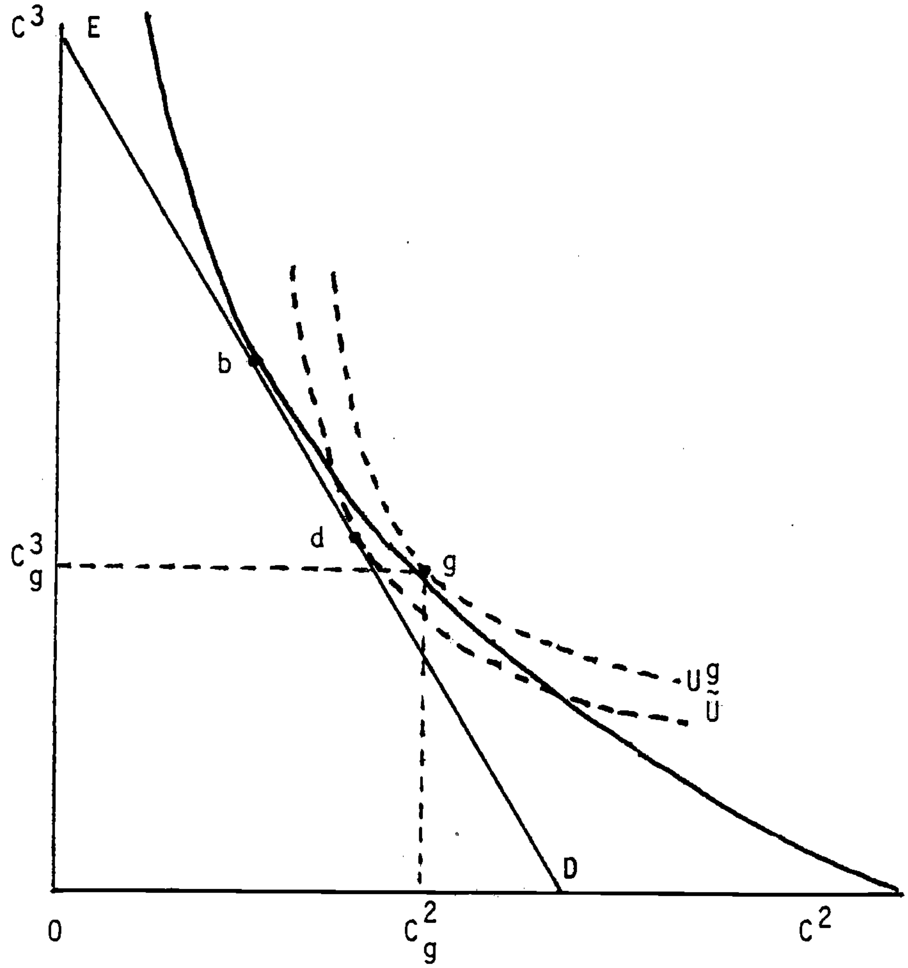

Figure 1: Efficient Consumption Possibilities Frontier and Pareto Optimal Age Distributions of Consumption

where the vertical axis measures old age consumption (C^3) and the horizontal axis measures adult consumption (C^2). The level of child consumption is assumed to be set at some constant level sufficient to allow for survival (i.e. $\overline{C}^1 \geq I$). Each point on AB corresponds to a particular efficient level of births as defined by (5). If the birth rate were not efficient, the attainable distributions of consumption between adults and the elderly would lie inside the frontier AB. These points would be inefficient in the sense that the consumption of individuals in a given age group could be increased without decreasing the consumption of any individual in other age groups.

As I noted earlier, under stationary conditions the cross-section distribution of consumption by age is identical to the life cycle distribution of consumption. Hence, the slope of AB at any given point gives the rate at which an adult must reduce his current consumption in order to increase his old age consumption. This slope, found by differentiating (8), is

$$-\frac{\partial C^3}{\partial C^2} = (C^3/C^1)^{\frac{1}{2}}(s_1/s_2)^{\frac{1}{2}}$$

$$= (s_1 B/s_2) = (1+\pi)/s_2 \qquad (9)$$

where $\pi = s_1 B$ = NRR is the generation rate of population growth.

The absolute value of the slope of the efficient consumption possibility curve is also equal to $(1+\rho)/s_2$ where

$$1+\rho = s_2 C^3/BC^1 = s_2(C^3/C^1)^{\frac{1}{2}}(s_1/s_2)^{\frac{1}{2}} \qquad (10)$$

and ρ is the average social rate of return to investments in children. The justification for this terminology is as follows. Consider a representative adult in period t. If he survives to old age, he will receive an old age consumption level of $C^3_{t+1} = C^3$ units of food which are produced by the adult labor force in period t+1. This labor force was born and reared in period t at a total cost of BC^1 units of food that alternatively could have been consumed by the adults in period t. Hence, the representative adult in period t achieves an expected total return of s_2C^3 units of food in period t+1 on a total investment of BC^1 units of food in period t thereby obtaining an average rate of return of ρ percent per period where ρ is defined as in equation (10).

The adjective "social" modifies the term "rate of return" to emphasize that it need not be the case that the old age consumption of a given elderly person in period t+1 is dependent on his own expenditures on children in period t. For example, it is possible that a society is organized in such a way that a given individual's old age consumption is financed entirely by monetary saving or a social security tax and transfer program and is entirely independent of his own reproductive behavior so that the private return to investment in children is minus one hundred percent. Still, the C^3 units of food that are consumed by the elderly in period t+1 are produced by labor that was reared at a social cost of BC^1 units of food in period t. Hence, the social rate of return to investment in children, as defined in equation (10), is greater than minus one if the elderly consume more than they produce.

If the society follows an efficient policy with respect to fertility and the age distribution of consumption as defined by equations (7) and (8), then from equations (9) and (10) it follows that

$$\pi = \rho \tag{11}$$

Put differently, if we observe an economy of the type described in this paper in which the rate of population growth differs from the average social rate of return to children, we may infer that the society is pursuing an inefficient population and distribution policy and is achieving some point inside the efficient consumption possibility frontier AB in Figure 1.

The curve AB shows all possible efficient life cycle consumption paths that can be maintained for adults in each generation. The question arises as to whether some paths are superior to others in terms of the preferences of individuals. One possibility is to choose that consumption path that maximizes the utility of the typical adult in any generation where the adult's utility function is of the form given in (2). This point is illustrated by point g in Figure 1, where the adult's indifference curve is tangent to the consumption possibility frontier.[7] At this point, his life cycle consumption path is (C_g^2, C_g^3) and the level of fertility is $B_g = (C_g^3/C_g^1)^{\frac{1}{2}}(s_2/s_1)^{\frac{1}{2}}$.

This life cycle allocation will be called the Golden Rule distribution for the following reason. Suppose that the s_1B_g surviving children of an elderly parent agree among themselves to share equally the costs of supporting their elderly parent. In choosing the total amount to transfer, they decide to follow the Golden Rule. That is, they decide to transfer to their parent the amount of consumption they would like their own children to transfer to them when they become old.[8] The Golden Rule distribution and the associated Golden Rule level of fertility are Pareto optimal. Given that the distribution of consumption in each period is initially at point g, no individual in any generation can be made better off without making some other person worse off.

In most problems in welfare economics, the Pareto criterion does not provide a unique way to rank the desirability of alternative allocations because there are many possible Pareto optimal allocations. The present model is no exception because the Golden Rule distribution (and level of fertility) is only one of many possible Pareto optimal distributions. Moreover, it is also the case that there exist many possible non-Pareto optimal allocations such that there exist changes in the distribution rule and/or fertility behavior that will increase welfare unambiguously by making at least one person better off without harming anyone else.

First consider the question of whether a society that has followed some non-Golden Rule policy in the past could make a Pareto efficient shift to the Golden Rule policy in some period t. In order for the policy shift to be Pareto efficient, it is required that no individual living in period t or in subsequent periods suffer a reduction in lifetime utility as compared to the utility he would have achieved under a continuation of the old policy. It is easy to prove that a shift to the Golden Rule policy will be Pareto efficient if and only if the social rate of return to children under the initial policy is less than the Golden Rule rate of return.

The proof is as follows. Under the initial policy in period t-1 (which may or may not be an efficient policy) assume that the birth rate is $B_{t-1} = B_0$ and the age distribution of consumption is $(C^2_{t-1}, C^3_{t-1}) = (C^2_0, C^3_0)$. A continuation of this policy implies that the elderly in period t would receive a consumption level of C^3_0 and that the lifetime utility of adults in period t and thereafter would be $U_\tau = U(C^2_\tau, C^3_{\tau+1}) = U(C^2_0, C^3_0)$ for $\tau = t, t+1, \ldots$ The old age consumption level of C^3_0 implies that the social rate of return on children under the initial policy is defined by $(1+\rho_0) = s_2C^3_0/B_0\bar{C}^1$. Hence, the representative adult's budget constraint if this policy is continued in period t is

$$C_t = \frac{s_2C^3_t}{s_1B_{t-1}} + C^2_t + B_t\bar{C}^1$$

$$= (1+\rho_0)\,\frac{\bar{C}^1}{s_1} + C^2_0 + B_0\bar{C}^1.$$

A permanent shift in period t to the Golden Rule policy would result in a change in the birth rate to $B_\tau = B_g$ and a life cycle consumption profile of $(C^2_\tau, C^3_{\tau+1})$ for adults in periods τ = t, t+1,.... Once the steady state is achieved in period t+1, the budget constraint will be

$$C_\tau = \frac{s_2}{s_1 B_g} C_g^3 + C_g^2 + B_g \bar{C}^1.$$

$$= (1+\rho_g) \frac{\bar{C}^1}{s_1} + C_g^2 + B_g \bar{C}^1 \qquad (\tau = t+1,\ t+2,\ \ldots) \tag{12}$$

where ρ_g is the social rate of return on children under the Golden Rule policy. Clearly, a shift to the Golden Rule policy would benefit each adult in period t and thereafter since $U(C_g^2, C_g^3) \geq U(C_0^2, C_0^3)$.

The only question remaining is whether the policy shift would be made without harming the elderly in period t. This can be done if the following inequality holds:

$$C_t \geq \frac{s_2}{s_1 B_0} C_0^3 + C_g^2 + B_g \bar{C}^1 = (1+\rho_0)\ \bar{C}^1/s_1 + C_g^2 + B_g \bar{C}^1. \tag{13}$$

This inequality states that output per adult, C_t, is sufficient to provide the consumption level of C_0^3 to which the elderly are "entitled" under the initial policy and, in addition, to provide for the level of adult consumption and childrearing expenses called for by the Golden Rule policy. To prove that the feasibility condition in (13) holds if and only if

$$\rho_0 \leq \rho_g \tag{14}$$

subtract (12) from (13) to obtain

$$0 \geq \bar{C}^1/s_1[(1+\rho_0)-(1+\rho_g)] = \bar{C}^1/s_1(\rho_0-\rho_g)$$

from which (14) follows immediately.

If the initial policy implies that the rate of return to children is greater than the Golden Rule rate (i.e. $\rho_0 > \rho_g$), this argument implies that it will not be possible to shift to the Golden Rule policy without reducing the welfare of the elderly who live during the period of transition. Although it might seem persuasive that a change in policy which harms only one generation and benefits an indefinitely large number of individuals in current and future generations represents an increase in social welfare, such a judgment cannot be made using a Paretian criterion. Indeed, the preceding proof implies that no shift in policy can be a Pareto improvement if it results in a social rate of return on children lower than the rate implied by the initial policy.

However, if the initial policy implies that $\rho_0 > \rho_g$, it is not necessarily true that the policy is Pareto optimal. The consumption of the elderly in period t can be maintained at the initial level of $C_t^3 = C_0^3$ by any change in policy that satisfies the constraint $\rho_1 \geq \rho_0$ where ρ_1 is the social rate of return to children implied by the new policy. Since $\rho_0 > \rho_g$, it would be best to choose a new policy in which the rate of return is as close as possible to ρ_g. Hence, assume that $\rho_1 = \rho_0$.

In this case, the range of policies available in period t are combinations of C_t^2 and B_t satisfying

$$\begin{aligned} C_t &= \frac{s_2 C_0^3}{s_1 B_0} + C_t^2 + C_t\overline{C}^1 \\ &= (1+\rho_0)\overline{C}^1/s_1 + C_t^2 + B_t\overline{C}^1. \end{aligned} \tag{15}$$

Given ρ_0 and the choice of B_t, the consumption of the elderly in period t+1 is determined by

$$s_2 C^3_{t+1} = \bar{C}^1 (1+\rho_0) B_t \qquad (16)$$

where $s_2 C^3_{t+1}$ is the expected value of the old age consumption of an adult in period t who will consume C^3_{t+1} in period t+1 if he survives to old age and $\bar{C}^1(1+\rho_0)B_t$ is equal to the amount of output, $\bar{C}^1/s_1(1+\rho_0)$, that must be transferred to the elderly by each adult in period t+1 multiplied by $s_1 B_t$, the number of children per adult in period t who survive to adulthood in period t+1. Clearly, the expected old age consumption in period t+1 of adults in period t can be increased or decreased by increasing or decreasing the fertility rate in period t.

Eliminating B_t from (15) and (16), it follows that policies satisfying the constraint $\rho_1 = \rho_0$ imply that the life cycle consumption path, (C^2_τ, C^3_τ), of adults in period τ = t, t+1, ... lies on the linear constraint,

$$C_\tau - (1-\rho_0)\bar{C}^1/s_1 = C^2_\tau + \frac{s_2 C^3_{\tau+1}}{1+\rho_0}, \qquad (17)$$

which has a slope

$$-\frac{\partial C^3_{\tau+1}}{\partial C^2_\tau} = (1+\rho_o)/s_2. \qquad (18)$$

The economic interpretation of this constraint is that the present value of any life cycle consumption path of adults in period τ, discounted at ρ_0, must be equal to "disposable income" per adult. Disposable income is equal to total output per adult, C_τ, minus the amount of output per adult, $(1+\rho_0)\bar{C}^1/s_1$, that must be devoted to the consumption of the elderly living in period τ. Since the birth rate in period t-1 is assumed to be $B_{t-1} = B_0$, this constraint implies that the consumption of each elderly person in period t will be $C_t^3 = C_0^3$, thus satisfying the condition that any change in policy not hurt the elderly during the period of transition.

The geometric interpretation of this constraint is also of interest. The constraint is represented in Figure 1 by the straight line DE that is tangent to the efficient consumption possibility curve AB at point b where the slope of AB is assumed to be equal to $(1+\rho_0)/s_2$ in absolute value and it is also assumed that $\rho_0 > \rho_g$. Point b itself corresponds to the situation in which the rate of population growth is efficient so that $\pi_0 = \rho_0$. All other points on DE correspond to inefficient rates of population growth with $\pi \neq \rho_0$ so that the life cycle consumption path lies inside the efficient frontier AB. Specifically, points on DE to the northwest of point b correspond to $\pi > \rho_0$ while those to the southeast correspond to $\pi < \rho_0$.

Given the constraint that $\rho_1 = \rho_0$, the Pareto optimal policy is to select a fertility rate, B_τ, such that the corresponding life cycle consumption profile $(\tilde{C}_\tau^2, \tilde{C}_{\tau+1}^3)$ maximizes $U_\tau = U(C_\tau^2, C_{\tau+1}^3)$ subject to the constraint in equation (17). This Pareto optimal profile is indicated by point d in Figure 1 where the indifference curve $\tilde{U}$ is tangent to the constraint DE. It is clear from inspection of Figure 1, that the Pareto optimal consumption profile must occur at a point on DE to the southeast of point b so that the Pareto optimal rate of population growth, $\tilde{\pi}$, will be lower than the social rate of return on children if $\rho_0 > \rho_g$. Since $\tilde{\pi} < \rho_0$, it follows that the Pareto optimal policy must be inefficient in the sense that the optimal consumption profile will lie inside the efficient consumption possibility curve AB.

The Old Age Security Hypothesis and Fertility Behavior

The problems of reproduction and distribution are central to the survival of any society and to the welfare of its members. The solution to these problems in our hypothetical society is complicated by the assumption that each individual is a selfish economic man who cares only for his own consumption. Adults who are the only productive individuals in society would appear to have no incentive to reproduce and care for children nor do they appear to have any incentive to provide for the elderly. Clearly, any viable society must place constraints on the pursuit of individual self-interest and provide an institutional framework to cope with the fact that the human condition entails dependency at the beginning and, often, at the end of life.

The family is the universal institutional solution to the problem of reproduction and the nurture of the young. In traditional societies, the old age security hypothesis suggests that the family also represents the solution to the problem of dependency among the elderly and, further, that old age security and reproductive motivation are closely connected. To incorporate this hypothesis into a microeconomic model, I shall assume that parents may inculcate their children with a sense of obligation to support their elderly parents when they grow up. This "distributional norm" overrides to a limited degree the otherwise self-seeking nature of individuals in our model. In particular, I shall assume for the present that parents have no preference for children as such; their only motivation for bearing and rearing children is the expectation that their children will provide transfers to them in old age. Thus, children are treated as pure capital goods in a world in which food is not storable and no other means is available to transform consumption during one period life into consumption in a later period.

In this model, I shall assume that the distributional norm takes an extremely simple form that I shall call a "fixed distribution" rule. Under such a rule, an adult feels obligated to transfer a fixed amount of food, $\bar{c}$, to his elderly parent and the rule is transmitted from parent to child across generations. The "strength" of the distribution rule is measured by the magnitude of $\bar{c}$, which may vary from family to family, among different cultural groups, or over time, in response to economic changes such as physical separation of adults from their children caused by migration or social change such as the importation of the idea of individualism from more modern cultures. For the present, however, the value of $\bar{c}$ will be assumed to be identical in all families and through all generations.

Since parents are assumed to have no interest in the welfare of their children beyond their survival to adulthood, I assume that parents produce their children at least cost by setting the level of consumption per child at $C^1 = I$ where I is the minimum amount of food required for survival to adulthood. (Note that there remains an exogenous child mortality risk, $1-s_1$).

This treatment of the cost of children ignores for simplicity a variety of issues that should be incorporated into a more complete model. For example, if a child is capable of performing some productive labor, its parent would be expected to have the child work in order to reduce the cost of his investment. Inclusion of child labor would not affect any of our qualitative conclusions, providing the net cost of children is positive. Otherwise, parents would choose to have the maximum possible number of children whatever the strength of the family's distribution rule. By the same token, I ignore the opportunity cost in terms of food production foregone of adult time devoted to child care. A more serious omission is my implicit assumption that the quality of labor is exogenous. This ignores the possibility that a child's productive capacity as an adult can be altered by investments in human capital in the form of health, education, or training. It should be noted that the assumption of a fixed distribution rule is ill-suited to the analysis of investments in children's human capital by parents because the return per child, $\bar{c}$, does not vary with its productive capacity.

In our simple model, $\bar{c}$ is the payment per surviving child to his surviving parent so that $s_2C^3_{t+1} = s_1B_t\bar{c}$. Abstracting from uncertainty caused by the fact that survival is random, the expected private rate of return to children is defined by

$$1+\bar{\rho} = \frac{s_2 C^3_{t+1}}{B_t I} = \frac{s_1 \bar{c}}{I} \tag{19}$$

where $\bar{\rho}$ is the rate of discount per period such that the present value of the expected transfers from children in period t+1 is equal to the expenditures in children in period t. Since each of the determinants of $\bar{\rho}$ is an exogenous constant, the private rate of return is also exogenous and independent of the number of children. Note that $\bar{\rho}$ may be either positive or negative, the latter being more likely the weaker the family's distribution rule, the higher is the rate of child mortality and the higher is the cost per child. Under the assumptions of this model, it should also be noted that the private rate of return to children, $\bar{\rho}$, is equal to the social rate of return, ρ, as defined in equation (10). As I pointed out earlier, the private and social rates of return to children may diverge if, for example, all or part of the consumption of the elderly is financed by past monetary savings or through a tax and transfer program.

The typical adult in period t faces the budget constraint

$$C_t = s_2\bar{c} + C^2_t + IB_t \tag{20}$$

where $s_2\bar{c}$ is the expected transfer to his elderly parent (again, I ignore the fact that the existence of a surviving parent is random), C^2_t is his own consumption and IB_t are his total expenditures on B_t children. The parent's old age consumption, conditional on his survival to old age, is

$$C^3_{t+1} = s_1 \bar{c} B_t = s_2 \qquad (21)$$

Substituting (21) into (20), the adult's expected wealth constraint in period t is

$$C_t - s_2\bar{c} = C^2_t + \frac{s_2 C^3_{t+1}}{1+\bar{\rho}} \qquad (22)$$

The adult is assumed to choose his level of current consumption, C^2_t, and future consumption, C^3_{t+1}, by maximizing his lifetime utility, $U_t = U(C^2_t, C^3_{t+1})$, subject to the wealth constraint in (22).

Let the adult's optimal life cycle consumption path be $(\tilde{C}^2_t, \tilde{C}^3_{t+1})$. From (21), it is clear that his optimal level of fertility, $\tilde{B}_t$, is proportional to the level of old age consumption, $\tilde{C}^3_{t+1}$, so that

$$\tilde{B}_t = \frac{s_2 C^3_{t+1}}{I(1+\bar{\rho})} \qquad (23)$$

Thus, the demand for births in this model is derived from the demand for old age consumption, and expenditures on children, IB_t, in effect measure the level of saving by the adult.

Specifically, let the demand for old age consumption be written as a function of the exogenous variables of the model as follows:

$$\tilde{C}^3 = G(C, 1+\bar{\rho}, \bar{c}, s_1, s_2, \theta) \qquad (24)$$

where θ is a taste parameter measuring the strength of the adult's preference for current relative to future consumption (i.e. his subjective rate of time preference). The lower is the rate of time preference (i.e. the lower is θ), the higher will be the demand for old age consumption and the higher will be level of fertility, $\tilde{B}_t$, and the level of "demographic saving," $I\tilde{B}_t$. Note that this implication is diametrically opposed to the view that is sometimes expressed that high fertility among the poor is a result of their myopia concerning the future consequences of their current behavior. If, as the old age security hypothesis implies, children are the "poor man's capital," the least myopic will accumulate the most capital.

For our current purposes, two important characteristics of the demand for old age consumption and the derived demand for births are the elasticities of these demands with respect to variations in family income (or adult labor productivity), C, and to variations in one plus the rate of return to children, $1+\bar{\rho}$. Define ε_C and ε_ρ, respectively, as the elasticities of $\tilde{C}^3$ with respect to C and $1+\rho$ and η_C and η_ρ as the elasticities of $\tilde{B}$ with respect to C and $1+\rho$. From (23), it is clear that $\varepsilon_C = \eta_C$ and

$$\eta_\rho = \varepsilon_\rho - 1. \tag{25}$$

The appropriate interpretation of $\varepsilon_C (=\eta_C)$ is as a measure of the elasticity of saving with respect to wealth. This elasticity is surely positive and is usually found, at least in developed countries, to be very close to one. Thus, our model implies that the elasticity of births with respect to family income (or adult labor productivity) is positive and probably close to unity. This implication appears to be contrary to empirical fertility differentials by income level in agrarian populations in many developing countries. Commonly, the gross correlation between fertility and family income is negative and, at most, becomes only slightly positive when other independent variables are controlled. These empirical observations might be interpreted as evidence against the old age security hypothesis.

In my view, this interpretation would be premature. For example, as I show in another paper (Willis, 1978), the cross-section correlation between family income and fertility will tend to be negative under conditions of land scarcity and diminishing returns even though each family would increase its fertility in response to an exogenous increase in its income. The reason for this is reverse causation: families (or cultural groups) in which fertility demand is high (e.g. because the rate of time preference, θ, is low) and who maintain land with the family, subdividing it among surviving children, will tend to have relatively small land endowments and low incomes. If rental markets for land or markets for agricultural labor develop, the poorer, high fertility families will tend to become tenants or suppliers of agricultural labor while the richer, low fertility families will tend to become landlords or demanders of labor.[9]

The elasticity of old age consumption with respect to one plus the private rate of return on children must be positive (i.e. $\varepsilon_\rho > 0$). This is the case for two reasons. First, an increase in $\bar{\rho}$ caused, say, by a stronger distribution rule in which each child contributes more than before to his elderly parent makes old age consumption cheaper in terms of adult consumption foregone so that the individual will tend to substitute toward C^3_{t+1} and away from C^2_t. Second, in the short run (i.e. in period t) an increase in ρ causes an increase in the real wealth of the adult family head in the sense that he could maintain his fertility constant and still achieve a higher level of old age consumption since the contribution from each child has gone up. In the long run (i.e. from period t+1 onwards), this wealth effect is counter-balanced by the increased contribution the adult must make to his own elderly parent. As I show later, this long run negative wealth effect is not as large as the positive short run wealth effect if $\bar{\rho}$ is lower than the Golden Rule rate of return, the case that I believe to be empirically relevant.

From the point of view of the effect of variations in $\bar{\rho}$ on fertility behavior, the crucial question about the magnitude of ε_ρ is whether it is greater or less than unity, as can be seen from the relationship $\eta_\rho = \varepsilon_\rho - 1$ in (25). I believe that a fairly strong case can be made for hypothesizing that ε_ρ is less than one so that η_ρ is negative in poverty-stricken societies. Since expenditures on births are equivalent in this model to savings, this hypothesis is equivalent to the hypothesis that the interest elasticity of savings is negative at low interest rates.

The argument is made most easily by example. Suppose for some initial value of $1+\bar{\rho}$ (or $\bar{c}$) that an adult chooses to have one child and that his old age consumption is virtually at the minimum biological subsistence level. Now suppose that $1+\bar{\rho}$ (or $\bar{c}$) falls to one-half its previous level. The adult must either choose to starve to death in old age or he must increase his fertility to two children in order to maintain a survival level of old age consumption. The latter course of action strikes me as the more likely. It would imply that $\varepsilon_\rho = 0$ and that $\eta_\rho = -1$. These are the lower bounds on these two elasticities. As the level of income increases, creating a margin for individuals to substitute away from old age consumption toward relatively cheaper adult consumption as $1+\bar{\rho}$ falls, I would expect ε_ρ to increase in value and η_ρ to become less negative and, perhaps even positive, at sufficiently high levels of income. In poor societies, however, I believe it is reasonable to hypothesize that low levels of transfers to the elderly per child will be associated with high levels of fertility.

This hypothesis is consistent with the results of studies in LDC's in which it is found that the rate of return to investments in children is negative when the level of fertility is high.[10] Such evidence is often interpreted to mean that the old age security hypothesis is false and that the "economic motivation" for child-bearing is weak, despite contrary indications from attitudinal surveys in which parents say that they expect support from their children in old age and that this expectation is one of the important reasons for having a large family. The observed high level of fertility is then either attributed to the intrinsic desirability of children (i.e. a consumption motive in which children provide direct utility to their parents); to irrational fatalism (e.g. "I will have as many children as God wills");

to non-rational behavior resulting from pro-fertility customs or norms; or to an inability to control fertility caused by a lack of availability of contraceptive techniques or knowledge.

While any or all of these factors may well be influential in a given population, it may not be necessary to invoke them in order to explain the coincidence of a high fertility rate and a low or negative rate of return to investments in children. In the model presented in this section, such evidence does not imply that the economic motivation for childbearing is weak. Rather, it suggests that the economic motivation may be desperately strong.

Population Policy and Economic Welfare

The view that the rate of population growth in the developing world is too high and that policies to reduce fertility would be socially beneficial is widely accepted in both scholarly and policymaking communities. Although economic studies by Coale and Hoover (1958), Enke (1960) and many others have supported this view, significant skepticism about its validity has been voiced by economists such as Robinson and Horlacher (1971) and Blandy (1974). The latter writers suggest that to support the view that population growth is too rapid it is necessary to demonstrate that there are "externalities" that result in a divergence between the social benefits and costs of children and the private benefits and costs that guide individual couples in their reproductive behavior. With the possible exception of issues surrounding family planning, my impression is that current research has not provided a firm conceptual and empirical justification for viewing private reproductive decisions in the developing world as socially non-optimal.

With this in mind, it is useful to ask whether the model presented in this paper can provide some insight into the question of excessive population growth in the less developed countries. Of necessity, the validity of any conclusions drawn from the model presented in this paper are limited by the extremely simplified assumptions upon which it is based and the poor quality of evidence on certain key empirical questions.

For the sake of illustration, suppose that empirical evidence for some developing country, Country A, shows that the private rate of return on children, $\bar{\rho}_a$, is less than the rate of population growth, π_a. Also, assume that the sole source of consumption of the elderly, aside from their own productive labor, is in the form of transfers from their children. Then, as I argued earlier, $\bar{\rho}_a = \rho_a$ where ρ_a is the social rate of return on children.

Given these assumptions the following inferences can be made about population growth and welfare in Country A. (i) Given that $\pi_a > \bar{\rho}_a = \rho_a$, it can be shown that $\bar{\rho}_a < \rho_g$ where ρ_g is the Golden Rule rate of return on children. (ii) As I proved in the first section, if $\rho < \rho_g$, the society is following a non-Pareto optimal policy and it is possible to make a Pareto improving shift to the Golden Rule policy. Under this policy, the fertility level would be $B_g = (1+\pi_g)/s_1$ and the contribution per current adult to the elderly would be $\bar{c}_g = (1+\rho_g)I/s_2$ so that $\pi_g = \rho_g$ and the life cycle consumption path of each individual would be (C_g^2, C_g^3).

(iii) The initial rate of population growth in Country A may be either "too high" or "too low" relative to the Golden Rule rate of population growth depending on the sign of the interest elasticity of saving, η_ρ. If η_ρ is negative, as I earlier argued is likely in poor countries, then $\pi_a > \pi_g$ and, in this sense, the rate of population growth in Country A is excessive. (iv) Assume that population growth is excessive according to this criterion. It is important to stress that a policy which reduces the rate of population growth from π_a to π_g but does nothing to alter the return to children would <u>reduce</u> welfare. The non-optimality involves <u>both</u> the rate of population growth and the age distribution of consumption. Correspondingly, policies designed to improve social welfare must deal with demographic and distributional issues simultaneously.

Before discussing specific policies, the assertion made in proposition (i) above needs to be proved. This is accomplished most easily with a geometric argument. In Figure 2, the curved line AB represents the efficient consumption possibilities frontier available to Country A and point g, where the indifference curve $U^g = U(C_g^2, C_g^3)$ is tangent to AB, represents the Golden Rule policy. The wealth constraint of the typical adult in Country A in period t is

$$C_t - s_2\bar{c}_a = C_t^2 + \frac{s_2 C_{t+1}^3}{1+\bar{\rho}_a}$$

where

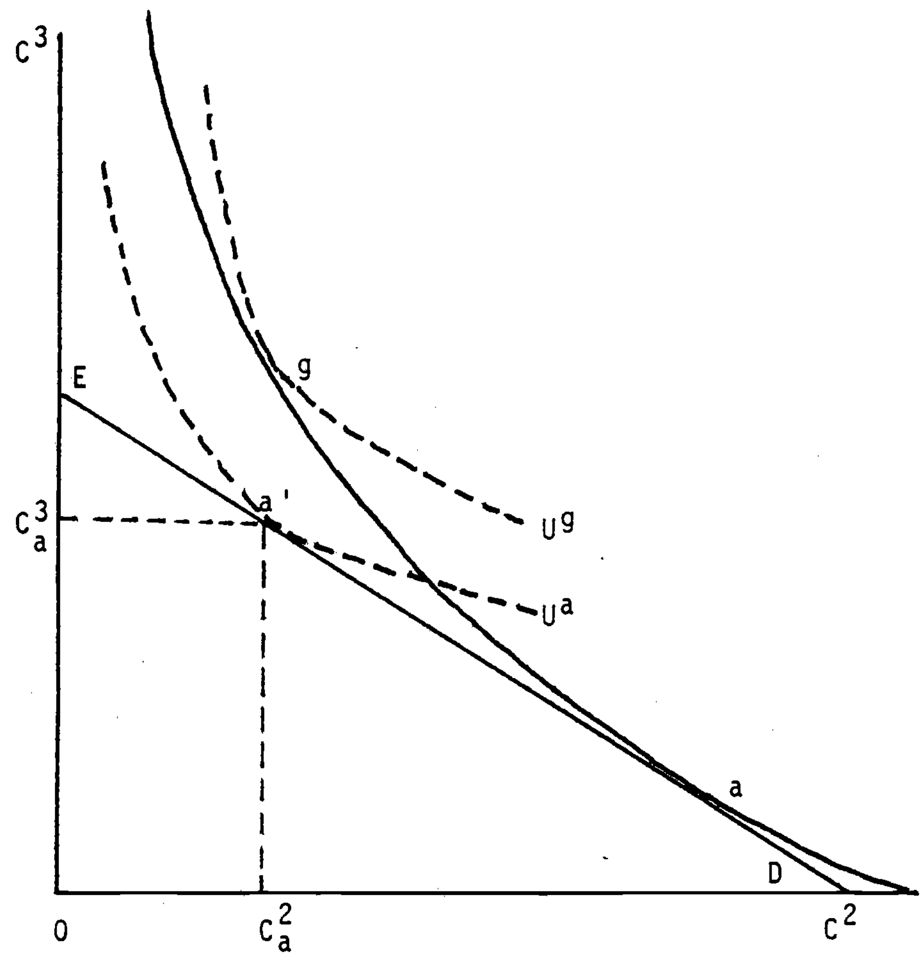

Figure 2: Non-Pareto Optimal Equilibrium with Positive Population Growth and Negative Rate of Return on Children

$s_2 C^3_{t+1} = s_1 B_t \bar{c}_a.$

Given the assumed data that $\pi_a > \bar{\rho}_a$ in Country A, I wish to show that one may infer that $\bar{\rho}_a < \rho_g$. To demonstrate this, note that the wealth constraint may be represented by the straight line tangent to AB at the point where the slope of AB is equal to $(1+\bar{\rho}_a)/s_2$ in absolute value. For the moment, assume that $\bar{\rho}_a < \rho_g$. In this case, the wealth constraint is represented by a line such as DE which is tangent to AB at point a to the southeast of point g. Point a itself corresponds to a situation in which the adult chooses a fertility level, $\tilde{B}_t$, such that the rate of population growth is equal to the rate of return, $\bar{\rho}_a$. However, the adult's utility maximizing choice will occur at the tangency between DE and his indifference curve $U^a = U(C_a^2, C_a^3)$ at point a' in Figure 2. Clearly, point a' must lie to the northwest of point a on DE. Hence, the fertility level corresponding to point a' must be larger than the fertility level, $\tilde{B}_t$, corresponding to point a so that $\pi_a > \bar{\rho}_a$. So far I have shown that if $\bar{\rho}_a < \rho_g$, optimizing behavior implies that $\pi_a > \bar{\rho}_a$. Using the same line of argument as above, it is easy to confirm that the optimum fertility choice would imply $\pi_a \leq \bar{\rho}_a$ if $\bar{\rho}_a \geq \rho_g$ with $\pi_a = \rho_g$ implied by $\bar{\rho}_a = \rho_g$. Therefore, it is appropriate to infer that data showing $\pi_a > \rho_a$ implies that $\bar{\rho}_a < \rho_g$ which, in turn, implies that a shift to the Golden Rule policy would be Pareto optimal.

To summarize these normative implications, evidence that the rate of return to investments in children is negative in societies in which the rate of population growth is positive implies that the division of consumption between the elderly and productive adults is both non-Pareto optimal and inefficient. It further implies that the actual rate of return to children is lower than the Pareto optimal Golden Rule rate of return and (given $n_\rho < 0$) that the actual rate of population growth is more rapid than the Golden Rule rate. The utility of each individual in the current and all future generations could be improved if somehow each child could be persuaded to increase the amount that he contributes to his dependent elderly parent to the Golden Rule level in return for the promise that his own children will likewise increase their contribution to him. In response to the prospective increase in the generosity of his children, each parent would voluntarily choose to reduce his fertility to the Golden Rule level.

In the process of socializing their children to a sense of obligation to contribute to their support in old age, presumably the selfish parents in our model are doing the best they can to overcome the innate selfishness of their children. Indeed, from the short run perspective of any given parent, it would be best of all if he could persuade his children to maintain themselves at the minimum survival level and transfer all their surplus product to him. The apparent fact that parents, even in traditional societies, cannot convert their children into slaves may be gratifying testimony to an inborn spirit of independence among the young, but it does suggest that the problem of inefficiently high rates of population growth is unlikely to be remedied by private action.

It would seem that collective action in the familiar form of a mandatory pay-as-you-go social security tax and transfer scheme offers an ideal way out of this dilemma. After all, if the current adults would like to have higher contributions from their children than they are able to persuade them to provide voluntarily, they could exercise the political power that their children do not as yet possess to pass a law under which each adult is taxed by an amount $s_2(\bar{c}_g - \bar{c}_a)$, the proceeds of which are transferred to the elderly.

This scheme has two defects. First, in the nature of the politics of self-interest the adults in period t will find it advantageous to pass a social security law to take effect in period t+1 when they stand to benefit without paying any of the costs. Symmetrically, their grown children in period t+1 might like the law but would like it best if its implementation were delayed until period t+2. Thus, in politics as in the home, the achievement of an increase in the utility of each selfish individual requires, paradoxically, some sort of social compact, to use Samuelson's phrase (Samuelson, 1958), that allows them to transcend their self-interest.

The second defect in the scheme lies in a technical failure in the wording of the law. As it was proposed, the law states that a tax is to be placed on the adults of period t (or period t+1 or whenever the social compact is finally attained) and the benefits to be distributed to the elderly in the same period. The law <u>should</u> have read that the tax is to be placed on each adult with the revenue to be distributed to his <u>own</u> elderly parent. The defective law, of course, would reward the childless as much as those who bear the costs of rearing a taxpayer to maturity. The privately rational adult in period t will reduce his own fertility, thereby saving these costs, in anticipation of a lump sum transfer $s_2(\bar{c}_g - \bar{c}_a)$ multiplied by one plus the percentage increase in the number of adults in period t+1 relative to period t. Under the non-defective form of the law, this increase would be precisely $1+\pi_g$, yielding each elderly person C_g^3, the Golden Rule level of old age consumption. Under the defective form, the increase in population will be less than this because of reproductive shirking.

An alternative approach which avoids conditioning the amount transferred to the elderly by their past fertility is available. This is simply to accompany a social security tax and transfer scheme with subsidies for childrearing expenses. Casual observation suggests that, wittingly or not, those societies in which the welfare state has progressed furthest in taking over responsibility for old age security and other forms of security from the family have also provided the largest subsidies for childrearing, both explicitly in the form of family allowances and tax deductions and implicitly in the form of public education.

Footnotes

[1]See Caldwell (1976) for a recent statement of this view. Also see Mamdani (1972), Clark (1977) and Boserup (1965).

[2]For an exception, see Neher (1971).

[3]In perhaps the most thorough investigation of this question to date, Mueller (1976) concludes that the rate of return to children is negative in most peasant agricultural settings. Further support for this view is offered by Repetto (1976), Ohlin (1969) and Robinson (1972) among others. It should be noted that none of these studies is based on fully adequate data. Recently, Cain's analysis of household data from rural Bangladesh suggests that the rate of return to children there may be positive (Cain 1977, 1978). For example, he concludes: "Male children appear to become net producers at least by age 12, and compensate for their own and one sister's cumulative consumption by age 22." (Cain, 1977, p. 224).

[4]See Willis (1978).

[5]Two exceptions are papers by Neher (1971) and Ben-Zion and Razin (1975). The approach in this paper is significantly different from either of these papers. After this draft was written, I also discovered relevant papers by Samuelson (1975, 1976).

[6]For example, see Norman Ryder's comment (Ryder, 1973) on my earlier theoretical paper on fertility behavior (Willis, 1973).

[7]Unless otherwise noted, I shall assume in this paper that the adult's indifference curves are more convex than the efficient consumption possibility curve so that there is a unique point of tangency.

[8]Clearly, this interpretation of the Golden Rule excludes the possibility of transfer rules that differ from one generation to the next. For example, the adults of period t would prefer to receive more than the Golden Rule level of transfer from their children provided that they could maintain a low level of transfers to their own parents.

[9]Another possibility should be mentioned. Suppose, contrary to the assumption of my model, that the elderly are productive and that their old age consumption is equal to the sum of their own output plus transfers from their children. Ceteris paribus, any (expected) increase in the productivity of the elderly in period t+1 would reduce the demand for saving in period t and, therefore, would reduce fertility in period t. If the productivity of adults and the elderly increased by the same proportion and $\varepsilon_c = \eta_c = 1$, the demand for children would remain unchanged. Hence, in a model of the demand for children as assets, the sign of the "income" elasticity of demand for children depends on age-specific changes in income. The possible empirical importance of this consideration is indicated by evidence cited by Mueller (1976) which shows that elderly males continue to be productive in peasant agriculture in many societies.

[10]See the studies cited in f.n. 3 above.

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