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7 Interactions of Economic and Demographic Household Behavior

Allen C. Kelley

7.1 Introduction

In the past decade there has been a notable increase in research studies by economists in the area of population-economic relationships. On the one hand, Malthusian demographics,[1] which emphasized biological drives in explaining family size, has given way to attempts to make population an endogenous rather than an exogenous variable in studies of economic growth and household behavior. For example, the "new home economics," pioneered by Gary Becker's seminal paper delivered at the 1960 NBER Conference on Demographic and Economic Change in Developed Countries, has convinced many social scientists that the decision to bear children may be productively analyzed in the context of rational decision-makers applying the calculus of cost-benefit analysis.[2] On the other hand, economists are beginning to question the theoretical and empirical foundations of some long-held economic-demographic connections highlighted in studies of economic development and to make needed refinements based on alternative analytical frameworks.[3] One of these connections relates to the effect of higher dependency rates

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on economic development, and in particular the effect of larger family sizes on the household's rate and composition of saving and labor force participation.[4]

In most models where these economic-demographic connections have been explicitly investigated, children are assumed (1) to make rather mechanically determined consumption demands (through adult-equivalency weights) on the household's resources; (2) to have an adverse (or possibly neutral) effect on the household's work force participation; and (3) to be "financed" by drawing down on the household's level of saving.[5] These models and assumptions are increasingly being questioned. The effect of children on the household's rate of asset accumulation is an empirical issue. For example, children may increase or decrease the market or home work activity of parents, and children may contribute directly to this activity. Likewise, children may make large consumption demands or relatively small ones, given the scale economies present in certain types of household consumption. Children may stimulate or deter the rate of asset accumulation, depending on the nature of the household's saving motivations and on whether the saving measure is broadened to include human-capital investments as well as financial saving. In summary, the influence of alternative family sizes and structures on basic household economic decisions—saving, consumption, income generation—is a very complex matter. The influences are likely to vary in direction and magnitude over time and across countries. We must be reluctant to accept simple generalizations of the adverse influence of large families until household behavior has been subjected to much closer analytical and empirical scrutiny. Lamentably, a careful assessment of the current state of the art in understanding the effect of population growth on the economy conforms to Simon Kuznets's analysis of this issue expressed at the 1960 NBER conference: "We have no tested, or even approximate, empirical coefficients with which to weight the various positive and negative aspects of population growth. While we may be able to distinguish the advantages and disadvantages, we rarely know the character of the function that relates them to different magnitudes of population growth."[6]

In this paper we develop several empirical models of the household that highlight the effect of alternative family sizes and structures on saving and income and that in turn examine the effect of selected economic influences on the family-size decision. Microeconomic and microdemographic data on urban Kenya are utilized to evaluate these models. We find that many of the traditionally held adverse effects of family size and structure on household saving and income simply do not hold in Kenya.[7] Moreover, some effects of children that are seldom considered in economic-demographic household modeling turn out to be relatively important there.

We cannot generalize from our results. While the basic models employed in this paper may be broadly applicable, their particular parameters may change from setting to setting and over time. Until these types of empirical paradigms are forthcoming in sufficient volume for several countries, using microeconomic and microdemographic data from low-income as well as high-income countries, there will be little solid basis for identifying the effects of alternative household sizes and structures on household behavior, and population's effect on economic development.

7.2 Models of Household Behavior

The primary dimensions of household behavior to be modeled are saving, income, and family size, all hypothesized to represent interrelated decisions. In exploring the various empirical and demographic specifications of such a model, the sets of equations describing household behavior will be modified in two general directions. First, the concept of household saving and investment will be expanded from the traditional financial concept to include the household's expenditures on children's education. This framework requires the construction of a different measure of saving that includes human-capital investments. Second, the occurrence of child deaths can itself be treated as endogenous, not so much in a decision-making, behavioral perspective, but rather because certain household attributes (e.g., children ever born and income) that may influence child mortality are in part within the control of the household's decisions.

Section 7.2.1 presents the "basic disaggregated model" where child deaths are taken to be exogenous, where saving is defined to exclude human capital investments, and where the effect of children by sex on saving is explicitly examined. This basic model is then extended to include investment in children's education (section 7.2.2) and endogenous child deaths (section 7.2.3). For ease of exposition the models are presented in explicit form, and the variables are specified to conform to Kenyan data-file restrictions.

7.2.1 The Basic Disaggregated Model

The basic structural model is presented in equations 1–4. Expectations on the direction of the partial effect of the various independent variables are indicated by superscript signs; a question mark appears where the causal influences flow in both directions and the net influence is therefore uncertain.

$$(1) \qquad S = a_0 + a_1 Y^{+} + a_2 C^{-}{}_{fh} + a_3 C^{-}{}_{mh} + a_4 C^{-}{}_{n} + a_5 A^{+}{}_{m} + a_6 A^{2-}{}_{m} + a_7 (1/U)^{?}$$

$$(2) \qquad Y = b_0 + b_1 C^{?}_{fh} + b_2 C^{?}_{mh} + b_3 C^{?}_{a} + b_4 A^{+}_{m} + b_5 A^{2-}_{m} + b_6 E^{+}_{mp} + b_7 E^{+}_{ms} + b_8 E^{+}_{fp} + b_9 E^{+}_{fs} + b_{10} T^{?}_{k} + b_{11} T^{?}_{l}$$

$$(3) \qquad C_{eb} = c_0 + c_1 Y^{+} + c_2 (1 - e^{-c_3 A f}) + c_4 E^{-}_{mp} + c_5 E^{-}_{ms} + c_6 E^{-}_{fp} + c_7 E^{-}_{fs} + c_8 C^{+}_{d}$$

$$(4) \qquad C_{eb} = C_{mh} + C_{fh}\, C_a + C_d,$$

where $S =$ household savings in Kenyan shillings
$Y =$ household income from all sources in Kenyan shillings
$C_{eb} =$ number of children ever born
$C_a =$ number of children living away from the household
$C_{ih} =$ number of children living at home ($i = m =$ male; $i = f =$ female)
$A_i =$ age of adult ($i = m =$ male household head; $i = f =$ wife)
$E_{ip} =$ primary level is the highest educational attainment of the household member ($=1$; 0 otherwise); $i = m =$ male; $i = f =$ female
$E_{is} =$ secondary level is the highest educational attainment of the household member ($=1$; 0 otherwise); $i = m =$ male; $i = f =$ female
$U =$ number of years the household head has lived in the urban area
$T_k =$ household head is a member of the Kikuyu tribe ($=1$; 0 otherwise)
$T_l =$ household head is a member of the Luo tribe ($=1$; 0 otherwise).

This model has three endogenous variables of primary interest: saving (S), income (Y), and children ever born (C_{eb}); and three endogenous variables of secondary interest: the number of children living away from home (C_a), the number of male children living at home (C_{mh}), and the number of female children living at home (C_{fh}).[8]

Since the primary emphasis of this model is to isolate some of the interactions of key economic and demographic variables, the demographic specifications are extensive, including (1) the number of children in the household ($C_{fh} + C_{mh}$), (2) the sex composition of the children (C_{fh}, C_{mh}), and (3) the household's structure in terms of the number of children living at home and the number living away from home ($C_{fh} + C_{mh}, C_a$). A justification of these choices of demographic influences is considered below in the equation-by-equation discussion of the model. It is sufficient to note here only that the traditional roles of male and female children are quite different in the Kenyan household. Moreover, the household's asset accumulation and labor force participa-

tion decisions (captured in Y) are plausibly influenced by the number of children outside the household who may potentially remit income to the primary household unit or who may be attending boarding school.

The Basic Disaggregated Model's Key Decisions: Saving, Income, and Children Ever Born

Saving. As in most models of saving, the primary economic influence is captured by the positive effect of income,[9] and the primary demographic influence is represented by a life-cycle plan measured by the household head's age.[10] There are reasons to expect a somewhat smaller life-cycle influence in developing than in the developed countries, as well as the possibility of a somewhat different life-cycle plan. These reasons relate to the importance of the extended family where children serve as a source of income security (particularly in old age) and to the frequently held proposition that individuals' planning horizons are relatively short in low-income countries.[11] The first observation suggests not that the life-cycle saving plan is unimportant, but rather that the pattern of life-cycle saving may be different in developing countries. That is, the household may substitute investments in children (both quantity and quality) and in the extended family for financial saving. If this were the case, the life-cycle financial plan would call for a decline in saving as the household head approaches retirement. This represents the age when the returns on previous child and extended family investments would begin to be realized.

The hypothesized influence of children on household saving is negative, although there are possible differential effects depending on the child's sex and whether the child lives at home. The overall negative influences are several: children may represent a form of future security and thus substitute for current financial saving; children will increase consumption expenditures, although scale economies in consumption will attenuate this effect; and large families provide greater security against uncertainty in earning power.[12] Whether boys have a greater or smaller negative effect on saving than girls is largely an empirical issue, depending on differential consumption requirements and on differential family investment levels in children. The latter influence will be sensitive to the relative rate of return of investing (e.g., educational expenditures) in boys versus girls. In some low-income settings, boys represent a more attractive investment than girls since boys are charged with providing financial security for their parents in old age. In Kenya, however, girls provide the household with a bride-price varying, in part, with the quality (e.g., educational status) of the girl. This bride-price phenomenon is plausibly explained by the high value of women in rural production, where they are not only responsible for child care and household upkeep, but are also farm laborers. Finally, children away from home will

lower current household saving to the extent that these children, as well as those at home, represent potential or actual remitters of income, that is, to the extent that these children are an income-yielding asset.[13] The negative effect of C_a on saving may be larger than that of C_{mn} or C_{fn} since children away from home are likely to supplement current income, while children at home are not yet in a position to do so. Children away from home may also induce a reduction in financial saving if these children are at school, and if as a result the household is shifting its resources from financial toward human-capital investments.

A final determinant of saving that is included in the model is urbanization, measured by the length of time the household has lived in the urban area. This variable might be taken as a proxy for the degree of household ties to the extended rural family, an influence that can be expected to exert a negative influence on household saving.[14] The urban area also provides wider outlets for saving, as well as some "forced" saving (e.g., employer retirement plans). For both of these reasons, urbanization should exert a positive influence on saving. Attenuating this influence might be the desire and ability of the household to increase its consumption owing to the desire to maintain a socially determined economic standing (i.e., the influence of the relative-income hypothesis),[15] as well as the wider opportunities for consumption afforded by the urban area. These various influences that flow in opposite directions result in an ambiguous prediction on the effect of urbanization on household saving. Irrespective of the direction of influence, however, the marginal effect of urbanization is likely to decline with the length of time the household is in the urban area. A nonlinear relationship, captured by the inverse of urbanization, is therefore postulated.

Income. The family decision that explains the household's income is the level and the nature of the labor force participation of the various family members. Ideally, a detailed household model would examine the determinants of this labor force participation as well as the determinants of nonlabor income. In the interests of simplicity of model construction, we have elected to explore a subset of this set of decisions and to focus on the determinants of total household income.

The two major determinants of household income incorporated in most models of this type are age and education. Age reflects the possibility of a life-cycle earnings pattern whereby earnings reach a peak and may decline at later stages of employment, depending in part on the type of employment. If skills and education are important attributes of the job, earnings may actually increase throughout the life cycle; that is, human-capital skills may appreciate in value and improve with use. The opposite argument might apply to manual employment, where the capital stock (in this case the physical capital stock of the worker) depre-

ciates with use. Earnings, in part reflecting labor productivity, would decline as a result. Since this latter type of employment is most prevalent in Kenya, we hypothesize that $\partial Y/\partial A_m > 0$ and $\partial Y/\partial A^2{}_m < 0$.

Education will exert a positive effect on income. This effect can be expected to be relatively large in the low-income setting where educational skills are relatively scarce.[16] In Kenya the value of education to economic advancement is widely known. The government has been committed to greatly expanding the educational opportunities of its population. There has been an emphasis on primary and intermediate schooling, and the supply of workers with secondary and college-level skills is still relatively small. As a result, the differential effect on income of secondary over primary education can be expected to be large. The model incorporates both the male household head's and the wife's education levels to reveal any differential effects of education that may occur in Kenya.[17]

Children may exert either a negative or a positive effect on income and work force participation. On the one hand, the presence of children in the household deters the labor force participation of the mother, although this effect may be small in the low-income setting where substitutes for the services of the mother in the home are more readily available.[18] On the other hand, children may add directly to the family's income;[19] they may also induce adult family earners to work harder and longer to support the added consumption.[20]

Sex-specific child effects on family income will vary from country to country, depending on the relative value of boys versus girls in terms of the household's commitment to investment in child-related human capital and depending on the possible existence of sex bias in employment. For example, if male children represent the primary form of security for the household in old age, there may be a greater allocation of educational expenditures to boys than to girls. Work force participation to provide the income for this investment may well be stimulated by the presence of male children. Moreover, mothers may directly assume some of the responsibility for educating and training their daughters. As a result, the mother's work force participation may be particularly deterred by the presence of daughters. Alternatively, daughters may themselves assist in housework and child care, permitting mothers to participate in the market work force. Finally, boys may find it easier to obtain market employment and to contribute to household earnings. Whether there are in fact differences in family income owing to the sex composition of the children cannot be assessed on a priori grounds and is therefore an empirical issue.

The effect on family income of children away from home is ambiguous. On the one hand, their separation from the household will result in a smaller contribution to the household's earnings derived from the

child's direct labor. On the other hand, they may represent an income-earning asset that reduces the need for the household to earn, given the commitment of children to care for their parents in old age.

The Kikuyu and Luo tribes, both politically powerful and economically active, may possess different income-earning levels and opportunities than other Kenyans. This possibility may be associated with the particularly strong value they place on investment in education; it may be associated with differential access to capital markets or possibly greater awareness of opportunities for investment in income-generating activities; and so forth. They may also have greater preferences for work over leisure.[21] Hard evidence that systematically documents any difference in economic behavior among tribes is almost nonexistent, although speculation is abundant. Given this lack of evidence, and given the inadequate analytical underpinnings predicting the nature of any tribal differences, we remain agnostic in our speculations and are content to explore the presence of a tribal influence empirically, but without any a priori expectation of the direction of the influence.

Children Ever Born. Families are assumed to strive for a number of surviving children, which is the net income of the number of children ever born (C_{eb}) and the number of child deaths (C_d). In the present version of the household model, the number of child deaths is taken to be exogenous; a later version will explore an endogenous specification of this variable. Because families attempt to meet their target number of surviving children, child deaths, other things being equal, will exert a positive influence on the number of children ever born.[22] Indeed, given a positive probability of child deaths, there may be overreplacement of children who have died; that is, the estimated parameter of C_d may exceed unity. On the other hand, if the household is unwilling or unable to replace a deceased child with another live birth, then the estimated parameter c_8 in the C_{eb} equation will be less than unity.[23]

The relationship between female age and number of children ever born is well established in the demographic literature. This is largely based on the relationship of age and biological fecundity. Fecundity is greatest in the early years of marriage, diminishes in middle age, and reaches zero when sterility occurs.[24] This relationship is captured in our model by a hypothesized nonlinear relationship in parameters.

The effect of income on the number of children ever born is somewhat complex.[25] This relationship has been most extensively exposed in writings on the "new home economics" by economists who effectively employ standard techniques of price theory to the family-size decision.[26] Children are assumed to be consumer durables, providing child services that are a normal good (i.e., the income elasticity of demand is positive) and that require direct costs (e.g., food and clothing) and indirect

costs (e.g., the parents' time) to acquire and enjoy. Through the standard income effect, an increase in income will increase the household's demand for child services. On the other hand, this increased income may be associated with (and caused by) a higher value of the parents' time. This higher value of time, in turn, will exert a negative price-substitution effect; that is, children will be more expensive to raise and enjoy in terms of the opportunity cost of the parents' time. It is often assumed that the negative substitution effect outweighs the positive income effect.[27] The relation of income and children ever born is, of course, an empirical issue. Indeed, in the developing economy where there are relatively more low-cost alternatives to the parents' time in child-rearing, the positive income effect could well dominate.

The positive income effect on the demand for child services has come under attack from authors who have questioned the ability to separate the income effects from the price effects. It has been alleged that society establishes "norms" or social pressures that result in higher costs for children of parents in higher status groups. As a result, larger incomes do not necessarily raise the utility of children. Operationally, greater utility can be derived only from child expenditure levels that are larger than those of the parents' "peer" group. Thus, the price of a given level of utility from children would increase with the family's normal income, since this income simultaneously implies a corresponding higher-status peer-group level. These arguments, if empirically important, would attenuate the positive income effect.[28]

If one extends the conception of the value of child services from that of a consumer durable to that of a producer durable, where children are expected to contribute directly to income as well as to remit earnings to their parents in old age, then the income effect may be even more powerful. Some authors have hypothesized that in a developing economy, given the high value of children for direct production, income security, and current utility, there may be an excess demand for children; supply factors may in fact constrain family size.[29] These supply factors relate in part to the health of parents, which affects fertility and child mortality. Higher incomes and education will result in lower child deaths and will provide the ability to acquire better health and nutrition, conducive to larger family sizes. For these supply-oriented reasons, increased income in low-income societies may also result in larger family sizes over those income ranges up to a threshold subsistence consumption level.

The effect of education on the number of children ever born is, like the effect of income, quite complex. More highly educated parents command higher income. This particular association between education and income may be quantitatively important in developing countries, where skilled and educated manpower is relatively scarce. However, in our model, this education-income effect is captured in equation 2, and thus

the influence of education in the children-ever-born equation represents influences other than the income effect of education.[30] More highly educated parents also command higher wages, and thus the opportunity cost of producing and consuming child services increases with education levels. Because wages increase more than proportionately to increases in education in Kenya, we would expect the negative price-substitution effect of education on children ever born to be higher for E_{is} than for E_{ip}. Moreover, since the burden of child care rests largely on the mother, we would expect $E_{mp} > E_{fp}$ and $E_{ms} > E_{fs}$.

Several other linkages have been highlighted in the literature. First, Robert T. Michael (1973, p. 173) has shown using American data that "more educated couples use contraceptive techniques more extensively, approve of their use more thoroughly, and adopt contraception at an earlier birth interval. Consequently, more educated couples are . . . less likely to have 'excess fertility' or 'unwanted' births." He also demonstrates that more highly educated parents employ relatively more efficient and effective contraceptive techniques, other things equal.[31] Second, in less developed countries where supply factors may constrain family size, more education may serve to release these supply constraints. According to Encarnacion (1973), below some threshold level more education results in better knowledge of health practices, enabling women to have more children and enabling families to avert some child deaths.

Finally, a few economists and many sociologists have associated higher levels of education with systematic changes in preferences away from child services and toward competing goods and services, and away from numbers of children and toward fewer but higher-quality children. It is held that more highly educated parents have a greater preference for better educated children, other things equal. Moreover, better educated parents may also have longer time horizons, influencing their preferences toward consumer durables, on the one hand, and toward more durable (e.g., higher-quality) child services on the other. Unfortunately, neither economists nor other behavioral scientists have developed an acceptable theory of taste formation. Thus, while education may indeed affect tastes in some unspecified manner, to date it has not proved feasible to identify this influence empirically.[32]

In summary, with the possible exception of the influence of education at very low income levels on the knowledge of health practices, the effect of education on the number of children ever born is expected to be negative.

Children at Home and away from Home: Closing the Basic Disaggregated Model

There are a priori reasons to expect that household saving behavior will be different depending on whether children are older and outside

the household or whether the family is supporting and investing in children within the home. In the present version of the basic model, the location of children is taken to be endogenous. This specification can be justified in econometric terms, since one would expect that the error term in the children-ever-born equation would itself be related to and explained by family size, the sum of children living at home and away from home. A somewhat improved model specification is therefore expected by the endogenous treatment of C_a, C_{mh}, and C_{fh}. It should be noted, however, that we are not particularly interested in explaining these child-location and child-sex relationships from a behavioral or an analytical perspective. The method of estimating C_a, C_{mh}, and C_{fh} is discussed below in section 7.4.2.

7.2.2 The Basic Disaggregated Model Modified: The Decision on Investment in Child Education

The basic model considers only household capital accumulation in the traditional forms of financial saving: housing, pension-fund contributions, savings accounts, bonds, stocks, and so forth. This may represent an overly restrictive and unrealistic model of the typical household in a less developed country, where the investment in human capital, and notably in the education of children, may represent a major saving motivation and a direct outlet for household investment funds. This follows for several reasons. First, as already discussed, children may represent a producer as well as a consumer durable. They may provide for parents in their old age; they may also contribute to the household's current income. The level of this earned and/or remitted income from children is related to the value the market places on the labor services of the child; this in turn is positively associated with the child's education.[33] Second, the value of education itself is relatively large in low-income countries, where educational skills are scarce. Third, children may represent a safer and less expensive outlet for investment funds than many forms of financial assets, where underdeveloped capital markets may result in expensive information and search costs, infeasibly large or "lumpy" investments, and higher investment risks given the uncertainties of investing in new enterprises in the early stages of economic development.

Finally, in Kenya a large share of the costs of education has in the past been privately assumed. Unlike higher-income countries where this form of "saving" is in large part involuntary through compulsory education, and where schools are financed largely through taxation, in Kenya education has been voluntary and school fees have constituted a notable source of educational finances. School fees on the order of 10% of household income have not been uncommon. Given the financial burden of school fees, members of the extended family have traditionally as-

sumed some role in amassing the savings necessary to underwrite the education of promising children.[34] In 1974 the government of Kenya removed fees for the first four years of schooling (standards 1–4); the fees for the upper elementary levels were also lowered and standardized. However, the data analyzed in the current study apply to the period of higher school fees. Moreover, there are still substantial private educational costs, particularly at the secondary and university levels.

Turning to the determinants of investment in children, we will consider four variables: income, number of children, education of the father and mother, and tribe. These variables, together with our expectations on the signs of the estimated parameters, are summarized in equation 5.

$$(5) \qquad I_e = f_0 + f_1 Y^+ + f_2 C^+_{mh} + f_3 C^+_{fh} + f_4 E^?_{mp} + f_5 E^?_{ms} + f_6 E^?_{fp} + f_7 E^?_{fs} + f_8 T^?_k + f_9 T^?_l.$$

Both as a normal consumption good and as a form of saving, educational expenditures will be positively associated with income. Similarly, investment in education will be directly related to the number of children, although this relationship may be somewhat complex. Other demographic factors such as child parity, intelligence, and sex may also have an effect on the household's educational investments. Indeed, a case can be made whereby the level of educational expenditures on children is relatively insensitive to the number of children in the household.[35] If, for example, educational investments in children are viewed largely as an augmentation of a producer durable, this investment will compete with other forms of financial investment by the household. The level of income may be the single most important factor determining the level of total saving. Other factors may then enter to largely explain the composition of that saving, as well as the composition of consumption.[36] If this is the case, the number of children may represent a relatively unimportant determinant of total educational expenditures.[37] Other factors could well dominate: the availability of "promising" (e.g., relatively bright) children, the number of boys (if they in fact possess a higher rate of return on educational expenditures), child parity (if custom and tradition allot the duty of supporting the parents according to parity), and so forth. In our model, while we hypothesize a positive effect of number of children on educational expenditures, this may not be a particularly strong relationship. Moreover, it is possible that educational expenditure on boys will exceed that on girls.[38]

The effect of the household head's education on investment in education is also complex. On the one hand, there may be a positive relationship to the extent that the household head's preferences for education as a consumption good are directly associated with his own education. On the other hand, there may be a negative relationship to the extent that the household head's own education may have been in part financed

by the extended family. As a result, the commitment to repay this family debt through remittances is likely to be directly related to the level of his own education.[39] The effect of the mother's education on child-investment expenditures is also complicated. Like her husband, she may have a preference for investing in her children's education that is positively associated with her own educational level. On the other hand, since she is responsible not only for child-rearing, but also for the education of the children, her own education may substitute for or be a complement of child-investment expenditures. The relative strengths of these various influences is not known with sufficient precision to permit a prediction of the direction of the effect of the mother's education on child-education expenditures.

It is widely asserted in studies of Kenya that there are differences by tribe in preference for education.[40] There is almost no concrete evidence that isolates these differences. We include tribe as a possible variable explaining educational expenditures but remain agnostic on the direction or magnitude of the effect.

7.2.3 The Basic Disaggregated Model Modified: Child Deaths Endogenous

Models that seek to explain the household's family-size decision typically formulate this goal in terms of the number of surviving children. A child death, other things equal, will exert a positive influence on the number of children ever born. There have been several successful empirical models that have estimated this effect of child mortality.[41] Seldom, however, have researchers also attempted to identify the factors that explain child mortality and to include child mortality as an endogenous variable in the children-ever-born equation.[42] Such an endogenous specification of child mortality is formulated in this section as a modification of our basic model of household behavior.

While a child death is not a behavioral phenomenon in the sense that the family "plans" to implement a number of child deaths, it is plausible that child deaths are influenced by several household-specific variables, some of which are to a certain extent within the household's control. These variables, together with expectations on the signs of the estimated parameters, are indicated in equation 6.

$$C_d = g_0 + g_1 Y^- + g_2 C^+_{eb} + g_3 A^-_f + g_4 A^{2+}_f + g_5 E^-_{fp} + g_6 E^-_{fs}. \tag{6}$$

We expect child deaths to decline both with the household's income and with the level of mother's education. Higher income provides more resources for better diet and health care for mothers and children. Additionally, higher levels of education provide knowledge of the dietary and health factors conducive to child survival.[43]

When deaths are included as an endogenous variable in the equation for children ever born, the influence of education on children ever born should decrease (given the removal of the negative effect of education on deaths); similarly, the influence of income on children ever born should increase (given the removal of the negative effect of income on deaths).

The effect of age on child deaths is straightforward. Since we are considering only child deaths related to children who are brought to term and excluding miscarriages, we expect the incidence of child deaths to decline with the age of the mother. This is due to the greater ability of older mothers to care for children. On the other hand, there are biological reasons to expect that child mortality will increase with age. In particular, the incidence of congenital malformation and genetic disease increases with age and parity; this increase is particularly rapid after approximately age thirty-five.[44] The net result is expected to be an increasing prevalence of child mortality by the age of the mother, especially toward the end of the childbearing cycle.

Finally, since the exposure to the risk of child deaths increases with the number of children in the family, we expect a positive sign on the estimated parameter of the variable children ever born.

7.3 Data, Variable Definitions, and Values

7.3.1 The Data

The data used in the empirical analysis below pertain to three urban areas of Kenya: Nairobi, Kisumu, and Mombasa. These data were collected from December 1968 to October 1969 by the Central Bureau of Statistics, an organization that has been responsible for many household surveys and that has a permanent staff of trained and experienced enumerators, statistical analysts, and data processors.

The sample frame was confined almost exclusively to African households. Through disproportionate stratified sampling, more households were selected from the upper- and middle-income strata than from the lower-income stratum. The final sample included 1,146 households. Most of these represented "complex" households, where there were more than two adults or where there were children who belonged to different adults outside the household. Unfortunately, both parents of the children were not identified in the survey. Since the present research focuses on the determinants of family size, as well as the effect of family size on other household decisions, it was therefore necessary to include in the sample only households with two married adults, where there were no "other" household members besides the children of the household head. This reduced the sample to 401 households.

This sample of households may exhibit somewhat weaker ties to the extended family than the complex households. However, an analysis of the expenditures of the subsample indicates that this group does indeed remit some income outside the household, presumably to the extended family. Thus the households in our subsample should not be interpreted as being nuclear in the behavioral sense of having no economic ties to the extended family.[45]

7.3.2 Variable Definitions and Values

Table 7.1 presents the means and standard deviations of the continuous variables used in the empirical analysis, and the relative frequency distribution of the classificatory variables.

Income (Y) refers to total household income earned (not received) during the period and includes the basic salary, bonuses, overtime, housing allowances, net business profits, receipts from the sale of own produce, and income from rents, pensions, and transfers.[46] This definition and measurement includes elements of both transitory and permanent income. Distinguishing between these two types of income would enrich the analysis both analytically and empirically, but for two reasons the costs of separating income components appears to exceed the benefits, given the present research objectives. First, those techniques that have been employed using cross-sectional data to measure permanent income have reduced estimation efficiency and are deficient analytically and statistically in other dimensions.[47] Second, the combination of the two income components employed in the present research identifies typical household income variation, assuming that the share of the household's transitory and permanent income does not change over time and that these classes of income are not differently distributed among households over time.

Financial Saving (S) is measured as the difference between earned income and actual household consumption.[48] This saving definition has two primary difficulties: the treatment of cash remittances outside the household and the treatment of consumer durables. Both are household expenditures; however, both also incorporate an element of saving. Remittances are used by the extended household for various purposes, including the financing of current consumption, investment in housing, and payment of school fees. That share of remittances that results in some form of saving or capital formation should presumably be classified as saving to the remitting household. However, no concrete information is available on the use of remittances by the extended household.[49] Based on data on average saving pertaining to the rural households (where the urban household income is largely remitted), 20% of the remittances are assumed to represent saving.

Table 7.1 **Means and Standard Deviations of Variables Employed in the Regression Models**

Variable Name	Variable Symbol	Mean	Standard Deviation	Percentage in Indicated Categories
Income (Kenyan shillings)	Y	719.5	794.4	
Financial saving (excluding education)	S	7.1	544.8	
Total saving (including education)	S^*	36.4	550.2	
Investment in education	I_c	29.3	57.4	
Children ever born	C_{eb}	4.1	2.8	
0				8.0
1				12.0
2				13.0
3				14.0
4				12.5
5				11.0
6+				29.5
Surviving children	C_s	3.7	2.59	
Child deaths	C_d	.4	.8	
0				76.8
1				13.2
2				7.2
3+				2.8
Children away from home	C_a	.6	1.3	
0				76.1
1				7.7
2				6.5
3+				9.7
Male children at home	C_{mh}	1.6	1.4	
Female children at home	C_{fh}	1.5	1.6	
Age of household head	A_m	36.4	9.0	
(Age) of household head	A_m^2	1,407.0	736.8	
Age of wife	A_f	27.9	7.4	
(Age) of wife	A_f^2	830.3	470.5	
Education of household head				
Less than completed primary				37.2
Completed primary	E_p			36.4
Some secondary or university	E_s			26.4
Education of wife				
Less than completed primary				57.9
Completed primary	E_{pf}			37.4
Some secondary or university	E_{sf}			4.7
Tribal status				
Kikuyu	T_k			17.7
Luo	T_l			24.9
Binary variable for age of wife	D			
$D = 0$ if $A_f \leq 29$				63.8

Table 7.1 (continued)

Variable Name	Variable Symbol	Mean	Standard Deviation	Percentage in Indicated Categories
$D = 1$ if $A_f > 29$				36.2
$D \cdot A_f$		12.8	17.4	
Urbanization	$1/U$	.2	.2	

*Significant at least at the .05 level.

Consumer durables are considered as current consumption. There is no feasible way to estimate the rate of depreciation of the household's stock of consumer durables. The treatment of consumer durables as current consumption, while not entirely satisfactory, is widely employed in these types of household studies, given the above-mentioned data constraints.[50]

Total Saving (S^*), which combines financial saving with human capital investments in education (school fees, school uniforms, books), broadens the concept of household capital accumulation and is justified by considering educational expenditures as in part an investment in a producer durable. While the analytical distinction between education as current or future consumption and as investment in an income-earning asset has been clearly delineated by Theodore Schultz and others, empirical estimates of the share of education which is consumption and that which is investment have been meager. This study will therefore examine the two extreme cases: one in which education is entirely a consumption good (whether current or future consumption); and one in which education is entirely a producer durable. In advanced countries, the consumer durable motivation plausibly dominates. In lower-income countries, educational expenditures are also likely to be influenced by investment motivations. Education, especially more advanced levels such as high school and college, is a luxury good, given the closeness of many households to a subsistence level of consumption. Moreover, the rate of return on education is high, making it an attractive form of investment.[51]

Measured financial saving in Kenya is small, 7 shillings per household per period, or about 1% of average household income. As in most household surveys of this type, saving is likely to be underestimated. When human capital investments are added, the saving figure rises to 36 shillings, or 5% of average household income. In both measures the variation is large. This variation is explained in part by real factors and in part by notable measurement errors common both to the measurement of saving and to any measure formed as a residual of two large elements.

Education (E_{ip}, E_{is}) is classified into three categories: less than completed primary education, completed primary education (E_{ip}), and some secondary or university education (E_{is}). Kenyan education is divided into three levels: primary (standards 1–8), secondary (forms I–VI), and university. There is at present an insufficient supply of secondary and university facilities, given the fee schedule. As a result, students can advance to higher education levels solely by passing various standardized examinations. Only a small fraction of college-age students are admitted to the university. Because there were only seven households in our sample that had a member with any university education, considerations of statistical estimation reliability dictated that we collapse the secondary and university levels into a single category.[52]

7.4 Econometric Considerations

The models considered in this study are interactive in nature; that is, they represent a household paradigm where key decisions are simultaneously made.[53] Two-stage least-squares regression analysis is therefore employed throughout.

7.4.1 Nonlinear Estimation

The basic disaggregated model of household behavior summarized in equations 1–3 is nonlinear in the parameters. This results from the nonlinear association between the variables children ever born and age of mother. To estimate this model, nonlinear regression procedures were employed. After some experience with these procedures, it was decided that the benefits of the precision of nonlinear estimation were far outweighed by the costs, especially by comparison with a simpler and almost as satisfactory estimation method whereby the nonlinear relationship was linearly transformed into two straight-line segments.[54]

Our a priori expectations with respect to the nonlinear association between children ever born and age of mother are presented by the solid line in figure 7.1. Initial estimates that employed nonlinear regression procedures in fact provided estimates of this relationship that conformed to these expectations. Namely, completed family size is reached rather rapidly after childbearing begins and approaches an upper limit in the middle to later years of life, owing to the onset of female sterility. A linear approximation to this hypothesis is presented by the two broken line segments in the figure.

The linear approximation is obtained by defining a dummy variable D that takes on a value of zero below a specified age A^*_f and a value of unity thereafter. The regression equation represented by figure 7.1 would therefore be written as $C_{eb} = \alpha + \beta D + \gamma A_f + \delta A_f \times D + \epsilon$. The line segment to the left of A^*_f has an intercept of α and a slope of

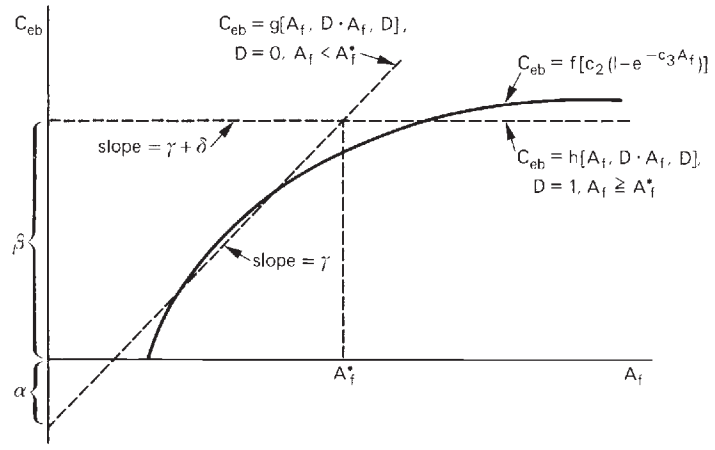

Fig. 7.1

γ. To the right of A^*_f, the intercept is the sum of α and β, and the slope is the sum of γ and δ. In practice, the estimate of A^*_f is given either on a priori grounds or is obtained by experimentation. In the present study, given our a priori expectations on the nature of the function, the value of A^*_f was obtained where the slope of the second line segment was flat, that is, where the sum of the estimates of γ and δ most clearly approximated zero.[55]

7.4.2 Categorical Variables, C_d and C_a, and the Estimation of C_{mh} and C_{fh}

Least-squares estimation procedures assume that the error terms of the estimated regression line are normally distributed.[56] This is not the case where the dependent variable is dichotomous or where it is categorical with limited variation. Examples of these types of variables in our model include children away from home (C_a) and child deaths (C_d). For C_a, the percentages of households who had zero, one, two, and three or more children away from home are 76.1, 7.7, 6.5, and 9.7 respectively; for C_d the corresponding percentages are 76.8, 13.2, 7.2, and 2.8. Since with ordinary least-squares procedures there are no constraints on the estimated values of C_a and C_d, the resulting estimates can be wide of the mark.

In the case of C_d, we have elected to explore two separate models: one in which C_d is endogenous and one in which C_d is exogenous. This treatment can be justified by our uncertainty about how this variable should be treated in our model. While child deaths may not be behaviorally determined and thus should not be taken as endogenous, they are indeed influenced by variables such as education and income over

which the household has some control. It would therefore be instructive to ascertain the extent to which the estimates of equation 3, children ever born, are sensitive to whether C_d is treated as exogenous or endogenous. In the latter case, however, the model must be interpreted with some care, given the econometric considerations noted above.

C_a, while appropriately treated as endogenous, partakes of the same types of estimation difficulties as C_d. Moreover, the two endogenous variables that measure the household's sex composition, C_{hm} and C_{fh}, cannot be estimated with a standard regression framework since the variation in these variables is not systematically explained by household characteristics. We will therefore estimate C_a, C_{mh}, and C_{fh} by an alternative procedure that is consistent with both the basic model specification and the econometric requirements of obtaining asymptotically unbiased estimates in a household model of the type considered in this study. In particular, we assume that the ratio of C_a, C_{mh}, and C_{fh} to surviving children for each household can be treated as exogenous. We first compute C_{eh}, which is estimated for each household from a regression where C_{eh} is regressed on the exogenous variables in the system. This C_{eh} is then netted of C_d or C_d (depending on whether C_d is taken as endogenous or exogenous) and divided into three parts for each household, using the ratios noted above. This provides the resulting values for C_a, C_{mh}, and C_{fh} that are used where these variables appear in the household equations.

7.4.3 Heteroskedasticity

It is plausible that there is less variation in saving for low-income families than for high-income families, since the ability to save at low incomes is constrained by subsistence needs. The saving equations were therefore examined for heteroskedasticity using the Goldfeld-Quandt test. In all cases heteroskedasticity was found and was corrected by standard econometric procedures.[57]

7.5 The Results

An examination of the results using the basic disaggregated model reveals that while the model in general conforms to a priori expectations, there are virtually no effects on household saving and income owing to the sex composition of the household's children[58] or to the proportion of the family living within the household. This result implies that we can notably simplify the modeling of the household's demographic structure by aggregating these sex- and location-specific influences into either children ever born (C_{eh}) or surviving children (C_s), whichever is appropriate to the relationship being examined. This is done in what we

denote as the "compact" model. For expositional convenience, only the compact model is analyzed in this section. The results of the disaggregated model are presented in appendix tables 7.A.1 and 7.A.2.

7.5.1 The Compact Model

The results are presented in table 7.2. The analysis will focus first on the version of this model where child deaths are treated as exogenous.

Child Deaths Exogenous

As expected, income is the primary determinant of saving. The marginal propensity to save is 0.110. Life-cycle factors (measured by age) do not appear to be important in explaining Kenyan household saving. This is not surprising given the discussion above in section 7.2.1. The most interesting result pertains to the effect of children on saving. Contrary to most theoretical discussions of household behavior, in our model children do *not* exert a direct negative effect on financial saving (S). However, a consideration of the total savings measure (S^*) provides some evidence that children may stimulate asset accumulation when the savings measure is broadened to include human-capital formation.[59] Here the marginal propensity to save is slightly higher, 0.139 compared with 0.110.

Support for a life-cycle pattern is also absent in the income equation, where neither of the age terms is significant. Tribal effects, held by many to be an important determinant of household income, do not emerge as a significant factor from the data employed in this study. It should be noted, however, that owing to the selectivity of rural-urban migration, where the better educated individuals of relatively higher socioeconomic status tend to migrate, tribal differences may as a result be difficult to observe in our particular sample. An interesting finding in the income equation is the large influence of education. While the effect of education on income has been shown to be high in studies of Africa and of Kenya, confirmation of this result using microeconomic data where some control has been obtained for related variables has not been fully explored.[60] Our results show that by comparison with the noneducated household head, primary education contributes 144 shillings per period; secondary education contributes 910 shillings (see above, table 7.2). Moreover, female education exerts about the same effect as male education. Given the mean household income level of 719 shillings per period in the sample, the distribution of educational endowments clearly constitutes one of the more important factors explaining the distribution of income in Kenyan urban society. Finally, it is of considerable importance to observe that surviving children exert a positive influence on household income. Whether this influence is direct, through the con-

Table 7.2 **Regression Results for Compact Model of Household Saving, Income, Children Ever Born, and Child Deaths Using 2SLS**

	Constant	Y	C_{eb}	C_s	C_d
Financial saving(S)[a]					
C_d exogenous	−263.26	.110*		7.46	
	(−1.09)	(2.13)		(.33)	
C_d endogenous	−241.01	.105*		10.61	
	(−.99)	(2.02)		(.48)	
Total saving (S^*)[a]					
C_d exogenous	−286.74	.139*		16.86	
	(−1.20)	(2.72)		(.76)	
C_d endogenous	−260.28	.132*		20.59	
	(−1.09)	(2.59)		(.94)	
Income (Y)					
C_d exogenous	−50.69			133.42*	
	(−.08)			(2.88)	
C_d endogenous	−134.72			123.66*	
	(−.23)			(2.72)	
Children ever born (C_{eb})					
C_d exogenous	−2.18*	.003*			1.08*
	(1.92)	(2.35)			(5.91)
C_d endogenous	−3.04*	.001			2.66*
	(−2.86)	(.84)			(2.30)
Child deaths (C_d)	−.16	−.0003*	.125*		
	(−.26)	(−2.36)	(2.26)		

[a]The heteroskedasticity correction divided each variable by $Y^{-.39}$.
*Significant at least at the .05 level.
†Jointly significant at least at the .05 level.
§Jointly significant at least at the .05 level.

tribution of child labor in the marketplace and through remittances, or indirect, by encouraging or permitting parents to work more in market employment, cannot be adequately isolated in our data set.

The children-ever-born equation provides several interesting results. Child services are normal goods; that is, they are positively and strongly related to family income.[61] Indeed, family size increases by one child for every increase in income of 333 shillings. This result is at variance with some of the "new home economics" studies that show a negative effect of income on family size. However, unlike some of these studies, we have been able to control for the interaction of the household size and income relationships through a model that highlights interactive decision-making. Finally, children may be more valuable in low-income societies, where they are not only a consumer durable but a producer durable as well.

Child deaths and age of the mother enter the C_{eb} equation in the expected manner. Families aspire to surviving children; indeed, they

A_m	A_m^2	A_f	A_f^2	D	$D \cdot A_f$	E_{mp}	E_{ms}
7.26	−.089						
(.57)	(−.67)						
6.07	−.080						
(.48)	(−.61)						
7.33	−.095						
(.58)	(−.73)						
5.91	−.084						
(.47)	(−.64)						
2.33	−.108					144.84†§	910.67*†§
(.07)	(−.31)					(1.54)	(7.83)
7.15	−.149					145.44†§	918.27*†§
(.22)	(−.44)					(1.56)	(7.99)
		.167*		6.27*	−.173*	−.32	−2.82*
		(3.09)		(1.74)	(1.94)	(−.67)	(−1.83)
		.193*†		3.63†	−.123†	.27	−.27
		(4.14)		(.96)	(−1.38)	(.50)	(−.14)
		.02	−.0003				
		(.38)	(−.52)				

appear to approximately replace those children who have died, given their expectation of a positive infant and child mortality rate.[62] (Although the parameter on C_d exceeds unity, tests indicate that it is statistically different from unity only at the 0.25 level.)

We anticipated that the effect of increased education levels would diminish family size. While the signs on the education variables are generally negative, the estimated parameters are not statistically different from zero for primary education levels. Moreover, primary education exerts a smaller influence on children ever born than secondary education, and the negative effect of female secondary education is larger than that of male secondary education. These are quite plausible results. The mother assumes the primary role in child-rearing in Kenya. The opportunity cost of the mother's time in household production rises rapidly and nonlinearly with education levels. The latter, of course, is partially a proxy for the price of children. The full effect of changing educational standards on family size must also take into account the indirect effects

Table 7.2 (continued)

	E_{fp}	E_{fs}	T_k	T_l	I/U
Financial saving (S)[a]					
C_d exogenous					66.13
					(.82)
C_d endogenous					66.78
					(.83)
Total saving (S^*)[a]					
C_d exogenous					79.88
					(1.01)
C_d endogenous					80.66
					(1.01)
Income (Y)					
C_d exogenous	119.03§	973.63*§	−105.93	−83.22	
	(1.34)	(5.42)	(1.14)	(−.99)	
C_d endogenous	120.23§	965.27*§	−106.56	−80.42	
	(1.37)	(5.44)	(−1.16)	(−.97)	
Children ever born (C_{eb})					
C_d exogenous	−.29	−3.88*			
	(−.70)	(−2.72)			
C_d endogenous	−.03†	−1.92†			
	(−.08)	(−1.20)			
Child deaths (C_d)	−.05	.18			
	(−.51)	(.68)			

of education on income, and of income on children ever born. These relationships are explored in detail in section 7.5.2.

Child Deaths Endogenous

The model that treats child deaths as an endogenous variable provides several interesting results. While for the statistical reasons discussed in section 7.4.2 we must be guarded in interpreting the C_d endogenous model, nevertheless the findings at least suggest some possible influences taking place within the family decision-making process.

The influence of family size and structure on financial saving (S) and total saving (S^*) is the same in this model as in the one where child deaths were taken as exogenous. Thus the main finding of the present study, which relates to the interrelationships of family size and structure on saving, is preserved.

As in the case of the child-deaths exogenous model, when child deaths are endogenous surviving children exert a positive influence on household income. This influence is quantitatively large. Each additional child results in a direct increase in income of 123 shillings. While our discussion above clearly allows for this possibility, these results are at variance with the negative relationship postulated (and sometimes

found) in the "new home economics" studies pertaining to high-income countries. The factors in the low-income setting that might account for this difference are (1) the possibility that children may be treated as producer as well as consumer durables, thereby directly contributing to income; (2) the lower educational requirements of children, permitting them to contribute to both market and home production; (3) the facilitation of the mother's market employment through providing assistance in home production (particularly babysitting); and (4) the absence of strictly enforced child labor laws.

Turning to the child-deaths equation, we find that income exerts a statistically significant negative effect. Child deaths are also directly related to exposure to the risk of death, as revealed in the significant positive parameter on the C_{eb} variable. Finally, child deaths are not influenced by the level of education. Presumably, the influence of education on mortality is less through "knowledge" of better nutrition and health and more through its effect on income, the latter providing the means for acquiring the inputs of better nutrition and health.

An examination of the C_{eb} equation where child deaths are endogenous provides more insight into this relationship. Specifically, education no longer enters directly as a statistically significant determinant of family size; moreover, even the direction of the relationship for E_{mp} has changed. Apparently the influence of education on family size is partially indirect, through its effect on the incidence of child deaths. This is an interesting finding, since education is an omnibus variable in family-formation studies. This variable has been taken as a proxy for tastes, the costs of children, and contraceptive efficiency. Our results provide some clarification of the specific interpretation of the education variable in the Kenyan case. Increased education is likely to provide more knowledge of, receptivity toward adopting, and ability to adopt better health practices, dietary standards, and procedures for child care.

An evaluation of the C_d endogenous model must be tempered by the existence of an implausibly large estimated parameter on the C_d term in the C_{eb} equation. Possibly more sophisticated statistical procedures would improve the results. On the other hand, the results of the C_d equation itself are plausible, the estimated parameters in the Y, S, and S^* equations are stable with respect to the C_d endogenous specification, and with only one exception, those parameter changes that have occurred in the C_{eb} equation broadly conform to a priori expectations. As a result, while we remain guarded in interpreting the C_d endogenous model results, we are mildly encouraged by the performance of this model and are optimistic that future research with endogenous mortality specifications will make more headway in untangling the nature of the complex family decision-making process.

7.5.2 An Alternative Conceptualization of Household Decision-making Behavior

Our conceptualization of the household views families as making several key decisions simultaneously. For example, the household's decision regarding family size, as well as its decision regarding the amount of labor services it supplies to the market (determining a large share of household income) are made jointly. This is not the only conceptualization possible. If instead the family size decision is either an overriding one in the sense that it is made first and without regard to decisions relating to labor force participation, or if economic factors do not enter the decision-making process relating to family size (e.g., if a naive Malthusian approach to family size determination is postulated), then a recursive decision-making conceptualization of the household may be more appropriate. With our simultaneous, decision-making framework, 2SLS provides consistent or unbiased (in the probability limit) estimates of the various parameters. If OLS procedures are employed, the resulting estimates would be inconsistent or biased. However, if a recursive decision-making framework is hypothesized, then OLS estimates would not be biased.

It is therefore useful to compare the OLS with the 2SLS estimates to identify the extent to which the key results are sensitive to the particular estimation method and to the particular conceptualization of household decision-making. This exercise has other benefits. When our results are compared with a limited number of others beginning to emerge in this literature, a pattern of biases may begin to emerge that will be useful to appraising a wide range of models of household behavior.[63]

Table 7.3 **Regression Results for Compact Model of Household Saving, Income, Children Ever Born, and Child Deaths Using OLS**

	Constant	Y	C_{eb}	C_s	C_d
Financial saving (S)[a]	−328.29*	.221*		−6.56	
	(−1.77)	(6.77)		(−.98)	
Total saving (S^*)[a]	−384.95*	.257*		−3.58	
	(−2.12)	(8.03)		(−.55)	
Income (Y)	−1017.14*			21.14	
	(−2.30)			(1.47)	
Children ever born (C_{eb})	−3.79*	.0002			1.03*
	(5.94)	(.97)			(7.82)
Child deaths (C_d)	.001	−.0001*	.127*		
	(.001)	(−2.04)	(7.58)		

[a]The heteroskedasticity correction divided each variable by $Y^{.39}$ (see section 7.4.3).
*Significant at least at the .05 level.

Accordingly, we have estimated both the compact and the disaggregated models using OLS procedures. The compact model OLS results are presented in table 7.3; the disaggregated model results are presented in appendix table 7.A.2. Only the compact model results will be analyzed here, and then only the major differences between these results and those provided in table 7.2.

The main finding of the study is upheld: children do not exert an influence on the household's saving level. However, in the OLS version the parameter on C_s is negative; it is positive in the 2SLS formulation. The major difference detected in the saving and income equations is the exceptionally large estimated marginal propensity to save in the OLS models, ranging from 0.221 to 0.257. This somewhat diminishes the credibility of the OLS model, although one might justify the larger than expected coefficient by arguing that the income measure includes notable transitory as well as permanent components, and thus a high saving propensity is plausible.

In the income equation there is a notable change in the interpretation of children's role in the household. In the OLS formulation, the parameter on C_s—while positive—is not significant. Thus children do not exert as strong a positive influence on income as they do in the 2SLS rendering of the household.

The major change in the models occurs in the children-ever-born equation. Income is not significant in the OLS model and, surprisingly, education exerts a much weaker negative influence on family size. Three of the four education terms have positive signs, and the negative effect of female education declines from −3.88 in the child-deaths exogenous

A_m	A_m^2	A_f	A_f^2	D	$D \cdot A_f$	E_{mp}	E_{ms}
8.47	−.079						
(.91)	(−.72)						
10.68	−.102						
(1.18)	(−.95)						
57.82*	−.586*					151.73*	998.10*
(2.56)	(−2.16)					(1.73)	(9.65)
		.265*		6.81*	−.207	.28	.45
		(11.40)		(2.60)	(−3.24)	(.93)	(1.15)
		.004	−.0001				
		(.12)	(−.28)				

Table 7.3 (continued)

	E_{fp}	E_{fs}	T_k	T_l	I/U	R^2
Financial saving (S)[a]					39.79	
					(.55)	.13
Total saving (S^*)[a]					48.76	
					(.69)	.17
Income (Y)	132.82	877.47*	−113.12	−51.03		
	(1.61)	(5.37)	(−1.31)	(−.66)		.41
Children ever born (C_{eb})	.06	−1.20*				
	(.22)	(−2.03)				.45
Child deaths (C_d)	−.12	−.04				
	(−1.42)	(−.22)				.18

model (2SLS) to −1.20 in the OLS formulation. Sign reversals are not uncommon between 2SLS and OLS models, especially where there are notable elements of colinearity between independent variables. Indeed, there are at least two other studies, which use Puerto Rican and Chilean data, that find that the positive effect of income on children ever born diminishes or even turns negative when one moves from 2SLS to OLS estimates.[64] This finding is consistent with our results where the estimated coefficient on income declines from 0.003 to 0.0002. The influence of education in the OLS model is less plausible than that of the 2SLS framework, given our interpretation of this variable, given the insignificant income effect in the OLS formation, and given the findings of others.[65]

There are at least two possible interpretations that might be offered in analyzing the differences between the OLS and 2SLS models. First, since economic factors (the income and price variables) do not enter as significantly in the OLS formulation, then the Malthusian conceptualization where biological factors explain family size, or the Easterlin framework where supply factors dominate at low-income levels, may appropriately explain urban Kenyan behavior.[66] Second, the OLS results are implausible and are due to the statistical biases inherent in using OLS estimators when one examines a simultaneous decision-making model of household behavior. We lean toward the latter interpretation, given (1) the large number of studies that have shown the education variable to exert a negative influence on family size; (2) the consistency of our results with the pattern of parameter changes beginning to emerge in the literature where both OLS and 2SLS results are presented; and (3) the somewhat lower marginal propensities to save found in other studies of saving. Moreover, if supply factors were constraining, we might expect to find a positive education effect at primary, but not at secondary, levels.[67] We thus concur with T. Paul Schultz that "simultaneous-equations techniques are needed if one is to obtain a deeper and more reliable

understanding of the effects of population policies on reproductive behavior."[68]

7.5.3 The Effect of Education on Household Demographic and Economic Behavior

The primary objective of this study has been to assess the effect of alternative family sizes and structures on household saving behavior. While in the previous sections we have shown that the direct effects of family size on household saving are negligible, there are indirect effects that must also be taken into account. For example, since family size (C_{eb}) is itself endogenous in the model, the full examination of changes in saving caused by changes in family size can be analyzed only through an examination of the effects of changes in one of the model's exogenous variables. The most interesting variable for this purpose is education.

Tables 7.4 and 7.5 present the effects on the endogenous variables owing to changes in the husband's and the wife's levels of education. There are two ways of presenting these effects. The first is to calculate the "total" effect. If we designate V_j as the endogenous variable of interest, then the total effect represents dV_j/dE_i, which holds constant all exogenous variables other than E_i and allows the remaining endogenous variables ($V_i, i \neq j$) to adjust to the change in E_i. This formulation provides no information on the specific way these endogenous responses are changing but gives only the total net effect of changes in V_j owing to changes in education. This total effect is calculated by computing the relevant reduced-form parameters using the estimated parameters of the structural system. All endogenous-variable interactions are therefore incorporated in the estimate of the total effect.[69]

To gain more information on the indirect effects, we can calculate $\partial V_j/\partial E_i$. Here all exogenous variables other than E_i are held constant, as well as all endogenous variables other than the one of specific interest. Since the variable of interest may be influenced by rapid changes in some of the other endogenous variables, the sum of the indirect effects will *not* necessarily equal the total effect. These indirect effects, then, are obtained from the chain rule where, for example, $\partial S/\partial E_i$ via income (Y) equals $(\partial S/\partial Y)\ (\partial Y/\partial E_i)$. The first term in the product is obtained from the estimated parameters in the structural equations, and the second term is obtained from the estimated parameters in the reduced-form equations.

Several interesting findings emerge from an examination of the results presented in tables 7.4 and 7.5. First, and most important, the indirect effects of children through the income and children-ever-born equations do not alter our basic conclusion that Kenyan household saving is virtually invariant to the number of children in the family. Thus, for example, if the male household head's or the wife's education were to

Table 7.4 **Changes in Saving, Income, Children Ever Born, and Child Deaths Resulting from Changes in Male Education Levels**

Variable and Model	Illiteracy to Primary Education					Primary to Secondary Education				
	Total Effect	Indirect Effects				Total Effect	Indirect Effects			
		Y	C_{eb}	C_s	C_d		Y	C_{eb}	C_s	C_d
Financial saving (S)										
C_d exogenous	22.76	15.77		.88		88.81	88.75		3.06	
C_d endogenous	29.95	14.74		1.66		86.94	84.71		4.59	
Total saving (S^*)										
C_d exogenous	31.05	19.93		1.99		113.76	112.15		6.91	
C_d endogenous	42.17	18.53		3.21		111.07	106.50		8.92	
Income (Y)										
C_d exogenous	185.98			15.74		793.38			54.71	
C_d endogenous	222.38			19.29		803.19			53.55	
Children ever born (C_{eb})										
C_d exogenous	.31	.43				.20	2.42			
C_d endogenous	.64	.14			−.61	.05	.81			−.46
Child deaths (C_d)	.02	−.04	−.01			−.2	−.24	.03		

Table 7.5 **Changes in Saving, Income, Children Ever Born, and Child Deaths Resulting from Changes in Female Education Levels**

Variable and Model	Illiteracy to Primary Education					Primary to Secondary Education				
	Total Effect	Indirect Effects				Total Effect	Indirect Effects			
		Y	C_{eb}	C_s	C_d		Y	C_{eb}	C_s	C_d
Financial saving (S)										
C_d exogenous	17.78	14.13		1.07		66.41	77.56		−7.71	
C_d endogenous	12.08	13.95		1.52		63.59	74.16		−10.54	
Total saving (S^*)										
C_d exogenous	24.04	17.85		2.41		74.64	98.01		−16.74	
C_d endogenous	15.02	17.53		2.68		72.22	93.24		−20.24	
Income (Y)										
C_d exogenous	147.28			19.08		688.22			−132.49	
C_d endogenous	117.39			16.08		713.29			−121.56	
Children ever born (C_{eb})										
C_d exogenous	.21	.39				−1.25	2.11			
C_d endogenus	−.12	.13			.01	−1.17	.71			−.28
Child deaths (C_d)	−.09	−.04	.02			−.11	−.29	−.14		

increase from prmary to secondary level, total financial saving in the C_d exogenous model would increase by 88.8 and 66.4 shillings, respectively. Almost all of this increase is explained by the influence of education on income (88.8 and 77.6 shillings); the direct effect of education through children ever born is negligible, as well as the net effects of the interactions between income and children ever born (not shown). Similar results are obtained when we consider the broader definition of saving and also in both saving equations in the models where child deaths are endogenous.

Second, education itself exerts a powerful influence on household saving through its effect on earnings. These results must be qualified, however. They represent partial equilibrium influences only—that is, the effect on a single household in isolation. If we were instead considering a macroeconomic counterfactual experiment whereby education levels were being notably advanced for the entire urban population, the results would have to be modified. A notable increase in education standards for the entire population would likely drive down the rate of return to education itself and as a result would diminish the income effect revealed at the partial equilibrium level.

Third, turning to the family-size equations and concentrating on the C_d exogenous model, we see that the total effects of increases in male education and of increases in female primary education are moderate. (The results of the experiment of changing the female's education from the primary to the secondary level will be discussed below.) These findings are due in part to the opposing income and substitution effects. The income effect appears to consistently dominate the price-substitution effect.[70] Higher male education levels are therefore likely to *increase* family size in urban Kenya. This is also true of an increase in the prevalence of primary education among women. Note that while the direct effect of education in our structural equation estimates is for the most part negative, representing the price-substitution effect owing largely to the increased opportunity costs of child-rearing at higher education levels, there are also powerful and more than offsetting indirect effects. In particular, increased education raises family income. Since the demand for child services increases with income, education also exerts a strong and dominant positive influence on family size. This result is in contrast with the findings of several "new home economics" studies for high-income countries and indeed with the usual assumption employed in the analysis of the Chicago model of fertility. However, our findings are entirely plausible given the institutional setting and the stage of economic development in the low-income country. In this setting, the return to education is unusually high, resulting in exceptionally large income effects. At the same time, increased costs of child-rearing associated with higher education (i.e., the higher opportunity costs of the mother's time) are

relatively low given the greater compatability of female work force participation and child-rearing. This is particularly true for the types of jobs available to women who possess only a primary education. Older children tend younger children; moreover, the extended family itself provides child-care services. If policy-makers are concerned, for example, about the pronatal effect of providing more education, then additional policies must be simultaneously implemented that effectively raise the cost of child-rearing. These policies might, for example, raise the opportunity cost to the female in terms of foregone earnings due to child-rearing. Compulsory education of children would be one such policy; implementation of child labor laws would be another. Both policies would increase the costs of children and, as a by-product, lower the rate of return to education as the greater supply of educated manpower is forthcoming.

Fourth, the effect of education on children ever born varies with the level of female education. An increase in female education from the primary to the secondary level dramatically *reduces* family size. This is in contrast to the *increase* in family size resulting from an improvement in female education from illiteracy to the primary level. The explanation for this relationship has been provided above. Namely, the opportunity costs in terms of market employment increase rather dramatically with higher education levels. Jobs that take advantage of higher education levels are less compatible with child-rearing than jobs that require only a primary education.[71] Government employment is an example of the former; domestic service is an example of the latter. These findings suggest that if reducing the birthrate is one of the objectives of policy, then distributing education toward female secondary education is likely to have a greater desired influence than a policy that is neutral toward education levels and toward the sex of the recipient.

Fifth, one of the beneficial effects of increased education is to reduce child mortality.[72] Currently the average number of child deaths per household is 0.40. An increase in female education from illiteracy to the primary level would reduce child deaths by 0.09, or 23% of the existing rate. This is a major reduction. It is interesting to note, however, that a comparable increase in male education levels has little influence on child mortality. Thus, in this education range, the greatest benefit of raising the education level comes through an investment in female, rather than male, education. Presumably much of the mortality reduction derives from the effect of education on the wife's *knowledge* about improved child-care practices: medical information, nutrition information, and so forth. We infer this because the negative income effect is relatively small. A quite different finding is obtained when one examines the effect of increasing male and female education from the primary to the secondary level. Here the dominant influence occurs through the income effect.

This likely represents a reduction of child mortality deriving from the *ability* to obtain better medical care, better food and shelter, and so forth. Given the greater importance of the male household head's earning power and the larger effect of education in raising male versus female earnings, the child-mortality-reducing effects are greater for male than for female education in the higher education levels. It is interesting that increasing both male and female education to the completed secondary level would reduce child mortality to the very low rates found in high-income countries. However, since such an increase in the education level is typically found only at rather advanced levels of economic development, our results, albeit founded on cross-sectional information, take on increased plausibility.

7.6 Conclusions

This study has employed microeconomic data from urban Kenya to examine the interactions of several key household decisions: saving, investment in education, family size, labor force participation (income), and child deaths. The underlying hypothesis is that these decisions are made simultaneously, and that the direct and indirect effects of key economic influences and outcomes cannot be revealed on a priori grounds. Several interesting results have been obtained.

First, the number of children does not influence the rate of household financial saving. Second, the number of children has an effect on the composition of saving if this definition is expanded to include human capital formation and specifically expenditures on education. Third, a simultaneous-equation model of the household appears to give a more plausible representation of behavior than a recursive decision-making framework. Fourth, additional insight into household decision-making can be obtained in models that consider child deaths an endogenous variable in the analysis.

Finally, the broad conceptualization of a household in which family size is determined in the context of a cost-benefit framework appears promising for urban Kenya. However, contrary to the usual model where children are considered only as consumer durables, there is some evidence that children may also serve as producer durables in the low-income setting. Moreover, in contrast to the usual assumption and finding of the "new home economics" model, we find that the income effects of an increase in education may in some instances outweigh the price-substitution effects, resulting in an increase in family size with increasing education levels.

Appendix

Table 7.A.1 **Results of Disaggregated Model of Household Saving, Income, Children Ever Born, and Child Deaths Using 2SLS**

	Constant	Y	C_{mh}	C_{fh}	C_a	C_d
Financial saving (S)[a]						
C_d exogenous	−219.88	.083*	−4.55	.97	−2.24	
	(−1.06)	(2.10)	(−.33)	(.07)	(−.17)	
C_d endogenous	−164.35	.073*	7.21	6.41	3.74	
	(−.73)	(1.78)	(.47)	(.40)	(.23)	
Total saving (S^*)[a]						
C_d exogenous	−262.44	.109*	−.88	2.46	−1.97	
	(−1.27)	(2.78)	(−.06)	(.18)	(−.15)	
C_d endogenous	−174.78	.094*	13.57	11.20	7.59	
	(−.78)	(2.31)	(.89)	(.71)	(.48)	
Income (Y)						
C_d exogenous	−835.64*		10.22	63.43*	29.45	
	(−1.81)		(.35)	(2.18)	(.96)	
C_d endogenous	−607.70		35.66	81.50*	47.04	
	(−1.17)		(1.05)	(2.34)	(1.31)	
Children ever born (C_{eb})						
C_d exogenous	−2.18*	.0034*				1.08*
	(−1.92)	(2.35)				(5.91)
C_d endogenous	−3.04*	.0014				2.66*
	(−2.86)	(.84)		C_{eb}		(2.30)
Child deaths (C_d)	−.16	−.0003*		.125*		
	(−.26)	(−2.36)		(2.26)		

[a]The heteroskedasticity correction divided each variable by $Y^{.39}$ (see section 7.4.3).
*Significant at least at the .05 level.
§Jointly significant at least at the .05 level.
†Jointly significant at least at the .05 level.

Table 7.A.1 (continued)

	A_m	A_m^2	A_f	A_f^2	D
Financial saving (S)[a]					
C_d exogenous	5.36	−.058			
	(.51)	(−.47)			
C_d endogenous	2.45	−.034			
	(.21)	(−.27)			
Total saving(S^*)[a]					
C_d exogenous	7.23	−.077			
	(.69)	(−.63)			
C_d endogenous	2.54	−.038			
	(.22)	(−.30)			
Income (Y)					
C_d exogenous	48.71*	−.496*			
	(2.07)	(−1.78)			
C_d endogenous	36.13	−.384			
	(1.34)	(−1.24)			
Children ever born (C_{cb})					
C_d exogenous			.17§*		6.27§*
			(3.09)		(1.74)
C_d endogenous			.193§*		3.63§
			(4.14)		(.96)
Child deaths (C_d)			.02	−.0003	
			(.381)	(−.52)	

$D{\cdot}A_f$	E_{mp}	E_{ms}	E_{fp}	E_{fs}	T_k	T_l	I/U
							60.21 (.75)
							61.09 (.76)
							65.92 (.83)
							67.30 (.85)
	150.41§* (1.69)	999.14§* (9.55)	125.86§† (1.51)	884.35§†* (5.36)	−119.36 (−1.37)	−59.36 (−.76)	
	143.42§* (1.60)	973.63§* (9.04)	120.99§† (1.43)	907.31§†* (5.39)	−120.80 (−1.37)	−67.65 (−.85)	
−.17§* (−1.94)	−.32 (−.67)	−2.81* (−1.83)	−.29 (−.70)	−3.88* (−2.72)			
−.123§ (−1.43)	.27 (.50)	−.27 (−.14)	−.03 (−.08)	−1.92 (−1.20)			
	−.05 (−.51)	.18 (.68)					

Table 7.A.2 **Results of Disaggregated Model of Household Saving, Income, Children Ever Born, and Child Deaths Using OLS**

	Constant	Y	C_{mh}	C_{hf}	C_a	C_d
Financial saving (S)[a]	−328.14*	.22*	−5.87	−6.90	−7.01	
	(−1.76)	(6.71)	(−.53)	(−.68)	(−.63)	
Total saving (S^*)[a]	−385.17*	.26*	−1.74	−4.79	−4.17	
	(−2.11)	(7.96)	(−.16)	(−.48)	(−.38)	
Income (Y)	−1002.03*		5.99	37.86*	12.99	
	(−2.26)		(.25)	(1.76)	(.50)	
Children ever born (C_{eb})	−3.79*	.0002				1.03*
	(−5.94)	(.97)				(7.82)
				C_{eb}		
Child deaths (C_d)	.07	−.0001		.13*		
	(.16)	(−.80)		(7.67)		

	A_m	A_m^2	A_f	A_f^2	D	$D \cdot A_f$
Financial saving (S)[a]	8.44	−.078				
	(.91)	(−.71)				
Total saving (S^*)[a]	10.66	−.10				
	(1.17)	(−.94)				
Income (Y)	57.17*	−.58*				
	(2.52)	(−2.12)				
Children ever born (C_{eb})			.27*		6.81*	−.21*
			(11.40)		(2.60)	(−3.24)
Child deaths (C_d)			.005	−.0002		
			(.15)	(−.42)		

[a]The heteroskedasticity correction divided each variable by $Y^{.39}$ (see section 7.4.3).
*Significant at least at the .05 level.

E_{mp}	E_{ms}	E_{fp}	E_{fs}	T_k	T_l	I/U	R^2
						39.94 (.55)	.13
						49.04 (.69)	.17
148.42* (1.69)	998.60* (9.61)	131.56 (1.60)	873.38* (5.33)	−112.95 (−1.31)	−50.16 (−.65)		.42
.28 (.93)	.45 (1.15)	.06 (.22)	−1.20* (−2.08)				.45
−.17* (−1.82)	−.30* (−2.49)						.19

Notes

1. Malthus (1970).

2. Becker (1960). See T. W. Schultz (1974); Easterlin (1971); and Leibenstein (1975).

3. Easterlin (1967, 1975); Kelley (1972, 1974); Leibenstein (1957, 1975*a*); and Simon (1976).

4. Bilsborrow (1975); Kelley (1973, 1976); and Kelley and Lillydahl (1976).

5. In aggregate model-building, these assumptions are reflected in varying degrees in the works of Barlow (1967); Barlow and Davies (1974); Coale and Hoover (1958); Denton and Spencer (1974); Enke (1971); and McFarland, Bennett, and Brown (1973).

6. Kuznets (1960, p. 339).

7. Peek (1974) has identified a negative dependency rate effect on saving using grouped Philippine data. However, in his model income is exogenous. Moreover, he is justifiably cautious in analyzing the results, given the somewhat tenuous quality of the data he used (p. 21). See also Leff (1969).

8. The manner in which C_a, C_{mh}, and C_{fh} are estimated is discussed in section 7.4.2.

9. The most appropriate analytical measure of this influence would be some form of permanent income. Friedman (1957) hypothesizes that households consume virtually none of their increases in transitory income; thus the marginal propensity to save out of transitory income is very high, approaching unity. This result has been widely confirmed in studies of developing countries. See Betancourt (1971); Friend and Taubman (1966); Gupta (1970); Ramanathan (1968); and Williamson (1968).

The present study uses current income, and thus the estimated saving parameter can be expected to be higher than if only permanent income were used. While it would be desirable to separate the permanent versus the transitory influence of income on saving, this is difficult using cross-sectional data. In addition, it is somewhat beyond the scope of the present study, which focuses on the influence of demographic factors on saving and income.

10. The Modigliani-Brumberg (1954) life-cycle model hypothesizes that individuals plan no net lifetime saving, leave no bequests, and allocate their consumption evenly over their lifetimes. This results in low or negative saving in early and possibly late life-cycle stages. Alternative life-cycle predictions are possible, depending on the assumptions of life-cycle consumption behavior and on the temporal pattern of income. Empirical studies include those by Gupta (1971); Kelley and Williamson (1968); Landsberger (1970); and Leff (1969). A detailed discussion of the life-cycle model is provided by Kelley (1968).

11. Mikesell and Zinser (1973) have observed that long-run planning horizons may not represent the appropriate time frame in developing countries where households, small businesses, and small farmers are subject to severe fluctuations in income, family size, weather, and so forth.

12. A more detailed discussion and bibliography relating to the saving, family-size relationships is found in Kelley (1976). See also Coale and Hoover (1958, pp. 139–273); Demeny (1967); Eizenga (1961); Goldsmith, Brady, and Mendershausen (1956); Henderson (1949–50); and Leff (1969).

13. An analysis of the saving, extended-family relationships in Kenya is provided by Lillydahl (1976, chap. 3).

14. See Kamarck (1967, pp. 64–68); Lillydahl (1976, chap. 3); and Snyder (1971, 1974*b*, pp. 139–51). Williamson (1961, p. 46) has emphasized this aspect

of economic development to explain in part the growth of government expenditure: "[With urbanization] disappears the informal security of the family and village. Urban populations must be supplied with formal social security, unemployment insurance, a complex cosmopolitan political machinery, and formal protection to replace the family and village functions."

15. Duesenberry (1949).

16. Fields (1974); International Labor Office (1971); and Thias and Carnoy (1972).

17. A historical account of the role of education in Kenya is provided by Forrester (1962). See also Castle (1966, pp. 103–11); Lillydahl (1976, chap. 2); Ministry of Education (1971–75); and Raju (1973).

While a comparison in Kenya of the education levels of males and females yields results consistent with Becker's hypothesis of positive assortive mating (Becker 1973), it is also clear that there may be enough variation in household education levels of mates to identify differential effects of education. Of the 401 households studied in the empirical analysis below, 240 couples had the same educational level. Males tended to marry women of the same or a somewhat lower educational stuatus. Only 8 males married women who had higher educational status.

18. This negative effect has been highlighted for advanced countries, especially in studies pertaining to the United States. See Bowen and Finegan (1969); Cain (1966); and Sweet (1970).

19. Peek (1976); Rosenzweig and Evenson (1975). For an examination of the positive and negative effects of children on female work force participation in low-income countries, see Kelley and deSilva (1976); Peek (1975); and Rosenzweig (1975).

20. This possibility has been stressed by Easterlin (1967, p. 104): "Population pressure arising from mortality reduction may provide the spur to work harder, search information, increase capital formation, and try new methods." See also Adams (1971, p. 472) and Scully (1962). Perrella's (1970) study of American moonlighting rates confirms the influence of family size on the propensity of the household head to hold multiple jobs. Finally, Simon's (1971) study of the relationship of family size and income arrives at an intermediate position: "The effect of incremental children on the parents' labor is not important" (p. 7). Here the negative influence of children on the mother's work force activity is roughly outweighed by an increase in the father's work force participation.

21. Forrester (1962, p. 123) presents evidence of significant differences in tribal consumption patterns in East Africa. For example, she shows that tribal values (after controlling for income) appear to influence the type of house furnishings, the preferences for clothing, and the extent of investment in higher education, saving, and landownership.

22. Ben-Porath and Welch (1972); DeTray (1973); and T. Paul Schultz (1974, pp. 15–19).

23. Less than complete replacement appears to be the more likely behavioral response of households to child mortality, according to a review of the literature by Preston (1975).

24. T. Paul Schultz (1974, pp. 4–7).

25. The complexity and specific nature of the income-fertility relationship is well documented in the writings of Simon (1969, 1974).

26. Early contributions to this literature are provided by Becker (1960) and by Mincer (1963). Later extensions and more detailed expositions are offered by Becker and Lewis (1973); DeTray (1973); Michael (1973); T. W. Schultz (1973);

T. Paul Schultz (1974); and Willis (1973). For critical reviews, see Leibenstein (1974, 1975*b*); the comment by Keeley (1975); Namboodiri (1975); Perlman (1975); and Pollak and Wachter (1975).

27. The strength of the income effect depends on the origins of the increase in income. If this increase derives from an increase in the father's wage rate, and if children consume relatively little of the father's time, then the negative price effect will be small. If this increase derives from an increase in the mother's wage rate, and if she spends a large amount of time caring for and enjoying children, then the negative effect could be large. If the increase derives from nonlabor income, there will be no negative price effect. Michael (1971, p. 126) summarizes the usual assumptions employed: "It is usually assumed that the production of childservices is positively related to the opportunity cost of the wife's time. It is also generally assumed that the production of childservices uses relatively little of the husband's time, so the relative price of childservices is negatively related to his opportunity cost of time."

The effect of increased wage rates of husbands versus wives may also affect the quality versus quantity decision in terms of the family's production of child services: "If we assume that the husband's time is used relatively more extensively in the production of child quality, increases in his time value, holding income fixed, induce substitution toward quantity of children and away from higher quality children, while through substitution in consumption the demand for childservices rises. So the model predicts a positive effect of his time value on quantity of children and the effect on quality of children depends on the strength of the effects of substitution in production (away from quality) and in consumption (toward more childservices and therefore toward higher quality)" Michael (1971, p. 127). See also Becker and Lewis (1973) and DeTray (1973).

28. A critical evaluation of this approach is provided by Cain and Weininger (1973). Support for this approach can be found in Blake (1968). Duesenberry, who has analyzed in depth the relative-income hypothesis in explaining aggregate consumption levels, has supported this relative income approach to explain the consumption of child services. He has observed: "Economics is all about how people make choices. Sociology is all about why they don't have choices to make" Duesenberry (1960, p. 233). See also Anker (1974); Easterlin (1969, 1971, 1975); Freedman (1963); Leibenstein (1974, 1975*a*); Ryder (1973); and Turchi (1975).

29. Encarnacion (1973, p. 3) has provided evidence based on Philippine experience that "there is a threshold level of family income such that below this level, the effect of more income is to increase fertility. Above this level, . . . the marginal effect of income on fertility is negative." A similar argument is made with respect to education levels. Both education and income affect nutrition, the ability to acquire health services, and knowledge of health services. See also Bourgeois-Pichat (1967) and Easterlin (1975).

30. Even though education is included in the income determination equation, it should be noted that education itself may be a better proxy for permanent income than the current income measure, and that children ever born in probably much more influenced (in its positive effects) by permanent income than by measured income. This is especially so if children are young at the time of data-gathering. Lifetime labor force participation of the mother and hence her earnings in a permanent sense should be strongly positively related to her schooling. But if children are young, she most likely shows zero present labor force participation. Studies showing a negative influence of education on fertility for less-developed countries are numerous: Anker (1975); Caldwell (1967); Dandekar (1967); Matsunaga (1967); Morrison (1957); Stycos (1967); and Yaukey (1971).

31. For Kenya, see Heisel (1968).

32. Economists' methodological stance with respect to incorporating taste changes in models of fertility (or in any other models) is well articulated by Michael (1973, p. 134) and T. Paul Schultz (1974, pp. 7–9). For empirical attempts to isolate taste influences, see Griliches (1973); and Gronau (1973*a*,*b*).

33. A detailed study of the rates of return to education in Kenya has been made by Thias and Carnoy (1972). See also Fields (1974).

34. "Owing to the high demand of Africans for education, the Kikuyu father will sell his land, or the Luo will sell his cattle, to educate his children" Forrester (1962, p. 139). "But an African has many people who can help him pay a school bill—wives, brothers, sisters, even cousins" Fisher (1969, p. 157). A primary motivation for remitting income outside the household has been identified as that of underwriting school fees. Johnson and Whitelaw (1974).

35. This hypothesis is at variance with the assumptions underlying most educational projection models, as well as the macroeconomic-demographic paradigms. In these studies, educational expenditures are taken to be examples of "population sensitive" forms of investments, typically competing with other forms of private and public investment. See Coale and Hoover (1958); McFarland, Bennett, and Brown (1973); and Denton and Spencer (1974).

36. This "strong separability" assumption is frequently employed in Engle curve analysis. See Houthakker and Prais (1955).

37. This may be particularly true where the extended family institution is strong, since in this setting there are opportunities for investing in the children of relatives, a reasonably close (although not perfect) substitute for investment in the household's own children. See Lillydahl (1976, chap. 6); Massell and Heyer (1969, p. 226).

38. Whereas in Kenya boys are traditionally assigned the role of caring for their parents in old age, girls—given their high value in Kenyan society owing to their extensive role in market and farm production as well as other household activities—command "bride-prices." These prices are directly related to the bride's level of education. An interesting research issue relates to the relative rate of return on educating boys versus girls. This depends, in part, on the influence of education on bride-prices, the expected remittances from boys of varying degrees of education, and the time path of the benefits and costs of the educational expenditures.

39. In Kenya a primary motivation for remitting income outside the household is to educate the children of the extended family. See Johnson and Whitelaw (1974); and Lillydahl (1976, chap. 6).

40. Forrester (1962); Fisher (1969).

41. T. Paul Schultz (1969, 1971*b*, 1973); Ben-Porath and Welch (1972); DaVanzo (1970); Schultz and DaVanzo (1970); Heer and Smith (1969); and Knodel (1968). For a recent survey of the literature for low-income countries, see Preston (1975).

42. Most studies of microdemographic behavior have been carried out using data from advanced countries. Child mortality is relatively low, and thus, for econometric reasons, it may be infeasible (if not unimportant) to explore an endogenous specification of child mortality in the household's children-ever-born equation.

43. Encarnacion (1973).

44. See Brass (1970); Kessner et al. (1973); and Shapiro, Schlesinger, and Nesbitt (1968).

45. A detailed study of the relationship of Kenyan household structure and alternative indexes of the extended family is currently being undertaken with Carolina Swartz of Duke University.

46. The measure also includes severance pay and compensation, income from casual employment, remittances received, other income, cash gifts, expense and travel allowance, value of rations received, and value of uniforms received. Cash receipts not earned during the period are excluded. Examples include salary advances, cash loans, loans repaid to the household, withdrawals from savings, and new credit.

47. A discussion of the possibilities and problems of estimating permanent income from cross-sectional data is provided by Betancourt (1971); Simon and Aigner (1970); Ramanathan (1968); and Watts (1960).

48. Total household consumption includes all cash expenditures, credit expenditures, in-kind expenditures, trade union dues, rent, contributions to health insurance and social security, electricity payments, water payments, waste disposal payments, insurance subscriptions, home-repair expenses, payments of interest on mortgages and housing loans, as well as food, clothing, and purchases of consumer durables.

49. Johnson and Whitelaw (1974).

50. Increases and decreases of household indebtedness are ignored, a procedure consistent with our treatment of consumer durables. Borrowing and debt repayment do not change the household's net asset position, but rather change the composition of the assets and liabilities. Moreover, if payment on debts were considered as expenditures, and borrowing as income, then the purchase of consumer durables on credit in contrast to outright cash purchase would result in different measured saving levels. This is considered an arbitrary and inappropriate distinction.

51. An early conceptualization of the human capital model is provided by T. W. Schultz (1961). Recent studies that have examined rates of return to education and lifetime allocation decisions as related to education include the works of Ben-Porath (1967, 1970) and of Johnson (1970). For Kenya, see Fields (1974) and Thias and Carnoy (1972).

52. The alternative of excluding households that had a member with university education seemed less satisfactory on methodological grounds.

53. Useful summaries of opposing views on the merits of simultaneous versus recursive models of various aspects of household decision making are provided by Rodgers (1974, pp. 3–9) and Peek (1974, p.11). See also Rosenzweig (1975), and Rosenzweig and Evenson (1975).

54. Nonlinear estimation requires extensive experimentation with alternative starting values of the various parameters and a testing of the sensitivity of the final parameter estimates to alternative starting values. The infeasibility of the current estimation scheme derived in large part from the interactive nature of the model. The nonlinear term appeared not only in the children-ever-born structural equation, but in the reduced-form equation of *each* of the endogenous variables that were estimated.

55. It has been pointed out to me by Marc Nerlove that this regression specification is not quite correct. To insure that the ends of the lines meet at A^*, it is necessary to incorporate the constraint $\beta + \delta A^*_f = 0$. The equation then becomes $C_{ch} = \alpha + \gamma A_f + \delta D(A_f - A^*_f) + \epsilon$. We checked our unconstrained regression results to ascertain the extent to which the constraint was in fact met. Fortunately it was met almost precisely, and thus the models were not reestimated.

56. I benefited from the advice of my colleague T. Dudley Wallace on the econometric issues raised in this section.

57. Goldfeld and Quandt (1965). The appropriate transformation of the variables was obtained by estimating the equation $\log |\epsilon| = \gamma \log Y$. Each term in the equation was then divided by $Y^{\gamma/2}$ to correct for heteroskedasticity. This in theory reduced the variance of the error term from $\sigma^2 Y^{\gamma}$ to σ^2.

58. There is one exception to this statement. Female children at home exert a significant positive effect on income, likely representing the contribution of young girls assuming some of the mother's domestic responsibilities and releasing the mother to engage in market employment.

59. A side equation, not integral to the household model under consideration, was run to explain the household's investment in education. In both models (child deaths exogenous and endogenous) the estimate of the C_s parameter was positive, statistically different from zero at least at the .05 level, and small, ranging from 6.3 to 8.9 shillings.

The child deaths exogenous model is as follows:

$$\underset{}{I_e} = \underset{(-3.83)}{-26.74} + \underset{(1.63)}{.05Y} + \underset{(1.70)}{6.29C_s} - \underset{(-.29)}{2.38E_{mp}} - \underset{(-.31)}{9.63E_{ms}} + \underset{(.28)}{2.01E_{fp}} - \underset{(-1.85)}{60.16E_{fs}}$$
$$- \underset{(-.07)}{.53T_k} + \underset{(.79)}{4.98T_l}.$$

The child deaths endogenous model is as follows:

$$\underset{}{I_e} = \underset{(-3.97)}{-28.04} + \underset{(.99)}{.028Y} + \underset{(2.66)}{8.93C_s} + \underset{(.20)}{1.60E_{mp}} + \underset{(.45)}{12.80E_{ms}} + \underset{(.68)}{4.84E_{fp}} - \underset{(-1.26)}{37.62E_{fs}}$$
$$- \underset{(-.46)}{3.38T_k} + \underset{(.49)}{3.09T_l}.$$

This model was reestimated using only households that had children, thereby permitting a slightly improved interpretation of the parameter on C_s. The results were virtually identical to those obtained above and are therefore not presented here.

60. An examination of the returns to education is provided by Thias and Carnoy (1972).

61. An extensive survey of the analytical and empirical relationships between income and fertility has been provided by Simon (1974). See also Chang (1976).

62. The findings on whether the household completely replaces or overreplaces a child who has died are mixed. See Fredericksen (1966); Heer (1969); Heer and Smith (1968, 1969); Preston (1975); and T. Paul Schultz (1969).

63. DaVanzo (1970); Harman (1971). Nerlove and Schultz (1970); T. Paul Schultz (1971*a*).

64. DeVanzo (1970); Nerlove and Schultz (1970).

65. The effect may be negative given the higher costs of child-rearing associated with higher education levels (the higher opportunity costs of the mother's time, and the higher costs due to social norms dictating more "expensive" or higher-quality children), and the greater contraceptive efficiency. Higher education levels also bring about higher income, the positive influence of which may dominate the negative "price" effects. Given the insignificance of the estimated parameter on the income term in our model, we might infer that the income effect is relatively low, and thus the negative price effects might well dominate.

66. Easterlin (1975).

67. Encarnacion (1973).

68. T. Paul Schultz (1971*b*, p. 1).

69. Let V be a matrix of endogenous variables, X a matrix of exogenous variables, and E a matrix of error terms. Our model can therefore be written in the form $V\Gamma + X\beta = E$, where Γ and β are the estimated or implied parameters of the endogenous and exogenous variables, respectively. These parameters are obtained from the structural equations. The corresponding reduced-form parameters can be found by expressing the endogenous variables as a function of the exogenous variables. Thus, $V = X(-\beta\Gamma^{-1}) + E\Gamma^{-1}$. The relevant parameters, then, are $\Pi = -\beta\Gamma^{-1}$.

70. Knowles and Anker (1975), who have employed single-equation OLS models using microeconomic household data to investigate various aspects of Kenyan household behavior, find that neither income nor the wife's education has a statistically significant effect on fertility. Only urban residence (here defined as whether the household is urban or rural) has an (negative) effect. Their model is formulated differently from ours, however, since in their framework income is exogenous. It is seen in our study that the endogenicity of income makes a considerable difference in the results.

71. This result has been found directly in a study of Brazilian urban households while the impact of female employment by occupation was examined in detail. While employment per se did not deter having large families, that specific type of employment which was incompatible with child-rearing did indeed exert a negative influence on family size (Kelley and deSilva 1976).

72. For a similar result using a different data file and estimation procedures, see Knowles and Anker (1975).

Comment

Warren C. Robinson

Professor Kelley's paper addresses two questions, which it argues are closely related: the influence of fertility on household savings and income; and the influence of economic factors on the family-size decision. The thrust of the answer to the first question is to refute once again the Coale-Hoover hypothesis that the higher the fertility rate the lower the savings rate. His interest in the other characteristics of household behavior—family size, labor force participation, and so on—leads him to adopt a deterministic, human-capital approach to the second question. It seems to me that within such a model, within such a conceptual understanding of the household, the original question regarding the savings rate is irrelevant.

Let me begin by agreeing with Kelley's rejection of the "orthodox" assumptions of economic-demographic models regarding the savings rate. There is growing evidence for questioning all three. For example, not all members of the household share equally in consumption, and this

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is a more subtle differentiation than can be handled by equivalent adult consumer weightings. Adult males get first priority, children next, adult females after that in some cultures; in other cultures there is a clear bias in division of consumables toward male children and against female children; in many others it has been found that high-parity children suffer a systematic deprivation as opposed to their older siblings. And so on. The notion that there is some linear relationship between family size and consumption needs, or that available consumables are divided in a more or less equitable way among all household members is almost certainly not right. The household is a small society with a power structure, and with rights and obligations distributed in unequal ways and with a systematic exploitation of some members by others. Children may be exploited by parents and, almost certainly, females are exploited by males insofar as they bear most of the costs of childbearing, get few of the benefits, and have little say in the decision process. One can argue that these arrangements, including the exploitations, are functional to the extent that under hard, subsistence agricultural conditions they do result in perpetuating the household through time as an economic, social, and demographic entity.

The second assumption of these models is equally dubious. In most developing countries children become economically active at early ages, and even before they do they are not a barrier to female work force participation. In very few parts of the world is child-care viewed as a full-time job or are children thought of as remaining useless and helpless until they turn 16 or 18.

Finally, it seems to me that the notion that spending on consumption for children may be at the expense of savings, and hence asset accumulation misses the whole point. Children *are* a form of asset accumulation in many developing societies. If the primary resource of the household is its own labor services and there is a positive relationship between the volume of these labor services and the household's income potential, then, far from competing with the growth of productive capacity and income potential, a larger family size may contribute to it. The distribution of such increases in income within the family may be highly exploitative, but that is beside the point. What I am suggesting can be put in the following way. Under conditions in which the only way to increase output and income is to increase the labor input, a large family may actually increase the savings potential of the household, not decrease it. This all changes quickly once we move into a world with child labor laws, compulsory schooling, in nonagriculture urban settings, with changed household production function and distributive rules.

But if this view is accepted the search for a link between family size and savings is pointless, for family size itself is a part of gross investment by the household. Very low financial savings coupled with large number

of children is merely an indicator of the asset portfolio held by the household, and rising financial savings coupled with falling family size indicates only a changing portfolio. Children cannot be a drain on savings if they are part of savings. This is what I meant by the irrelevance of Kelley's first question once a human-capital model is adopted.

As regards the savings ratio, the basic model takes into account only financial savings. This is modified to take into account investment in child quality, namely, educational expenditures. But, if there is anything to the human-capital approach, then spending on quantity of children as well as quality should be considered savings also. If couples are considered to demand children when quality (or price) has started going up, then surely they must be demanding them when price (or quality) is lower and quantity is greater. Indeed, the very low financial savings rate the data present suggests that most of the family savings are taking the form of investment in children (quality and quantity).

Finally, the nature of the subsample troubles me. The group analyzed covered 401 urban Kenyan households in which only two married adults and the children of the head of the household were present. All "complex" households—the other two-thirds of the overall sample—were excluded. But, if the "complex" household is the norm, does not this partitioning of the data introduce possible bias in the income or savings reported? Are not these households more likely to be sending cash remittances to other households, which are notoriously elusive for survey instruments to catch? Again, financial savings may be understated on this count.

Turning now to the economic variables effect on fertility, I wonder if there is any evidence that urban Kenyans actually plan their fertility as carefully as this model assumes. The mean children ever born is 4.1 in a sample in which 64% of the women are 29 years old or younger. Also, 40% report 5 or more children, close to the 36% over 29 years of age. Completed family size for this group almost certainly would be 6 plus, and if this is not natural fertility, it is at least high fertility for an urban sample. Without some information on knowledge, attitudes, and practices of contraception, I do not think we can assume that a deterministic model of fertility applies. Both on conceptual grounds, as developed by Easterlin, Leibenstein, and others, and also on empirical grounds as revealed in several recent surveys, including those of Simon, T. W. Schultz, and Ann Williams, there is abundant room for skepticism about the usefulness of the same model with the same assumptions in both developed, literate contracepting populations and less-developed populations with excess demand for children.

As regards the type of model, it is a simultaneous equations approach implying a series of interrelated simultaneously determined decisions

within the household. Kelley argues that to use a "recursive" model rather than a simultaneous one is equivalent to saying that one decision comes first—family size, say—and that the others—labor force activity, savings versus consumption—follow from this. This he identifies with a naive Malthusian (biological) no-decision model or, alternately, with Easterlin's hypothesis about a supply constraint at very low levels of income making the fertility decision primary. He rejects this approach and his own OLS results in favor of the more comfortable 2SLS simultaneous model.

I have no quarrel with this operational judgment, but I do feel that there are substantial grounds for rejecting the notion that completed family size (or children ever born), quality of children, female labor force participation, and other asset acquisitions are decided in one single simultaneous decision process when the household is formed. The real system is recursive and sequential. The decision shortly after marriage is not Will we have zero to six children? but Will we have a child, and if so when? That decision is made simultaneously with a host of other decisions, including wives' immediate labor force plans, the vacation next year, buying or renting a house, and so on. The outcome of these decisions is in turn the input for a later round of decisions centering on a possible second child. And so on. Presumably the system grows smaller through time as some fairly permanent decisions are made—a home is purchased, the wife makes a considerable investment in acquiring special labor market skills, and so forth. Such a sequential model can also be explicitly stochastic by allowing for such factors as contraceptive failure, tastes for children (or other goods) that change with socioeconomic status, and objective changes in external labor market conditions. The deterministic, simultaneous equations model assumes not only rationality but unchanging utility functions, perfect foresight, and no genuinely stochastic elements. These conceptual matters have been treated at length by Namboodiri, Turchi, Simon, Leibenstein, and others.

I am fully aware that an approach such as I am suggesting would not be possible using Kelley's data set. He has undoubtedly done the best he could using a thin data base and a highly simplified model. His discussion of the variables and his econometric manipulations of the data are full of insight and skill, and the paper is a contribution to our understanding of African demographic-economic interrelationships.

Comment

Julian L. Simon

General

The context of Allen Kelley's paper is the nonagreement of population theory with the empirical data on the relationship between per capita income and population growth from additional children (Kuznets 1967; Easterlin 1978; Chesnais and Sauvy 1973). The data show no negative effect, though existing theory does.

More specifically, one of the strands in Malthus's theorizing is that the resource stock—that is, land—is fixed in the short run. An additional child therefore causes no *immediate* increase in total income, and hence average income immediately falls proportionately when a child is born. "The constant effort of population . . . increases the number of people before the means of subsistence are increased. The food, therefore, which before supported eleven million, must now be divided among eleven million and a half" (Malthus 1817, p. 11). This proposition, zero short-run elasticity of family income with respect to children, is the secondary element in Kelley's study. The main topic of Kelley's paper is the Coale-Hoover idea of a negative savings effect of additional dependents.

So among the questions Kelley addresses are two of the central concerns of economic population theory: the response of family income with respect to fertility and the effect of fertility on savings.

Kelley's study is well and ingeniously done, up to the limits of the data. And its presentation is even better—clear, well organized, and sensible. Confidence in the results is increased by their insensitivity to making the child mortality rate endogenous or exogenous, and to the aggregation experiments. The difference between the OLS and 2SLS results is gratifying rather than worrisome and confirms an important piece of technical knowledge, that simultaneous-equation estimation is more appropriate in studying this question.

Kelley's Findings

I am prepared to agree with Kelley that fertility does not depress total saving. The past evidence on this matter has been mixed, and people's predisposition to think that fertility depresses savings may have been part of a general prejudice against poor people's economic rationality and ability to save. Not only laymen but also economists believe that the poor are unable to save. For example, in a comment on Leff's work on dependency and saving, Gupta wrote, "When income levels are as low as in these two [low-income] groups, there is no margin left for

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savings" (1971, p. 471). Similar views were asserted in the past by such writers as Arthur Lewis, E. M. Bernstein, J. M. Keynes, and Ragnar Nurkse (summarized by Panikar 1961). But the data do not confirm this view.

The biggest body of data on household saving and income is from India. And many village surveys of Indians, summarized in a fascinating article by Panikar, then discussed at length by Hoselitz (1964), show that poor Indian farmers save very respectable proportions of their incomes—cash savings of perhaps 12% gross and 8% net. And when nonmonetary saving is included—as it should be—"the gross saving-income ratio among rural households would rise to 20% or so." The savings ratios of poor farmers, then, are not significantly lower than for the better-off farmers in the world.

Nevertheless, the Kenya data leave me with qualms about Kelley's finding on savings and fertility. It is hard to know whether the lack of effect of children on savings indicates real neutrality or errors in measurement. Such measurement error arises, as Kelley notes, both from the usual problems of measuring savings and from the fact that saving is here estimated by the arithmetic difference between two large magnitudes, income and expenditure, both measured with error.

The dimensions of the observations also give grounds for worry. The mean income of a family in the subsample Kelley reports on is 719 shillings. Mean financial saving is only 7 shillings, 1% of income. But Kelley estimates a marginal propensity to save (financially) as 11%. This means that if the representative household's income goes up by just 10%—from 719 shillings to 790 shillings—total saving would *double* (to 14 shillings). And if the representative household's income falls by only 10%—from 719 to 647 shillings—saving would fall to zero. Such a violent response of saving to income, over the very range of experience that Kelley focuses on, gives one pause. An observed marginal propensity to save ten times as large as the average propensity to save suggests a major difficulty in permanent-income measurement as well as errors in measurement of current income.

In brief, Kelley's finding that fertility does not depress saving makes sense and is consistent with other work. But reservations about the data sap this finding's strength.

On children and total income, now: Kelley's finding that additional children increase the work done by parents makes sense. If anything, Kelley qualifies his finding too much. It is true that he cannot distinguish between remittances and household earnings. But he can buttress his findings with the findings of others. Long ago Chayanov (1966), using Russian peasant data, and a flock of recent writers using data from the United States and Israel (summarized in Simon 1977, chap. 3), have found a large positive effect of children on the hours worked by the

father and a positive effect of older children on the hours worked by the mother. A positive effect of fertility on average hours of work also appears in a cross-national study done by Pilarski (1976). And Scully (1962) showed higher physical and money output per acre of Irish farmers per unit of land input with more children. So Kelley might be more assertive in interpreting the increased income that accompanies more children as showing that children do indeed lead to more work.

My main technical suggestion for the study as a whole is to check whether the results are sensitive to the *sample*. It was sound workmanship for Kelley to restrict the main subsample to families with two married adults, because the status of adults—that is, the identification of which adults are parents of whom—is not given in the data. But this subsample made up only 29% of Kelley's original sample.

Kelley should be able to make good guesses about the status of the third (or even fourth) adult in many families. For example, a woman more than fifteen years older than the other two married people surely is a mother of one of them. It would be interesting to rerun the data with the original subsample augmented in this and other fashions to see whether the effects of children on income and savings are thereby altered. If there is no change, we would have still greater confidence in the results. And if there *is* a difference, these results might be the more valid because they cover more people. And Kelley would learn something about the effects of extended families and of having in-laws in the home.

A related technical suggestion for his further work is that Kelley split his observations into those with wife's age 29 or less and those with wife's age 30 or greater. This would avoid the nonlinear estimation problem and would enable him to check for interactions between wife's age and other variables—interactions that are not unlikely. Insensitivity of results to such a splitting of the observations would strengthen the results, in my judgment, at almost zero cost.

Now a question: An increment of woman's education causes about the same increase in income as a similar increment of men's education, in Kelley's results. This suggests that women work as much as men. Does this, in turn, suggest that children have no negative effect on labor force participation? If this result is reliable, it is startling.

Where Do We Go from Here?

If we accept the findings of Kelley and others that explode myths about family savings and income responses to fertility, where do we stand with respect to understanding the effect of population growth on income? By themselves these corrections to the received theory provide only a very partial reconciliation of theory and empirical reality. Even if income and saving are not reduced, the family data still imply less

education and physical capital bestowed on *each* additional child. If we are to reconcile theory with the aggregate data on the relationship of population growth to per capita income, *we must go beyond the individual household and ask about an increase in the number of households, and investigate the macroresponses to fertility.* For some examples:

1. The fertility-induced reduction in investment in educational expenditures per child by the *government* is far less than the household reduction suggested by Kelley's data, as shown in cross-national studies by Simon and Pilarski (forthcoming) and by Anker (1978).

2. We must know more about economies and diseconomies of scale. It is easy to speculate about the congestion effects in this room of doubling the participants at this conference. But we must also learn more about how increased population density increases the infrastructure available to all. For example, increased population density has a very strong effect on the stock of roads, as is shown in Glover and Simon (1975).

3. Last, and perhaps most important, we must know more about the effects of more households and individuals on our stock of knowledge, as was emphasized by Kuznets at the NBER conference in 1960. And please note that the knowledge in question is not just the knowledge created by scientific geniuses. Rather, much of the relevant new knowledge is created by people who are neither well educated nor well paid —the dispatcher who develops a slightly better way of deploying the taxis in his ten-taxi fleet, the shipper who discovers that garbage cans make excellent cheap containers for many items, the supermarket manager who finds a way to display more merchandise in a given space, the supermarket clerk who finds a quicker way to stamp the prices on cans, the market researcher in the supermarket chain who experiments and finds more efficient and cheaper means of advertising the store's prices and sale items, and so on.

I will end with what I hope is an inspirational message, and what I am sure is a pat on the back for economics as a science.

The great strength of economics is its insistence on, and its capacity for, dealing with the *indirect* and *delayed* effects of system changes. This is one of economics' main improvements over untutored common sense. Our stock in trade is the human and institutional responses to such changes in circumstances. Population economics is a subject in which the indirect and delayed effects are particularly crucial, and leaving them out of the reckoning can lead to absolutely wrong conclusions.

Let's consider some examples, starting with Kelley's work:

1. *Saving.* A baby immediately needs milk and diapers and a costly priestly ceremony. All other expenditures are fixed in the very short run, so these new expenditures must come out of savings. But economics points to a longer-run delayed phenomenon, gradual substitution among

expenditures. And indeed this is what Kelley finds, in contrast to casual observation.

2. *Total income.* The amount of income-producing labor is fixed in the very short run, and hence total income does not immediately respond to an additional child. This is obvious to laymen. But the labor-leisure tradeoff depends on tastes, and these tastes are a function of per capita income, as Chayanov showed theoretically and empirically. Kelley once again confirms this indirect long-run effect, which differs from the short-run direct effect.

Now let us consider some examples of delayed and indirect effects that economics has not yet given enough attention to in the context of population:

3. *Natural Resources.* Malthus slipped up on the fixity of land, and Jevons (1865) on the fixity of the coal supply. The difficulty here is largely definitional. In the short run the relevant quantity is the known well-defined material stock. But in the longer run, substitution and invention render a physical definition meaningless. Does the concept of oil include shale oil? Oil from coal? Oil made with solar energy? It is true in the short run that resources are limited. But in the long run we create resources and actually reduce scarcity, as is shown by the long-run downward trends in resource prices (Barnett and Morse 1963). But this Resources-for-the-Future idea has yet to be integrated into formal economic thinking about population.

4. *Physical capital.* In the short run physical capital is fixed in supply. But in the longer run it is a function of profit. And population size influences sales and profits. Nor is additional investment always at the expense of consumption or other investment. So the long-run effect of population on the stock of physical capital, in contrast to the short-run effect, might well be positive.

5. *Knowledge.* Not in the short run, but in the long run additional children create new knowledge. They do so both because of additional demand for output and because of the additional supply of minds. We must stretch our science's capacity to the utmost to determine the nature and magnitude of this very important but very long-run phenomenon.

We must also come up with more new hypotheses about the long-run macroeffects of increased population. For example, is there a positive effect on mental agility and one's stock of information from having contacts with more people?

My pat on the back for economics is that—though perhaps not as quickly as one might have hoped—it has taken up and emphasized the indirect and delayed effects of population growth, as is seen in Kelley's paper. My message is that we must continue to do this with even more vigor and resourcefulness until we are able to improve our theory of population and our statistical data on population growth and economic

growth to the point where we can consider them satisfactorily reconciled. At that time we may well see that the same increment of population growth that has a negative effect on income in the short run has a positive effect in some long-run future. Our judgment about whether population growth's overall effect is positive or negative thus depends on the discount factor with which we choose to weight the long-run relative to the short-run futures of our society.

Comment

Paul Demeny

The subject of Professor Kelley's paper is economic and demographic household behavior in the urban population of Kenya. Surely, as any tourist who ever descended on Nairobi could confirm, this is a theme admirably suited for dissection at a conference on population and economic change in developing countries. In Nairobi, the visitor sees a city in the throes of rapid development—a picture of life rich in sharp contrasts of poverty and affluence, tradition and modernity, tribalism and Western mores, disorganization and upward social mobility. He sees the ubiquitous signs of class conflict; the clash of the young and the old; and environmental decay next to manifestations of some of the best urban planning anywhere in the developing world. What is below the surface is bound to be even more exciting. An anatomy of household behavior, organized around its crucial demographic components, should provide important insights into the dynamics of the development process in contemporary urban Kenya. It would be, of course, unreasonable to expect Kelley's equations somehow to capture all the essential features of the ongoing socioeconomic transformation that is behind the picture even the most unperceptive tourist will not fail to see—unless his gaze is totally riveted on giraffes. Scientific understanding progresses by disciplining one's curiosity and proceeding with rigorous analysis of a manageable segment of life.

Unhappily, the slice of life examined by the paper under discussion is much too thin to be justified by this principle. In the familiar fashion of the art, Kelley does deliver numerous propositions on economic-demographic interactions supported by whole tablefuls of quantitative findings. But these propositions and findings are singularly uninteresting and implausible. Let me pick some representative examples. "An increase in female education," we learn, "from illiteracy to the primary level would reduce child deaths by 0.09." "Each additional child results

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in a direct increase in income of 123 shillings." "If the male household head's . . . education were to increase from primary to secondary level, total financial savings . . . would increase by 88.8 . . . shillings." "An increase in female education of the same sort dramatically reduces family size." We are also told why, in simple declarative sentences. "The opportunity costs, in terms of market employment, increase rather dramatically with higher education levels." The findings, of course, make eminent econometric sense as they follow logically from the data, the model, and its specifications. But it seems to me that the model is far too anemic to inspire much confidence in the substance of such statements, let alone to support the policy suggestions the paper sparingly but bravely spells out. We are dealing with a conflict-free society of unchanging tastes whose past is neatly captured by the reciprocal of something called U, the number of years the household head has lived in the urban area. What about its future? Can the model provide a prediction on the expected pattern of fertility change in urban Kenya and on the mechanisms that are likely to govern the process? The model specifies the variable children ever born in terms of income and educational attainment and, trivially, of age. Interpreting these as proxies for the true causal variables enables Kelley to make numerical propositions on what will happen under certain specified conditions; but, plainly, the ability of the model to grasp the essence of the relevant aspects of the developmental process is severely limited, hence the findings command little interest. It is hardly surprising that we are warned not to generalize from the results presented in the paper and are admonished that model parameters are apt to change from setting to setting and, more ominously, over time. One can surmise that a series of similar studies for urban Kenya are in order. But, by the time a pattern of change for the parameter values has emerged—and there is no reason to expect that such a pattern will lend itself to any useful interpretation—one hopes the problem that sparked the investigation to begin with will have long lost its significance.

There is, of course, a possibility that that has already happened, at least if one takes at face value Kelley's argument on the need for his analysis. That argument focuses on the issue of the influence of demographic variables on the rate and composition of household savings. Kelley posits an adverse effect of fertility on savings (in first-approximation financial savings) as the kingpin of the dominant models of economic-demographic development, but he claims that these models are "increasingly being questioned." Such a claim amounts to a vast understatement. A stress on the significance of household savings, to my knowledge, disappeared from the literature years ago, and for excellent reasons. Once Kelley found that the average yearly level of household saving was 7 shillings in his Kenya sample—barely 1% of total income

—perhaps simply reporting that result would have made his recapitulation of the verdict just as effective. Kelley's extension of the concept of saving to include saving for human-capital investment is salutory but far too narrow. What really matters to society on that score is the quality of children and, in particular, their economic abilities—entrepreneurship, diligence, honesty, ability to cooperate with their fellowmen, and so forth. These characteristics of crucial importance for development are manufactured primarily in the family unit rather than in the schools. Neither can they be captured by the kind of survey techniques Kelley has access to.

Let me conclude my remarks by venturing a somewhat fanciful report on the state of the field to which this conference is addressed. On the fringes of the social sciences there once lived a primitive tribe called demographers. They had a happy time in a hunting-gathering existence, picking up and consuming raw bits and pieces of data that they called names like "birthrates," "death rates," "rates of dependency," and "gross reproduction." To diversify their diet, they enjoyed digging up old chestnuts that their ancestors had buried many years before and chewing on them. Must infant mortality fall for birth control to be practiced? Is it true that affluent people have low fertility, and why? Keen to make sense of their small world, the demographers looked about in wonder and tried to explain puzzling changes in the objects of their curiosity. Some came to attribute magic properties to some happenings beyond their ken, developing strange beliefs such as that industrialization makes the birthrate drop or that education makes gross reproduction wilt. Others concluded that hospital beds per 1,000 population or telephones per capita have equally remarkable clout.

These happy and imaginative—if somewhat childlike—people were one day invaded by a bunch of warlike neighboring tribesmen who got tired of watching their neighbors' bumbling ways. Equipped with their superior bronze-age technology, the invaders had little trouble taking over the demographers' territory; and for a while they had great fun renaming the trees and the fruits in a logical and elegant fashion and driving out superstition about causes and effects. Education, they held, for example, demonstrably does have that wilting effect on birthrates; but it must be first tidily measured, labeled, and subscripted and seen as a proxy for other things, such as the value of mother's time. Such discoveries and the accompanying tidying-up were quite plausibly the dawn of a new era, with continuing rapid technological progress in store and full enlightenment within sight. As often happens, however, the conquerors liked the pickings on the new land, and soon they settled down, gathering and consuming the same fruits as their former neighbors who, subjugated and docile, still lived on the same territory. A not unpleasant symbiosis had developed. Even though things became a bit

crowded sometimes, there were plenty of data to pick from to keep everyone well fed and satisfied. Also, new data kept growing, the ground having been fertilized by increasingly benevolent weather, bringing a steady rain of dollars. The demographers and the now-settled warriors happily shared a seemingly inexhaustible supply of married women 25–29, or of other more or less interesting age intervals, whose fertility rates needed to be urgently explained; and there was a rich storehouse of variables to help the explaining. Lacking in new challenges, sloth overcame the conquerors. The promise of a golden age faded, and a bastard bronze age began.

The parable should not be labored further. The main point I am trying to make is not that the theoretical and methodological advances made in the eighteen years since the predecessor of this conference met in Princeton in 1958 are insignificant. Certainly, the superior power of the models of household demographic decisions borrowed from the theory of consumers' behavior—in contrast, say, to regression analyses of piles of socioeconomic and demographic data relating to country units—is beyond dispute. Still, the new micromodels of demographic behavior remain patently inadequate to the task, drained as they are of sociological content and institutional, historical, and psychological substance. To this basic complaint another should be added, although blandly and without elaboration. Even within the narrow confines of the model, the grasp on behavioral variables and processes that can be gotten by using the kind of data that are now the staple of studies on developing countries—census data and survey data collected through remote control, as it were—has now run into rapidly diminishing returns. I know that many people are highly optimistic about the prospective yield of further exploitation of the standard survey methodology and the resultant better microlevel data. Certainly the sponsors of the World Fertility Survey must be among them. But the available evidence supporting optimism on that score does not strike me as persuasive.

If the complaints just registered have any merit, some serious soul-searching is in order for the field. The analytical approach exemplified by the paper under discussion now seems to claim a disproportionate share of the attention, the time, and the brains of the best practitioners of economic demographic studies. The opportunity costs are potentially important. I suspect, for instance, that I could have been a far more enthusiastic discussant at this conference if I had a chance to comment on a work by Professor Kelley that picked up some of the demographically relevant themes of his recent remarkable book on dualistic economic development. Paradoxically, since that economists' invasion the parochial and narrowly conceptualized traditional concerns of demographers seem to hold greater sway over the field than ever before. This

conference bears the general title Population and Economic Change in Developing Countries. Perhaps it has a subtitle I am unaware of, making it a more specialized affair than this general label indicates. Or perhaps the National Bureau intends to organize another conference without waiting until 1994—another eighteen years—to explore important areas and issues of the economics of population not covered in this conference. Certainly, even the program of the 1958 NBER conference—although focused on the less obvious and less pervasive population problems of the *developed* countries—had a more catholic formulation than the present one. Then there were papers on macroeconomic aspects of population growth; on the effect of demographic change on aggregate demand, price level, aggregate employment, and labor supply; on population and resources; on the influence of population on the demand for food; on sectoral effects such as the demand for services. Forays into general equilibrium analysis were not off limits. In contrast, a detached observer, listening to our discussions, would have a very lopsided appreciation of economists' potential contribution to a scientific analysis of demographic aspects of development. Examples of subjects that were given short shrift form a long litany: from welfare economics to the economics of international trade; from externalities theory to the economics of public goods; from resource economics to the economics of development proper. It is unfortunate that little of that potential is captured by the present program; and it is even more so if the bias correctly reflects the actual distribution of ongoing academic research in economic demography. Arguably, what the field needs is another invasion by a marauding tribe of economists, equipped with new ideas and new analytical tools.

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