RURAL DEVELOPMENT AND FERTILITY CHANGE IN TROPICAL AFRICA: EVIDENCE FROM TANZANIA

by
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AFRICAN RURAL ECONOMY PROGRAM

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AFRICAN RURAL ECONOMY PROGRAM

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1. INTRODUCTION: FERTILITY AND AFRICAN RURAL DEVELOPMENT

In recent years the rural sector has become a major focus of development activity throughout the world. While there are many definitions of rural development, for purposes of the discussion and analysis in this paper, rural development will be defined as both a process and an outcome which includes each of the following three components: (1) general improvements in the material well-being of rural people, (2) the capability for sustaining continuous improvements over time, and (3) absence of gross inequalities in the distribution of the gains during this process.

The nature, the causes, and the consequences of socioeconomic and demographic interactions in the development process are among the most interesting and important issues of our times. As a case study of some of these interactions in tropical Africa, this paper will analyze the effects of socioeconomic development on fertility in rural northeastern Tanzania.

Tanzania is internationally known for its commitment to rural development and for its unique ujamaa village development strategy. Tanzania has committed substantial national resources toward providing agricultural extension, education, health and other development services and facilities to rural areas, and since 1974 almost the entire rural population has been resettled into "development villages" (ranging in size from less than 100 to over 500 families). The purpose of villagization is to

facilitate the provision of essential infrastructure and services to rural areas and to promote the eventual adoption by villagers of communal (ujamaa) modes of production and distribution. Tanzania's emphasis on improving material well-being and promoting local self-reliance through a process which minimizes social and economic inequality is certainly consistent with the definition of rural development given above.[1]

It is a premise of the analysis in this paper that conditions in many rural areas of tropical Africa are roughly similar (or may become so over time) to those in the study areas which are analyzed here. Although Tanzania is unique among African countries in its approach to rural development, the rural development experiences which are analyzed here all occurred prior to 1974, and hence preceded Tanzania's 1974-76 villagization program.[2] Moreover, as will later be described in detail, these northeastern Tanzania study areas have experienced considerable socioeconomic change and commercialization of agriculture during this century. Some of their development experiences may be similar to those of rural areas in other African countries (or to what will be experienced by other rural areas).

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[1]For references to literature on Tanzania's rural and ujamaa development, see Kocher, 1977a.

[2]Although many ujamaa villages had been established prior to 1974 (an estimated 15 percent of the rural population was living in officially-designed ujamaa villages by 1974), the ujamaa movement had had very little effect on the areas included in the analysis in this paper.

The population of tropical Africa is presently about 300 million and is growing at an estimated rate of 2.6 percent annually.[3] Overall, the population is about 80 percent rural although the percentage rural varies from less than 70 (e.g., Senegal, Ghana) to over 90 (e.g., Tanzania, Upper Volta). The United Nations projects a near doubling of the population of tropical Africa by the year 2000, with the rural population projected to increase at least 50 percent while still comprising over 60 percent of the total.

Among the most important demographic characteristics of tropical Africa are the following: (1) Due to past and current high fertility, the populations are very "young"; nearly half of the people are under age 15 compared to only about one-quarter in the populations of Europe and North America. (2) Fertility is still very high; the overall crude birth rate is over 45 per thousand and the total fertility rate is over 6 which is higher than any other area of the world of comparable population size. (3) Although mortality has been declining in recent decades, it is still very high by international standards. The overall crude death rate is around 20 per thousand and the average expectation of life at birth is less than 50 years.

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[3]Tropical Africa excludes the five African countries which border the Mediteranean Sea as well as the white-dominated countries of southern Africa, but includes Madagascar and several smaller islands. The actual United Nations mid-1977 population estimate for tropical Africa is 302 million. The population of the five North African countries is estimated to be (an additional) 84 million while that of the white-dominated countries of Southern Africa is estimated as 37 million (of which 2.3 million live in Botswana, Lesotho and Swaziland) [Population Reference Bureau, 1977].

This information makes it possible to estimate the rough magnitudes of the overall demographic situation of tropical Africa over the next several decades, particularly population sizes and growth rates. For example, assuming that both mortality and fertility will decline to low levels by early in the 21st century, and barring a devestating catastrophe, the population of tropical Africa will at least quadruple by the year 2050. Should mortality decline more rapidly and/or fertility decline more slowly than anticipated by this projection, the increase in total population will be even greater. In fact, the total population of the area could quite possibly increase up to 8 times in size by the year 2050 [Frejka, 1973a: 126; 1973b]. Moreover, most of the additional people will inevitably reside in rural areas and depend on agriculture and agriculturally-related activities for their livelihood. Thus, while urban population growth rates will without doubt be substantially higher than rural population growth rates, the population of tropical Africa will still be predominately rural well into the 21st century.

It is inevitable that overall population growth in tropical Africa must eventually slow down. Whether Africa can support a considerably larger population is not an issue. Africa can and must. The relevant issue is the magnitude of the population increase during the next 75 years or so. Will the population only quadruple in size or will it increase five to eight times?

There are only three ways to greatly reduce population growth rates: fertility reduction, mortality increase, or massive out-migration. Massive out-migration is impossible for tropical Africa as a whole. Rising mortality rates or even cessation of mortality decline would be a

monumental human disaster and would indicate a total development failure. Thus, a decline in the overall population growth rate depends entirely on fertility decline, and the earlier and more rapid the fertility decline the better.[4]

Much remains to be learned about the determinants of fertility levels and changes. There is no longer any doubt that fertility can decline in rural as well as in urban areas of low income countries which have been experiencing substantial socioeconomic development [Kocher, 1973]. During the past two decades fertility has declined significantly in rural areas of several Asian, Latin American and North African countries. There is as yet no evidence of fertility decline in tropical rural Africa.

In the next chapter a model of the effects of rural development on fertility is presented and discussed. The essence of the model is that fertility is determined by both supply factors--e.g., health and cultural

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[4]Development objectives are usually concentrated within the near future--seldom more than the next two decades. (With a 10 percent discount rate, events beyond year 20 are of virtually no significance.) Demographic aspects of development are also usually considered only within this time horizon--e.g., the impact of changes in demographic parameters on attainment of educational and health objectives. However, some of the most important effects of changes in demographic parameters in the near future occur only in the more distant future. Frejka [1973a] demonstrated that a population which has the demographic characteristics of tropical Africa--i.e., a young age distribution, a total fertility rate of 6 or above, and relatively high but declining mortality--can be expected to about quadruple in size even if it experiences a relatively rapid transition to low mortality and replacement-level fertility. Furthermore, the population would continue to grow for at least two generations after achieving replacement-level fertility. Thus, should fertility in tropical Africa go into a prolonged and substantial decline commencing in the near future and reach replacement-level by early in the 21st century, the population will still at least quadruple by the mid-21st century. However, if fertility does not begin a sustained decline until early in the 21st century, then the eventual quadrupling (or more) will occur from a much larger population base--e.g., 600-800 million rather than the current 300 million.

characteristics--and demand factors--incomes, prices (i.e., cost of children) and tastes, and that in traditional rural African societies and during early stages of rural development fertility is determined largely by supply factors, while during later phases of development declining demand for children is likely to dominate the determination of fertility. The discussion elaborates some of the complex causal mechanisms which may affect fertility during this development process. An important implication of this model is that during the initial stages of rural development the average number of surviving children per family will increase while the net effect on fertility is indeterminant; fertility may be rising, falling or about constant.

In chapter 3 the socioeconomic and demographic characteristics of four rural areas in northeastern Tanzania are described. The relationships between socioeconomic change and fertility in these areas are analyzed in chapter 4 within the theoretical framework developed earlier. Chapter 5 discusses and summarizes some of the effects of socioeconomic development on fertility in these rural areas. In the final chapter some implications of this analysis for research and policy in tropical Africa are discussed.

2. TOWARD A MODEL OF RURAL DEVELOPMENT AND FERTILITY DECLINE

Introduction: Rural Demographic Transition

During the past century or so, much of the world has experienced a long term process of socioeconomic development together with a dramatic decline in both mortality and fertility--an association which has come to be called Demographic Transition. Fertility decline has long been recognized as one of the consequences of urbanization and industrialization, but virtually every country which has experienced substantial rural development has also experienced fertility decline in rural areas [Kocher, 1973], although the decline in rural areas has typically lagged somewhat behind the decline in urban areas. Recent research has documented some of the complexities and variations in demographic transition experiences, and considerable controversy remains about (a) the determinants of fertility, (c) the rate at which fertility is capable of declining, and (d) the extent to which family planning programs can expedite the fertility decline process.[1]

Easterlin [1975] and Caldwell [1976] have recently made important contributions to our understanding of the relationships between socioeconomic development and fertility decline in low income countries.

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[1] See for example, Coale [1973] and Teitelbaum [1974, 1975]. Much of the research documenting the demographic transition in the "West" has been done under the auspices of Princeton University's Office of Population Research.

Easterlin's theoretical framework explicitly incorporates supply factors as potentially important fertility determinants as well as the possibility of disequilibria in the household's supply of and demand for children. Caldwell's analysis emphasizes the important contributions that children make--both economic and sociopsychological--to the welfare of both parents and the larger community in tropical Africa and the effect of the roles of children on desired and actual fertility. He concludes that particularly in traditional rural African societies the net transfer of societal resources is from younger to older generations, that fertility decline requires a switch in the direction of net intergenerational resource transfer (so that parents find it personally disadvantageous to have large families) and that socioeconomic development--which brings with it the adoption of Western values and attitudes--is a precondition for this switch to a net resources transfer from the older generation to the younger. Caldwell's analysis of the causes of fertility decline is basically consistent with that of Easterlin and with the model of the effects of socioeconomic development on fertility in rural Africa which is presented and discussed below.

The Conventional Economic Approach: Demand Analysis

Most economic approaches to the analysis of micro level determinants of fertility have been addressed in terms of demand analysis--i.e., parents' desires for children. In the economic theory of household or parental choice, the three basic components of the determinants of demand are income, relative prices, and tastes (or preferences). If children are a normal good, a rise in parental income would produce a rise in the number of children wanted; a rise in the price of children vis-a-vis other goods

would cause a decline in the number of children wanted; and a shift of tastes in favor of children relative to other goods would cause a rise in the desired number of children. However, a rise in income (due to a rise in wage rates) is hypothesized to have both a positive effect on demand for children as well as an offsetting negative effect because the value of time parents spend with their children is also increased thus increasing the price of children. An implicit assumption of virtually all of these models and analyses is that supply and demand are in (at least approximate) equilibrium, both for individual parents and for the society as a whole.[2]

Two "schools" of demand analysis emerged in the 1960s. One was the so-called Chicago School (i.e., Gary Becker and associates) and the other Easterlin School. According to the former [e.g., Becker, 1960, 1965; Becker and Lewis, 1973], fertility declines because the price effects (price being negatively related to fertility) exceed the income effects (income being positively related to fertility). That is, as a result of socioeconomic improvements, the aspirations that parents have for their children cause them to undertake substantially greater child-related expenditures as their incomes rise. This, in effect, increases the price per child thereby reducing demand (i.e., number desired) and this reduced demand more than offsets any increase in demand due to rising incomes. In effect (according to the Chicago School), real preferences of parents do

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[2]The validity of this assumption can certainly be questioned since it seems quite likely that in some circumstances supply may exceed demand--for individual women or parents (e.g., "unwanted pregnancies") and/or for the society as a whole, while in other circumstances demand may exceed supply.

not change. Only incomes and prices change--with opposite effects on demand, and usually the price effect dominates.

According to the Easterlin School [Easterlin, 1969, 1973, 1976], demand for children declines primarily due to rising aspirations of parents for non-child goods and services (or in some cases, due to the increasing difficulty of fulfilling existing aspirations). That is, tastes and preferences (of parents) change, and the net result is that parents want fewer children. In Easterlin's formulation, the aspirations (read "tastes and preferences") of parents are determined by their backgrounds and experiences. As aspirations change from one generation to another (e.g., as a consequence of socioeconomic modernization and/or upward mobility), the average number of children parents want may change as the outcome of their trying to satisfy their desires to have both children and other acquisitions.[3]

Economic demand models of fertility have been more successfully applied to high income, low fertility populations than to populations in relatively high fertility (developing) countries [Schultz, 1976]. One possible explanation--noted earlier and discussed below--is that actual fertility in developing countries may not reflect actual demand (desired number of children) very well. That is, supply (either actual fertility or actual number of surviving children) and demand (either desired fertility or desired number of surviving children) may not be identical.

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[3]For further discussion of these two "schools," see Sanderson, 1976.

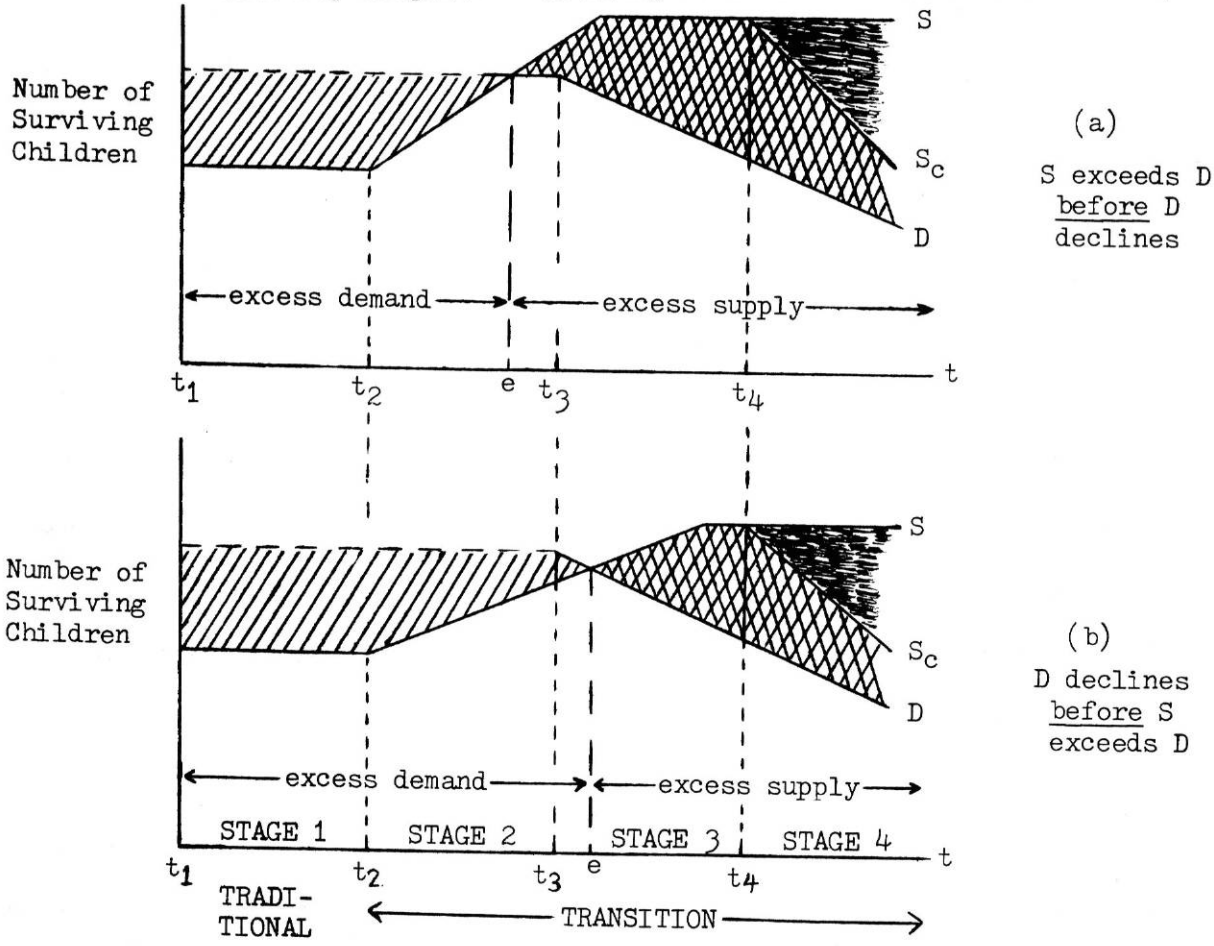
A Modified Easterlin Model of the Determinants of Fertility

More recent theoretical developments by Easterlin [1975] and Kocher [1975, 1976a, 1976c] postulate a distinct and potentially important role for supply determinants of fertility--at least in some socioeconomic and demographic circumstances, and explicitly incorporate supply-demand disequilibria. Within this framework, a parent's supply of children is determined by certain of his or her individual characteristics together with certain characteristics of his or her culture and society. Demand for children is determined by other individual and societal characteristics. Thus, a parent's supply of and demand for children are assumed to be determined essentially independently, and over time one or both may change--again, independently of what is happening to the other.

The Model: Part One

A somewhat modified version of this Easterlin model is described below and illustrated in Figure 1. The figure shows hypothesized relationships between supply of surviving children (S) and demand for surviving children (D) in a rural society which over time experiences the transition from a socioeconomically traditional state towards a modern state. (Supply in this case means the actual number of surviving children the parent has, while demand means the number of surviving children the parent wants.) It is hypothesized that in a traditional (pre-modern) society, women (used as a shorthand for parent or parents) typically want more surviving children than they actually end up with; that is, they experience excess demand. As one initial consequence of economic, educational and health improvements, the typical woman's supply of surviving

Figure 1. Hypothetical relative levels and trends in demand for and supply of surviving children for a typical woman who has recently completed fertility in a transitional rural society.



D = Demand: Desired Number of Surviving Children (for completed family size)
S = Supply: Number of Surviving Children with Unregulated Fertility (completed family size)
S_c = Decline in Actual Number of Surviving Children Due to Deliberate Fertility Control

Deficit Fertility (excess of desired number of surviving children over actual number)
Surplus Fertility (excess of actual number of surviving children over desired number)
Amount of Deliberate Birth Prevention, measured by number of children averted

Transition Stages

t_2 = beginning of Stage 2: Average Number of Surviving Children begins to Rise
t_3 = beginning of Stage 3: Desired Number of Surviving Children begins to Decline
t_4 = beginning of Stage 4: Beginning of Individual Practices (contraception, abortion, etc.) to Intentionally Reduce Fertility.

Notes: The absence of a solid line for D to the left of t_3 is intended to portray the possibly indefinite nature of desired number of surviving children in traditional and early transitional societies. The relevant characteristic of D in this area is that it exceeds S.

Source: Kocher, 1976a: 21, Figure 4.

children (S) increases. In the transitional model illustrated by Figure 1, the rise in average number of surviving children is identified as the end of the strictly traditional state and the beginning of the socio-economic and demographic transition period. A rise in the average number of surviving children presumably has no effect on the number of surviving children desired (D).

The second significant point in this model is when demand for children starts to decline. This is identified as t_3 in Figure 1. The onset of decline in the number of children wanted by the typical woman is presumed to come about only after a prolonged period of socioeconomic transition and development which eventually cause parents to conclude that they would be better off with somewhat fewer surviving children than the number typically desired in the past.[4] Point e (supply and demand equilibrium) can be located almost anywhere prior to Stage 4; its location is simply the coincidence of actual and desired numbers of surviving children being equal. Its significance is that two very different disequilibria are found on either side. To the left, D exceeds S and women would presumably do whatever they could to increase the number of surviving children. To the right of e, S exceeds D and women would presumably want to do whatever they could to hold down fertility.

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[4]Figure 1 actually illustrates two (of several) possible variations in the timing and sequencing of supply and demand changes. In (a), D starts to decline only after S exceeds D (i.e., excess supply) while in (b) D begins to decline while it still exceeds S (excess demand). Another pattern (for example) might be a declining D prior to a rising S. In fact, D could decline to below S (excess supply) before S rises. This version of the model might be appropriate to areas where fertility began to decline--implying excess supply--before or concurrently with mortality decline--i.e., rising S (e.g., parts of France in the early nineteenth century).

Note that the model illustrated in Figure 1 does not indicate what is happening to fertility in Stages 1 through 3. The dependent variable in the model is number of surviving children. As discussed later, until the beginning of Stage 4 of the transitional model, fertility could be rising, falling or about constant. The beginning of Stage 4 in the model (point t_4) is identified as the point at which women begin to restrict fertility for the specific reason that they want no more children, and it is only subsequent to this point that fertility unambiguously declines. The model presumes that women typically experience considerable excess supply of children before they are sufficiently motivated to take necessary measures to prevent future births.[5]

Determinants of the Supply of Children

The supply of children surviving to a woman is equal to the number she has given birth to less those who subsequently die. The number of children a woman bears during her lifetime can be viewed as the result of (1) her age at the time of her first birth, (2) her age at the time of her final birth, and (3) the average interval or spacing between births. These three parameters are determined by a large number of both biological (including health) and behavioral characteristics of the woman, her spouse and her society. These include the age at which she first has

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[5]Women who want more children (D exceeds S) may, however, practice birth control to help achieve a more desirable interval between births. For example, Ware [1976] found in a sample of 1050 urban Nigerian women who had practiced birth control that, within marriage, spacing--and not the limitation of family size--was the most prominent reason for contraceptive practice. To the extent that these women are successful, their fertility will of course be lower. However, the criteria for entering Stage 4 of the transition, is that S either equals or exceeds D and that the reason a woman is practicing birth control is that she wants no more children.

coitus, its frequency thereafter, her fecundity throughout this period, and the amount of time she abstains from coitus during fecund periods. The latter may be the result of disrupted marriage including voluntary separation of spouses and/or sexual abstinence due to a lactation taboo or other cultural practice. Age at first (or at least frequent) coitus may depend on age at first marriage. The frequency of coitus may depend in part on whether the woman is married to a monogamous or polygynous husband; duration of infecundity (following childbirth) depends in part on the length of time the woman breastfeeds [van Ginneken, 1974] which in turn depends on cultural practices, individual preferences of the woman, and whether the child survives at least to weaning.

As an example of the way a cultural practice may affect fertility, women in many African societies traditionally abstained from sexual intercourse for up to two years or more after the birth of a child. One effect is to prolong the average interval between births, which in turn causes fertility to be lower than it would otherwise be. This postpartum or lactation taboo can be considered a cultural practice which also functions as fertility determinant via its effect on the average interval between a woman's births. A set of social, cultural, and economic changes (which may be difficult to specify individually) may alter the adherence to this particular cultural practice. Some proportion of the childbearing women might discontinue the practice altogether or might follow it for shorter periods of time than in the past as the consequence of changes in social, economic, or educational circumstances. Even if these women continue to breastfeed while resuming coitus, there will be some chance of becoming pregnant. By changing the average birth interval, this would affect the

level of fertility for both individual women and the society as a whole. It would presumably have no independent effect on the desired total number of surviving children.[6]

Changes in the average length of lactation would probably have a similar effect, provided that women resume coitus either prior to or soon after weaning. Breastfeeding itself prolongs the time interval between childbirth and the resumption of ovulation, and hence prolonged breastfeeding increases the average interval between the birth of one child and the next pregnancy, even if women engage in coitus regularly before weaning the child. Studies have shown that this ovulation-inhabiting effect exists for breastfeeding which lasts up to 1-1/2 to 2 years. However, the variation in resumption of ovulation is considerable [van Ginneken, 1974]. A study in Taiwan showed that "the relationships of lactation and amenorrhea ceased to exist when length of lactation exceeded 21 months and amenorrhea remained at a level of 12 to 13 months" [van Ginneken, 1974: 203]. This means that among this group of Taiwanese women, of those who breastfed for 21 months, ovulation resumed on the average at 12-13 months although some women resumed ovulation at 4 or 5 months after giving birth and some not until 21 months even though all breastfed for 21 months. In addition, full breastfeeding delays ovulation more than partial breastfeeding (i.e., supplementing breast-milk with other foods in the baby's diet).

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[6]Almost all women in the sample indicated that the postpartum sexual taboo is breaking down. Morgan [1975: 206] reports similar finding in Nigeria.

Hence, socioeconomic and cultural changes affect the number of children born primarily by altering the average interval or spacing between births and by changing the average age of women at first coitus (and hence average age at the birth of the first child).

Changes in the mortality rates of infants and unweaned children would also be expected to affect fertility by altering the average interval between births although there is clearly a two-way causal relationship between a woman's number of deceased children and her number born. On the one hand, the number of children a woman gives birth to partly determines the number who die because the more children that a woman bears, the greater the risk that one (or more) will die. Expressed another way, one would expect that due to simple mortality probabilities alone the average number of children deceased would be a direct function of the average number born.

However, it is also hypothesized here that the number of deceased children a woman has is also a major determinant of the number born due to the effects of the mortality of infants and young children on the mother's fecundity and average birth intervals. Most child mortality occurs within the early months of life. Cessation of lactation due to a child's death would result in earlier resumption of ovulation. Since post-birth abstinence from coitus is traditionally usually conditional upon and corresponds to the period during which the woman breastfeeds, the death of a child who had not yet been weaned would presumably result in earlier resumption of coitus by the woman than would have been the case had the child survived (at least in traditional African societies). This combination of earlier resumption of both ovulation and coitus

consequent upon the death of an unweaned child (usually accounting for the preponderance of childhood deaths) can be expected to result in a smaller average interval between the births of children where the first of a pair dies as compared to the average interval between births of children of whom none die.[7]

Changes in age at first marriage, incidence of polygyny, duration of breastfeeding, or infant and young child mortality rates would affect both individual and average fertility and actual number of surviving children. The net effect would depend on the strength of each of the relationships and the mix of the changes. In nearly all rural societies, socioeconomic changes change all (or most) of these characteristics. Although changes in these supply characteristics affect both average fertility and average number of surviving children per woman, they presumably have no effect on the number of children women want.

Determinants of Demand for Children

Parents are assumed to want children because of the satisfaction children provide. Leibenstein [1974] identified three types of satisfaction or utility which children (potentially) provide to parents: income utility (income or wealth, net of their costs), security utility (financial and/or emotional support, particularly in parents' later years), and consumption utility (personal enjoyment or satisfaction from children). Within this economic framework, parents are assumed to be

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[7]For a summary of some studies which generally support the above hypotheses, especially for "populations at the lowest level of development," see Preston, 1975.

rational, to have limited material resources, and to prefer to allocate their material resources so as to maximize their satisfactions subject to their preferences and to the prices of available goods. Children represent one of a large number of potential acquisitions among which they can choose in attempting to maximize satisfactions. Hence, parents' demand for children is assumed to be the outcome of the interaction of their income, the relative prices of children vis-a-vis other goods, and their preferences for children vis-a-vis other goods.[8]

Both Leibenstein [1957] and Becker [1960, 1965] also gave explicit recognition to the opportunity cost of time spent by parents (especially mothers) in bearing and rearing children. Thus, an increase in permanent income (wealth) due to a rise in a parent's permanent (average lifetime) wage rate implies both a positive wealth effect on fertility together with an off-setting negative effect due to an increase in the cost of parents' time required in bearing and rearing children [Schultz, 1973:

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[8]The treatment of children as a "good" is complicated by the quantity and quality components of children. Some analysts treat quality and quantity of children as two distinct goods, substitutable in part for each other and with separate income and price elasticities. In the analysis here it is assumed that the price of children reflects prevailing community standards and norms and the roles of children and families change. In practice it is virtually impossible to estimate the objective net price (cost) of children, particularly in low income countries; the approach selected to handle the price component of children is therefore important primarily for its contribution to theoretical clarity and consistency.

Analysis of both demand and supply for children is further complicated by pregnancy and sexual pleasure being joint products of sexual intercourse and possibly having very different demand functions. Demand for children and demand for sexual pleasure may also be partial determinants of the demand for each other. Obviously, the desire for a child may affect the demand for sexual intercourse. Demand for sexual intercourse may affect demand for children in that pregnancy may be viewed by one or both parents as interrupting the future flow of sexual pleasures.

72]. However, although this is probably an important determinant of demand for children in high income societies where working mothers must usually make relatively costly child care arrangements and where parenthood increases the cost of many leisure time activities, these costs are probably of much less importance in rural areas of low income countries.

Indifference (or welfare) curve diagrams are used below to illustrate hypothesized relationships between income, relative prices, and tastes as they determine the demand for children. An indifference curve represents a set of combinations of "x" and "y" values among which a person is "indifferent;" that is, each combination would provide exactly the same amount of satisfaction as every other combination on the curve. A straight line drawn from the origin would intersect ever-higher curves representing ever-greater amounts of satisfaction. It is assumed that a person wants to maximize total satisfaction but is indifferent as to the particular combination of x and y, so long as it is one of the combinations along the highest attainable curve.

In trying to maximize satisfaction, one ordinarily faces two economic constraints. The first is total income; this is indicated by the budget or income line, GC in Figure 2, and can be measured as the total amount of either x or y which can be purchased with the given income (OG or OC respectively in Figure 2). The second constraint is the prices of x and y. This is indicated by the slope of the budget line, and it can be interpreted as the amount of x that one could purchase by foregoing one unit of y. Given income and relative prices as represented by the budget line, a person will prefer that combination of x and y at which

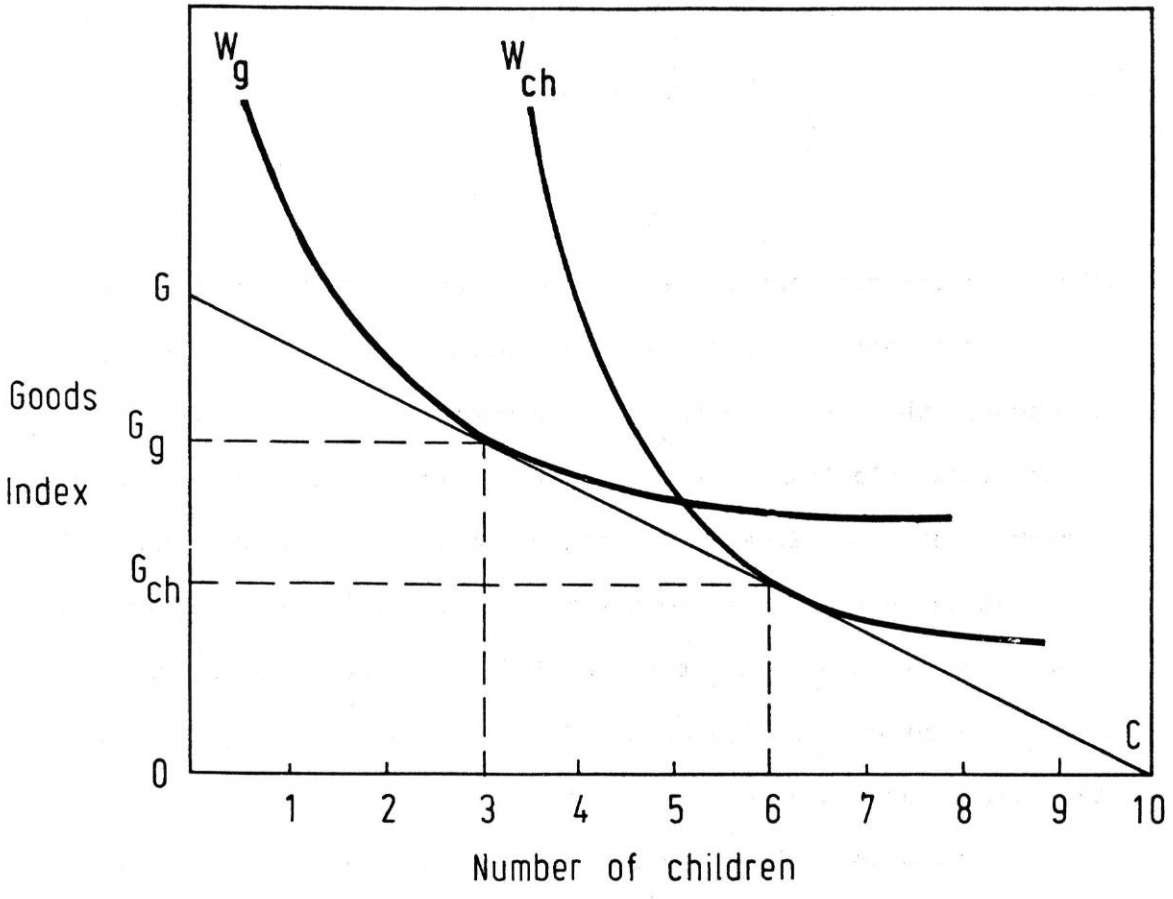

Figure 2. Hypothetical illustration of the interaction between income, prices and two different sets of indifference curves in determining demand for children and other goods.

W_g = Set of indifference curves which are relatively in favor of goods as compared to children

W_{ch} = Set of indifference curves which are relatively in favor of children as compared to goods

point the budget line is just tangent to an indifference curve because this would be the highest attainable curve given these prices and income.[9]

It is quite conceivable that two people in a particular society with similar incomes and facing identical prices might have somewhat different sets of indifference curves representing different tastes and preferences. As illustrated in Figure 2, the person with the W_g set of indifference curves (relatively in favor of goods) would prefer the combination of 3 children and G_g goods, while the person with the W_{ch} set of curves would prefer the combination of 6 children and G_{ch} goods.

If the price of one of the items increases, this changes relative prices and reduces the person's income as measured by that item. In Figure 3, the relative price of children as represented by budget line GD is double that represented by line GC (i.e., total income would purchase 10 children with line GC but only 5 with line GD, although income as measured by goods has not changed). As drawn in Figure 3, as the price of children doubles (from GC to GD), $W_{ch}1$ becomes the highest attainable indifference curve, and it can be reached only with the combination of 4 children and 0.5 G_{ch} goods. This is, in adjusting to the new price and income situation, the preferred number of children has been reduced by one-third (from 6 to 4) and the preferred amount of goods reduced from G_{ch} to 0.5 G_{ch}; he or she is now at indifference level $W_{ch}1$, down from $W_{ch}2$.

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[9] In this context, the "price" of children refers to "net" price; that is, the child's contribution to parental income less the costs which parents incur in bearing and rearing the child (with appropriate discounting of the child's future costs and contributions).

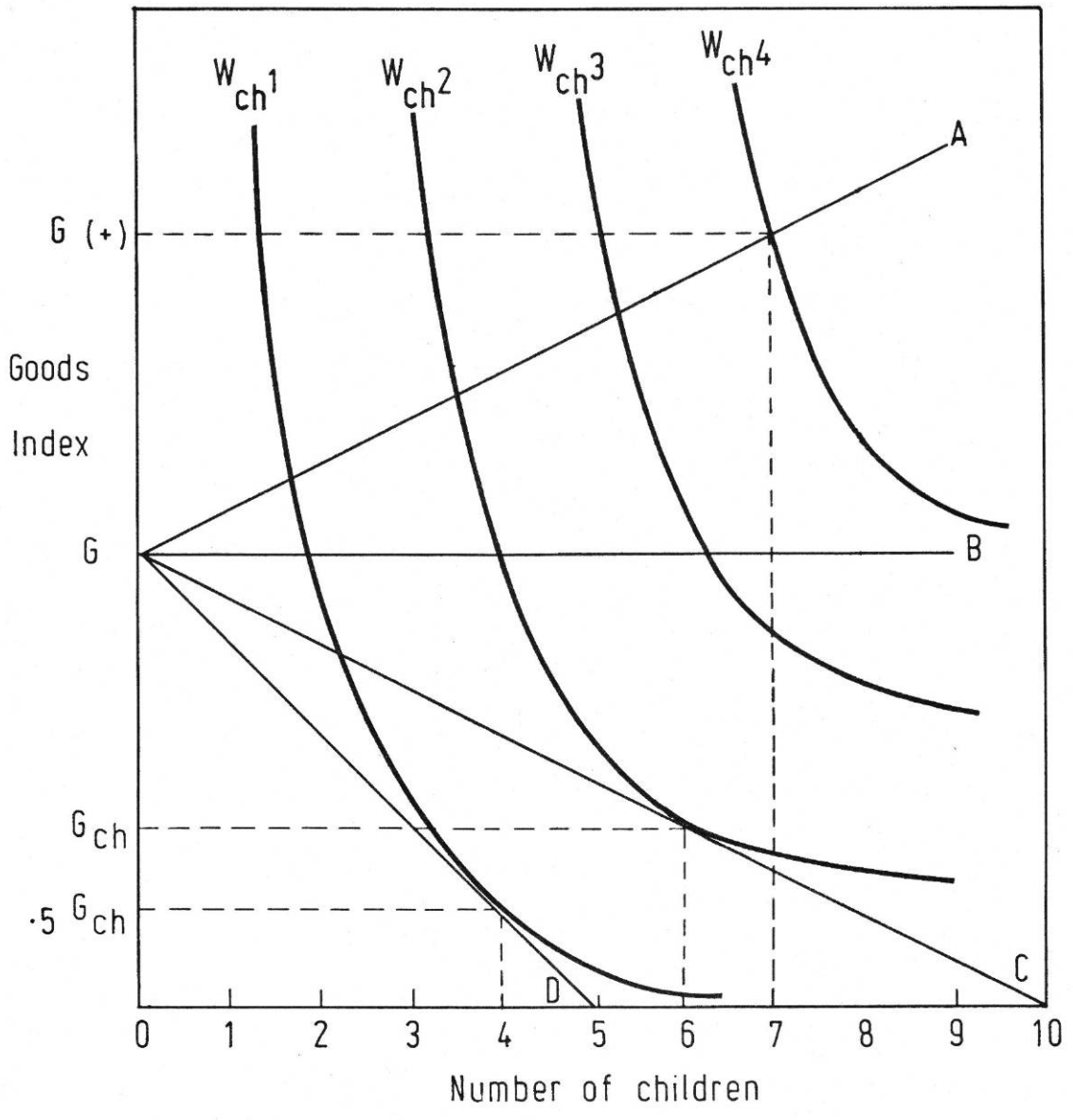

Figure 3. Hypothetical budget lines showing price effects with welfare curves relative in favor of children.

Budget lines:

GA = Price per child is negative (i.e., net income/ wealth gain from an additional child)

GB = Price per child is zero

GC = Price per child is positive but "low" (i.e., net income/wealth loss from an additional child)

GD = Price per child is positive and double that of GC

The analysis to this point has assumed that the prices of both goods and children are "positive." In Figure 3, however, line GA shows the price of children being negative; that is, one obtains more income with an additional child. As drawn in Figure 3, a person with budget line GC and W_{ch} set of indifference curves will choose 6 children and G_{ch} goods. He or she would want a seventh child because the amount of goods given up to attain that child would cause a shift to a lower welfare curve. However, with the same initial income (as measured by OG on the y-axis) but with a budget line of GA, one would want as many children as possible because each additional child increases income (thereby enabling one to obtain more goods) and also moves the person to successively higher indifference curves.

If the net price of an additional child is negative, the shape of one's indifference curve is irrelevant in determining the number of children and amount of goods preferred, because regardless of the shape of the curves (i.e., relatively in favor of either goods or children), each additional child increases income and thereby the amount of goods which can be acquired, and the increase in both goods and children together provide the person with either higher levels of satisfaction.[10]

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[10] Caldwell [1976] argues that the net price of children is (was) negative in traditional rural societies, and particularly in Africa. Although there are very few good data on child labor in rural Africa, Cleave [1974] reports data from farm surveys in Uganda and Gambia which show that children ages 10-15 spent almost as much time on farm work as did their parents. Caldwell [1977] describes the substantial economic contributions of Yoruba children (Nigeria) and concludes that for most Yoruba families children are still a net economic asset.

The Model: Part Two

The model presented in Figure 4 is a further elaboration of that shown in Figure 1. The four transitional stages (from Figure 1) are identified along the bottom of Figure 4. The upper portion illustrates the roles of selected supply determinants; the lower portion illustrates the roles of demand determinants. Throughout Stages 1 through 3 of the socioeconomic transition, both fertility and the actual number of surviving children are determined by supply rather than demand characteristics. Figure 4 is intended to depict the basic societal and individual characteristics as continually changing throughout Stages 2 through 4 of the transition and as affecting both supply and demand determinants throughout all the transitional stages.

Note that the models in Figures 1 and 4 specify distinct and important roles for both supply and demand variables in determining fertility, and they also identify the sequence in which the dominant role is first assigned to supply and later to demand determinants. In the models illustrated in Figures 1 and 4, demand determinants are present throughout all stages of the transition, but their first potential for affecting either fertility or actual number of surviving children comes only when demand and supply are first equal (point e in Figure 1), and demand characteristics first affect the level of fertility and actual number of surviving children only after t_4 (beginning of Stage 4) in Figures 1 and 4.[11]

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[11] Although the implication of both this model and Caldwell's [1976] is that in societies where children are net assets parents would want as many children as possible, Caldwell concludes that "economic rationality" would also dictate having zero fertility in societies where children are net economic liabilities, and hence demand should decline precipitously

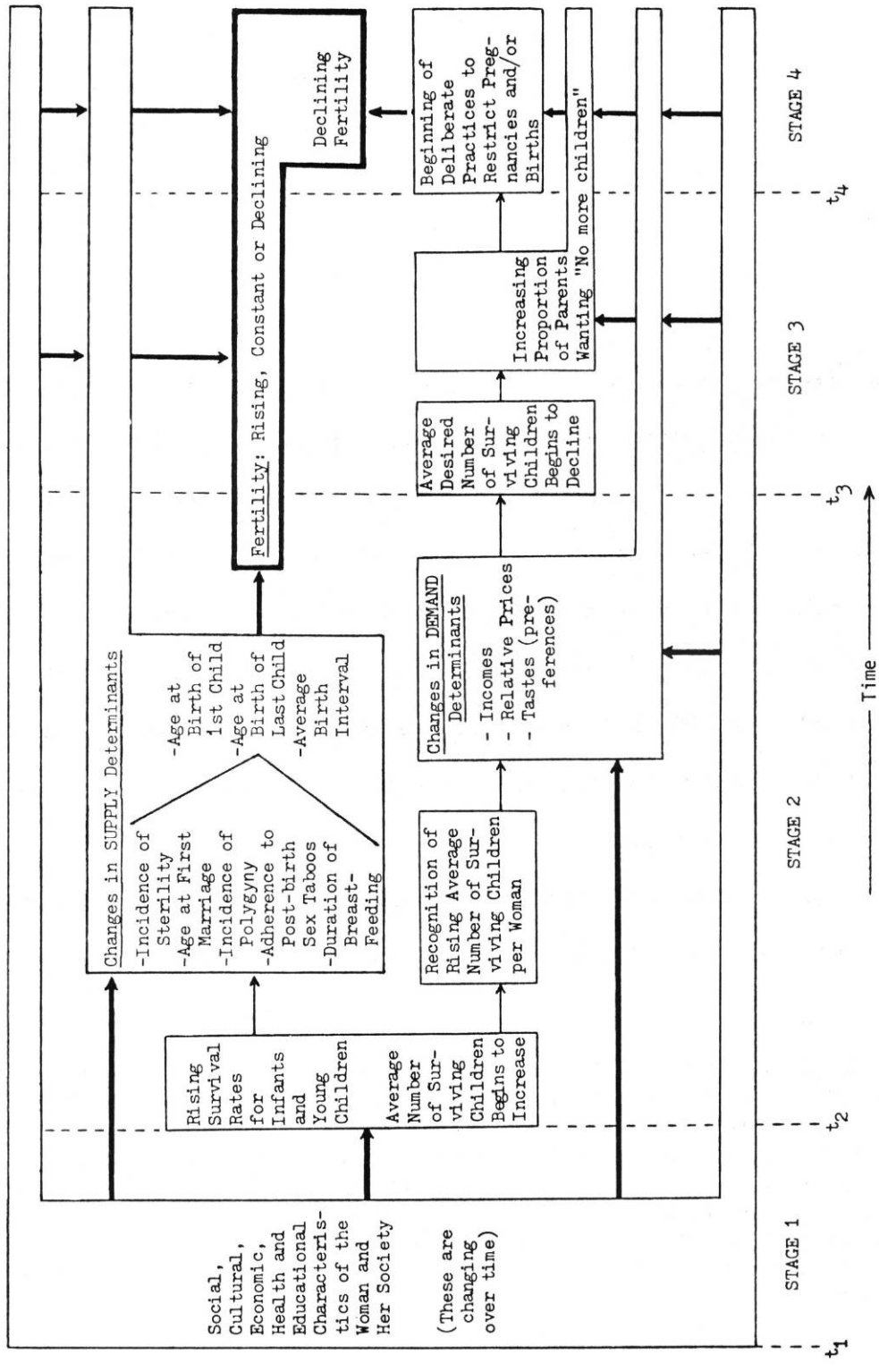

Figure 4. Model of hypothesized socioeconomic and demographic transition in rural Africa and the linkages to fertility change and eventual decline.

Source: Kocher, 1976a: Figure 7.

3. A DESCRIPTION OF DEVELOPMENT AND DEMOGRAPHIC CHANGE IN NORTHEASTERN TANZANIA

Data for about 1500 households in four rural areas of northeastern Tanzania were collected by means of a socioeconomic and demographic survey carried out in August-November 1973. The main objective of the survey was to obtain data which would permit an analysis of the relationships between socioeconomic characteristics and fertility and mortality in these rural areas. As shown on Figure 5, two of the areas are located in the former Moshi district on the slopes of Mount Kilimanjaro. (In 1975 Moshi district was subdivided into Moshi and Vunjo districts.) The other two are located about 200 kilometers to the southeast in Lushoto district in the Western Usambara mountains. The study areas are identified as M1, M2, L1 and L2 respectively.[1]

All four areas have experienced considerable socioeconomic change during this century. These areas were among the first in Eastern Africa

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once the "divide" is crossed and the net wealth transfer switches and becomes from the older generation to the younger (i.e., after the price of children becomes positive). However, only "prices" determine "economic rationality" in Caldwell's model; incomes and tastes are omitted as demand determinants. In the model presented here, however, even after crossing this "divide", demand may still exceed supply because tastes (which are determined by the consumption--i.e., social and psychological--value parents attach to children) may change much more slowly than do prices.

[1] M1 is located around an area known as Kibosho (or Kiwoso); M2 is located northwest of the village of Marangu in the present Vunjo district. The small settlement of Bumbuli is located on the northeastern edge of L1. The settlement of Soni is located in about the middle of L2.

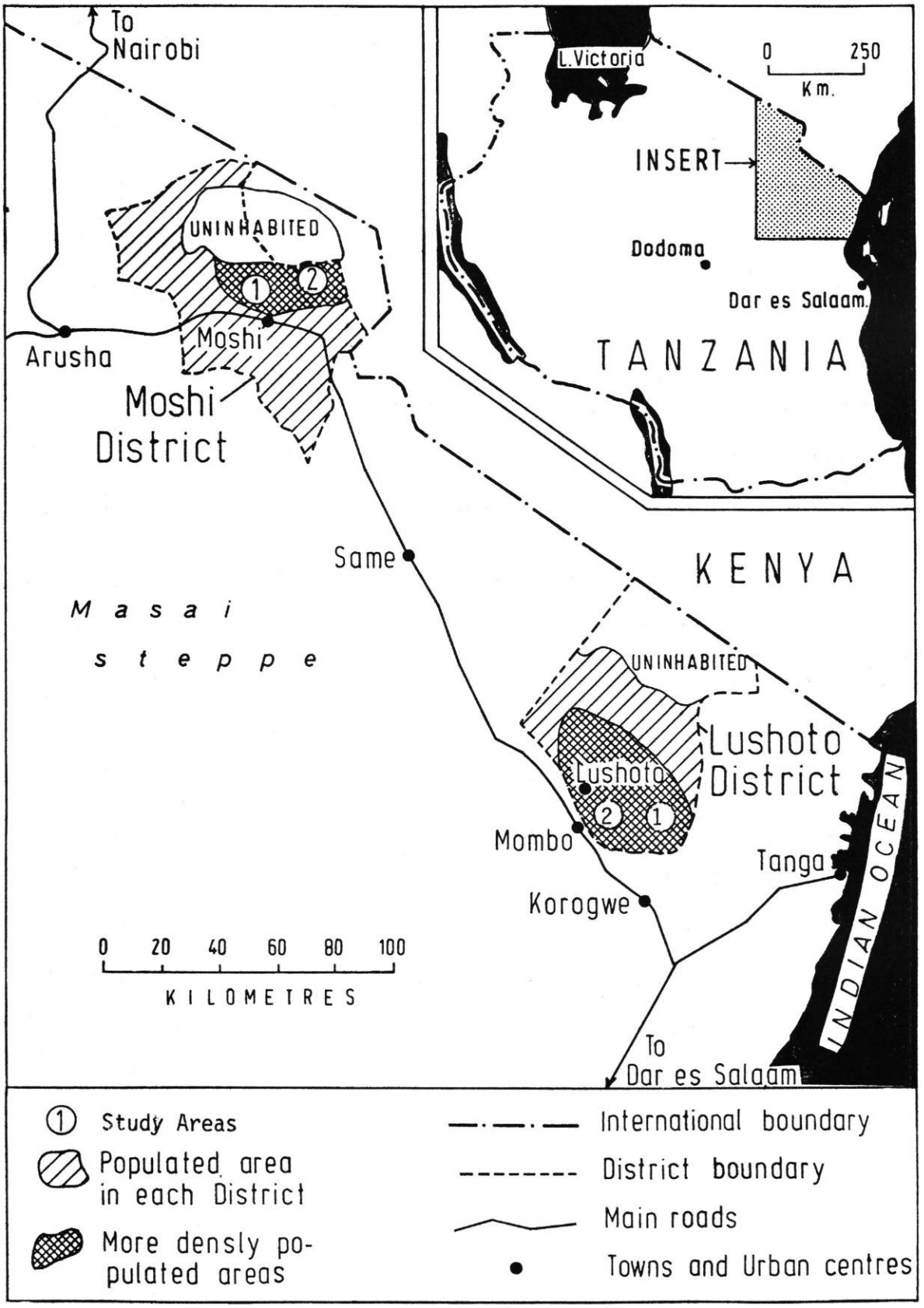

Fig. 5. Study areas within Moshi and Lushoto Districts

to experience significant Western influence. During the late 19th century (the 1890s) this took three principal forms. One was the establishment of a German administrative presence and authority in both the Kilimanjaro and Usambara mountain areas. (The British replaced the Germans during World War I and governed Tanzanyika until Independence in 1960.) The second was the establishment of Christian missions in both areas. The third was the influx of European settlers (farmers) into both areas and their cultivation of the newly-introduced coffee (and in the lowlands, sisal). All three intrusions had increasingly important effects on the indigenous people, right through the time of the 1973 survey.

On Measuring "Development" in the Study Areas

"Development" implies a process which takes place over time, proper measurement of which requires something akin to time series data. Time series data per se were not generated by this study. In fact, the nature of the relationships being analyzed would require time series data which extend over a period of at least two to four decades. Such opportunities do not yet exist in rural Africa.

However, these survey data do provide two different types of information about changes over time. One is the comparison of conditions which prevailed in each area at the time of the survey with conditions presumed to have prevailed at some time in the past. The most satisfactory reference period is about the turn of the century, which is reckoned to be--for all practical purposes--the approximate beginning of socioeconomic transformation in each of the four study areas. Since all four areas were initially exposed to non-traditional outside influences (e.g., missionaries, European settlers, schools, and new crops) at about the same time,

comparisons of the four areas as of 1973 provide some insights about the rates at which various changes have taken place on each of the four areas and the extent to which the changes had permeated the areas by 1973.

The second comparison is of the characteristics of the different age groups currently residing in the areas at the time of the survey as indicators of the timing and rates of changes. These comparisons are particularly useful for education, health care, polygyny, and to some extent incomes. Age groups can also be compared among the four areas.

The term "socioeconomic" as used here encompasses a broad array of agricultural, economic, demographic, social, cultural, educational and health characteristics of the population. Many of these are briefly described below.

Agricultural and Socioeconomic Changes in the Study Areas

In the late nineteenth and early twentieth centuries the Western Usambara mountains were described by European observers as being a densely populated but prosperous area with health inhabitants and a flourishing agriculture. The Sambaa, the principal tribe in the area, were known by the German administrators as progressive farmers.

> They possessed "rich banana crops" which . . . took in "half of all the fields." They practised furrow irrigation and . . . had "a significant wealth of livestock" . . . of "superior quality" [Attems, 1968: 140, quoting German travelers writing in the 1880s and 1890s].

> On the slopes one sees thick clumps of banana palms and between these, fields of sugar cane, maize, beans, pumpkins, and tomatoes. All the fields are extremely well tended. In the pastures numerous well-fed cattle graze . . . All the settlements and inhabitants of this delightful area display a certain prosperity [Bauman, 1890, as quoted in Iliffe, 1971: 33].

However, apparently during the first half of the twentieth century the general prosperity of Sambaa traditional (subsistence) agriculture declined and the well-being of the Sambaa deteriorated. Iliffe [1971: 36, 41] notes a tendency towards agricultural involution (i.e., falling labor and/or land productivity) in the Western Usambaras, and Attems paints a very bleak picture of agricultural involution and pauperization which has occurred despite the many development efforts of colonial administrations.

> There is hardly any other district in East Africa where development efforts began as early as in the Usambara Mountains, were so manifold and so often repeated . . . One scheme after another failed . . . The absence of agricultural development in a region which had had a sharp increase in population for decades has resulted in the classical process of involution. Shifting cultivation and semi-permanent farming have been widely replaced by permanent cropping with one or two annual harvests. The concomitant circumstances are erosion and a great number of usually small holdings. The originally high-quality nutrition with maize and beans has largely been replaced by cassava, which is poor in protein and minerals. Whereas well-nourished herds of cattle were once present, we now find numerous emaciated animals and overgrazed areas. It is to be assumed that the economic situation of the population is worse than it was seventy years ago, that is, before the development efforts were begun [Attems, 1968: 139, 141].

Other possible contributing factors are the increase in population density, the lack of suitable cash crop from which to bring income into the area and serve as a catalyst for increasing agricultural productivity, the failure to maintain and develop irrigation networks, and poor soil conservation practices.[2]

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[2]Although it seems quite plausible that the agricultural and nutritional conditions of the Sambaa have worsened during this century, whether this is really the case, and if so, the extent to which conditions have worsened is really unknown because information from earlier periods is inadequate for making such comparisons. One should not take the idyllic descriptions of early European travelers at face value--as Attems seems to do.

In contrast to the Western Usambaras, Kilimanjaro is commonly viewed as an area which has experienced considerable prosperity and economic improvement during the twentieth century. Substantial economic growth and commercialization occurred in Kilimanjaro agriculture during the first half of the 20th century, although the gains were unevenly shared. In the former Kilimanjaro district (now Moshi, Rombo, and Vunjo districts), there were 3,300 African coffee growers in 1923/24, 16,800 by 1933/34, 36,900 in 1953/54, and 87,000 in the late 1960s [Maro, 1974: 237] which at that time was about 90 percent of all rural households. Average annual coffee income per grower (household) was 800 to 1,000 shillings during most of the 1950s and 1960s. In the three peak years of 1953/54, 1955/56 and 1965/66, average annual coffee income per grower was in the range of 1,600 to 2,000 shillings [Maro, 1974: 237]. (The official exchange rate has been about 7 shillings per one U.S. dollar.)

Land pressures have increased very substantially during the past century in both the Kilimanjaro and Usambara areas. The rural population of Moshi district is estimated to have increased between 400 and 500 percent from 1900 to 1967.[3] Farm size in the Kilimanjaro highlands fell from an estimated average of about 2.2 hectares per household in 1921 to 0.5 hectares per household in 1967 [Maro, 1974: 85]. Similar changes have taken place in the Western Usambaras.

One response to the rising population density in the Kilimanjaro area has been more diversification and intensification of agriculture

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[3]The rural population of Moshi district was 362,000 at the time of the 1967 census and that of Lushoto district was 210,500 [Tanzania, 1969].

in both highlands and lowlands. Coffee was planted among the banana groves, and stall-feeding of cattle on banana leaves and stems and on grass brought up from the lowlands was introduced. More maize and beans were grown in the lowlands, former fallow and grazing areas in the highlands came under permanent cultivation, steep riverbanks were planted with coffee and bananas, and more marginal areas in both highlands and lowlands were cultivated [Maro, 1974: 86-88]. Accompanying the increasing land scarcity were fragmentation of land holdings to enable most sons to inherit land, increasing land litigation among kinsmen, and an estimated 700 percent increase in the value of land in the highlands [Maro, 1974: 88].

Additional evidence of increasing pressure on the land is available from the 1973 survey. Each adult male respondent in the study areas was asked how the size of his land holdings compared to those of his father when the respondent was a boy. He was also asked how the number of cattle he owned compared to the number owned by his father. Between 73 and 85 percent of the respondents in the four areas said their land holdings were smaller than their father's had been; approximately similar proportions of respondents said they owned fewer cattle than their fathers had owned. In three of the four areas, nearly half of all respondents reported that they now owned no cattle while only 11 to 18 percent reported that their fathers had owned no cattle. This suggests that the proportions of residents in these three areas who do not own cattle have increased by 2 1/2

to 4 1/2 times during the past generation or two (of course, as a result of population growth, the absolute number who have no cattle has increased much more).[4]

As a result of the many changes which occurred during the past several decades, many residents of these rural areas now have non-agricultural jobs. In the four areas combined, 18 percent of married men and 6 percent of married women reported a non-agricultural occupation; for the four study areas individually the percentages ranged from 8 to 23 for men and from 4 to 8 for women. Overall, only one percent of the men and none of the women were primarily employed as agricultural paid laborers; the rest--81 and 94 percent of men and women respectively--reported themselves as self-employed in agriculture.

These areas have experienced many other significant changes in addition to the ways of making a living. Around the turn of the century almost all residents of these areas still adhered to traditional religions, fertility was high (crude birth rates were probably 45-50 per thousand) and mortality was probably not yet much below its historical average level (crude death rates were probably close to 40 per thousand with average expectation of life at birth of 25-30 years). Almost no one had received any formal (Western-style) education. Non-traditional forms of housing had only recently been introduced by European settlers but had not yet been adopted by Africans.

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[4]Although there was an equivalent proportional increase in the numbers not owning cattle in the fourth area--M2, only 9 percent of the respondents and 4 percent of the respondents' fathers were reported as owning no cattle.

By 1973 crude death rates had declined to below 15 per thousand in the study areas and average expectation of life at birth was 50-55 years although fertility had apparently not yet changed much. Relatively few residents still followed traditional religions, most children were receiving at least primary education, substantial numbers of households resided in non-traditional houses, and almost all households participated in the cash economy. While these were clearly not yet modern rural societies, they were also no longer traditional. They had experienced very considerable social, economic, and cultural change and could be characterized as societies in transition.

Many of these and other characteristics of the study areas are summarized in Table 1. Information on quality of housing--used as an indicator of accumulated wealth--is summarized in colums 3-5. The most striking comparison is between the Lushoto and Moshi areas. Expenditures on housing have certainly been substantially greater in the Moshi areas, and particularly in M2. However, the information on occupation shows that by 1973 non-agricultural activities had become of considerable importance in all areas but L1, and available information on current income--provided by the estimated values of crops produced and sold--shows that in 1973 average household earnings from crops were higher in L2 than in the Moshi areas. These differences support the conclusion that a period of relative economic prosperity was experienced earlier in the Moshi areas (primarily in the 1950s and 1960s) than in L2.

The next section gives information on the two cultural practices of age at first marriage for women and incidence of polygyny among men. Only in M2 has age at marriage declined substantially during the past 15 years.

As indicated in the appendix, it is not possible to conclude that the incidence of polygyny has declined in the Lushoto areas (although it may have), but it has apparently declined at least somewhat in M1 and has declined dramatically in M2.

In the next section, women ages 40-44 are compared to women ages 20-24 in their respective behaviors for duration of breastfeeding, prenatal medical care, and the place their babies were delivered. Although there are a variety of interesting comparisons, in general the less traditional behavior occurs in the Moshi areas while the most traditional behavior is found in L1.

As an indicator of health and mortality conditions, estimates of female expectations of life at birth are given in Panel 2 of Table 1 (column 19). For all four areas the estimates fall within the range of 50 to 55 years which is relatively high for rural Africa. Although it is not possible to know what mortality rates were during the past, mortality has certainly been declining in all four areas in recent decades. Responsdents were asked how they thought the likelihood of children dying these days compared to that of the past. The next section shows the proportions of both men and women in age groups 50-59 and 20-29 who thought that children were <u>less</u> likely to die these days than in the past. Most residents of the Moshi areas believe that mortality among children has declined while most residents of the Lushoto areas believe that it has not. This is consistent with the conclusion that Moshi residents hold less traditional view and values than do Lushoto residents.

The next section shows the proportions of three different age groups who obtained some formal schooling; the age groups are those who at the

Table 1. Summary of Selected Characteristics of the Study Areas in 1973

Panel 1

Study Area	Tribe and Religion	Housing Quality: % of all households with at least 1 building with following: Good Roof	Good Floor	Good Walls, Roof, Floor	Main Occupation: Percent Non-Agricultural Men	Women	Est. Ave. Shilling value per household of 13 crops (previous 12 months)[1] Produced	Sold	Age at First Marriage: Years When Age 20	Percent of all Women Reported Married Before Age 20	Incidence of Polygyny: Approximate Years Born	% of Men Reported Polygynous at least once	Current Age Group	Duration of Breast-Feeding: Percent of Babies Reported Breast-fed More Than 2 Years	Prenatal Care: Percent visiting health facility before last birth	Delivery Place: Percent of babies born in hospital or with trained midwife
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
L1	92% Sambaa 82% Moslem 18% Christian	34%	5%	2%	8%	4%	725	481	1954-68 1969-73	70% 61%	pre-'10 1914-33	48% 41%	40-44 20-24	71% 56%	57% 74%	11% 25%
L2	80% Sambaa 75% Moslem 24% Christian	34%	12%	4%	22%	8%	1053	817	1954-68 1969-73	72% 70%	pre-'10 1914-33	62% 47%	40-44 20-24	73% 33%	67% 88%	21% 36%
M1	99% Chagga 82% Christian 16% Traditional	65%	27%	22%	23%	6%	837	729	1954-68 1969-73	68% 61%	pre-'10 1914-33	54% 23%	40-44 20-24	68% 25%	59% 86%	46% 74%
M2	99% Chagga 99% Christian	92%	42%	29%	20%	7%	976	748	1954-68 1969-73	60% 34%	pre-'10 1914-33	62% 10%	40-44 20-24	45% 16%	60% 97%	42% 71%

[1]Excludes bananas and cassava; the official exchange rate in 1973 was about 7 Shillings = $1.00.

Panel 2

Study Area	Estimated Female Expectation of life at birth (years)	Perceptions of Mortality Changes[1]: Current Age Group	% Who believe children less likely to die these days: Men	Women	Formal Education[2]: Approximate Years Born	Approximate Percent With Some Formal Education: Men	Women	Livebirths Compared with Formal Education: Current Age Group	Years Born	Livebirths: Ave. No. Live-births	% with 2 or fewer births	Formal Educ. of Women: % with "some"	% with 5 or more years	Want No More Children[3]: No. Surviving Children	% Who "Want No More" Children: Fathers	Mothers
(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)
L1	53-55	50-59 20-29	41% 23%	16% 20%	pre-'14 1944-53 1954-58	4% 73% 75%	1% 20% 58%	20-24 25-29 30-34	1949-53 1944-48 1939-43	1.4 3.4 4.6	85% 24% 11%	22% 17% 8%	9% 3% 0	3-4 5-6 7+	8% 17% 29%	8% 32% 43%
L2	50-52	50-59 20-29	36% 33%	15% 31%	pre-'14 1944-53 1954-58	23% 82% 94%	0 33% 74%	20-24 25-29 30-34	1949-53 1944-48 1939-43	1.6 3.7 4.6	74% 26% 14%	38% 29% 26%	19% 10% 8%	3-4 5-6 7+	25% 19% 28%	16% 26% 42%
M1	50-52	50-59 20-29	89% 89%	73% 76%	pre-'14 1944-53 1954-58	21% 77% 94%	1% 49% 76%	20-24 25-29 30-34	1949-53 1944-48 1939-43	1.6 3.2 4.9	76% 30% 13%	57% 40% 36%	33% 16% 12%	3-4 5-6 7+	16% 34% 55%	30% 40% 72%
M2	53-55	50-59 20-29	76% 65%	58% 65%	pre-'14 1944-53 1954-58	5% 83% 97%	1% 65% 90%	20-24 25-29 30-34	1949-53 1944-48 1939-43	0.8 3.0 5.0	92% 42% 17%	72% 62% 40%	32% 13% 10%	3-4 5-6 7+	10% 27% 45%	13% 29% 45%

[1]From among the following 3 categories: (1) less likely, (2) same likelihood (responses ranged from 4 to 7 percent of total responses), and (3) more likely. Excluded are all "don't know" responses; these ranged from 2 to 7 percent of the total.

[2]1954-58 refer to children of respondents; 1944-53 and pre-1914 are the respondents themselves.

[3]Fathers, ages 25-59 (if monogamous, wife is under age 45); mothers, ages 25-44 (currently married, married once only).

Source: [Kocher, 1976a]

time of the survey were over age 59, ages 20-29, and ages 15-19. Although some older residents in all four areas had received formal education, for the younger two age groups L1 lags substantially behind and M2 is substantially ahead of the other areas. Differences are particularly striking for women ages 20-29 where the percentages with some formal education are 20, 33, 49 and 65 respectively, for areas L1, L2, M1 and M2.

The next section compares information on fertility with information on women's education attainments, for women 20-24, 25-29 and 30-34. The most striking difference is for the two younger groups of women in M2, and particularly for women 20-24. Average number of livebirths is lower, and much higher proportions have two or fewer births. This is consistent with the earlier data which showed that age at first marriage has been rising in M2. Although delayed marriage is not necessarily directly caused by higher educational attainments of women, it is of note that higher proportions of women have received "some" education in M2 than in the other areas.

The final section in Table 1 shows the proportions of both fathers and mothers who said they wanted no more children. Among those with five or more children, the largest proportions wanting no more are in M1, although over 40 percent of women with 7 or more surviving children in all four areas said they wanted no more (only women ages 25-44 are included). However, among men with 5 or more, and particularly among men with 7 or more surviving children (only men ages 25-59 included, with wife under age 45 if monogamous), M2 is a rather close second to M1 in the proportions who said they wanted no more children. However, among men with only 3 or 4 surviving children, L2 has the largest percentage who said

they wanted no more children. Although these patterns are not clear-cut, they do suggest that attitudes may be becoming less traditional--particularly among men--with respect to desired number of surviving children, although as with many other changes, L1 is apparently lagging behind the other areas and--with the exception of men with 3 or 4 surviving children--L2 is lagging behind the Moshi areas.

In summary, a great deal of change has taken place in these areas during this century and particularly in recent decades, but there has also been much variation in the participation in these processed, both within and among the study areas. The models and the discussion presented in chapter 2 suggests that some of these changes should have affected both supply of and demand for children. These relationships are analyzed in the next chapter.

4. NORTHEASTERN TANZANIA: ANALYSIS OF THE DETERMINANTS OF FERTILITY

Consistent with the theoretical framework developed in chapter 2, two different fertility models are tested in this chapter. One uses only so-called supply characteristics as independent variables. The second uses only demand characteristics as independent variables. Regression results for both models are presented and discussed below. Results are presented at the aggregate level (data from all four areas "pooled", the district level, and the (study) area level.

Results of the Supply Model

Two variations of the basic supply model are given in formulations 1a and 1b below:

(1a) $NBORN_{ij} = f\ (WOMAGE_{ij}, AGEMAR_{ij}, DHPOLY_{ij}, BRSTFED_{ij}, NDIED_{ij}, e)$

where: $NBORN_{ij}$ = the number of children born alive to woman i in age group j

$WOMAGE_{ij}$ = the age of woman i in single years

$AGEMAR_{ij}$ = the age at which woman i married (as a proxy for age at first coitus, or at least the onset of frequent coitus)

$DHPOLY_{ij}$ = a dummy variable whose presence indicates that the husband of woman i is polygynous (as a proxy for frequency of coitus and perhaps for duration of post-delivery sexual abstinence)

$BRSTFED_{ij}$ = the reported duration of breastfeeding (in months) by woman i (as a proxy for duration of infecundity following the birth of a child)

$NDIED_{ij}$ = the number of woman i's children who have died (as a proxy for duration of infecundity following the birth of a child)

e = random error

i = each currently married woman, married only once, in age group j

j = the age group; it may be a 5-year, 10-year or n-year

The direction of expected relationship between each independent variable and the dependent variable (NBORN) is the following: WOMAGE (+), AGEMAR (-), DHPOLY (-), BRSTFED (-), and NDIED (+).

In formulation 1b WOMAGE and AGEMAR are collapsed into the single variable, YRSMAR (for the number of years the woman has been married), where YRSMAR = (WOMAGE - AGEMAR).

(1b) $NBORN_{ij} = f\ (YRSMAR_{ij}, DHPOLY_{ij}, BRSTFED_{ij}, NDIED_{ij}, e)$

The expected relationship between YRSMAR and NBORN is of course positive, and the directions of the expected relationships between the other independent variables and NBORN are unchanged from formulation 1a.

Regression Results at the Aggregate Level

Table 2 through 4 present regression results for both formulations of the basic supply model. Table 2 presents results at the aggregate level (all four areas combined) for the following five age groups: 20-49, 40-49, 20-39, 20-29 and 30-39. Three of the results given are for formulation 1a; the other five are for formulation 1b. For all eight regressions, the signs of each of the dependent variables are in the expected directions (with the exception of the coefficients of DHPOLY for age group 20-29 which are positive but low). That is, WOMAGE, YRSMAR, and NDIED are

Table 2. Aggregate Level Regression Results for Model of Determinants of Number of Children Born, Women (Currently Married, Once Only), Ages 20-49, 40-49, 20-39, 20-29, and 30-39

Dep. Var.	j			Inter-cept	Independent Variables						N	R^2
					WOMAGE	AGEMAR	YRSMAR	DHPOLY	BRESTFED	NDIED		
NBORN	20-49	AGG	Coeff:	1.765*	0.211*	- .174*		- .454*	- .029*	0.736*	942	.574
			(t)	(5.130)	(25.79)	(11.21)		(3.366)	(5.647)	(13.06)		
	20-49		Coeff:	2.495*			0.206*	- .430*	- .029*	0.734*	942	.572
			(t)	(15.47)			(25.86)	(3.192)	(5.650)	(13.01)		
	40-49		Coeff:	6.805*			0.015	- .691#	- .021	0.752*	230	.192
			(t)	(11.48)			(0.867)	(2.074)	(1.629)	(6.219)		
	20-39		Coeff:	1.954*			0.255*	- .421*	- .029*	0.703*	714	.623
			(t)	(12.18)			(25.66)	(3.146)	(5.765)	(11.70)		
	20-29		Coeff:	0.498	0.305*	- .258*		0.054	- .024*	0.674*	350	.562
			(t)	(0.817)	(13.70)	(12.87)		(1.059)	(4.682)	(7.842)		
	20-29		Coeff:	1.516*			0.278*	0.058	- .024*	0.678*	350	.558
			(t)	(8.970)			(16.94)	(0.371)	(4.698)	(7.870)		
	30-39		Coeff:	1.864/	0.244*	- .207*		-.770*	- .038*	0.686*	364	.450
			(t)	(1.827)	(8.295)	(8.697)		(3.662)	(4.228)	(8.168)		
	30-39		Coeff:	2.872*			0.221*	-.753*	- .037*	0.691*	364	.449
			(t)	(7.799)			(11.03)	(3.592)	(4.186)	(8.245)		

*Significant t-ratio at .01 level #Significant t-ratio at .05 level /Significant t-ratio at .10 level.

positively related to NBORN, and AGEMAR, DHPOLY, and BRSTFED are negatively related to NBORN. The t-ratios for WOMAGE, AGEMAR, YRSMAR, and NDIED are all significant at the .01 level. The constant is significant in seven of the eight regressions at the .01 level. Examination of results for age groups 20-29, 30-39 and 40-49 indicates that the larger age groups (20-39 and 20-49) obscure some important differences due to age in the effects of the independent variables on fertility.

As expected, the substitution of YRSMAR for WOMAGE and AGEMAR has little effect on either R^2 or the other three independent variables. (Comparisons between these two formulations are given in Table 2 for age groups 20-49, 20-29, and 30-39). Although formulation 1b (with YRSMAR) is intuitively superior to formulation 1a in that it shows the importance of total years married in explaining fertility (particularly among younger women), it has the disadvantage of obscuring the importance of age of marriage as a determinant of fertility.

The poorest performing regression is for women 40-49; R^2 is 0.192. (For formulation 1a with WOMAGE and AGEMAR, R^2 is 0.212). The signs are all in the expected directions, but only the constant and NDIED are significant at the .01 level; DHPOLY is significant at the .05 level. The coefficient for YRSMAR is nearly zero. Since most of these women have completed childbearing, it is to be expected that YRSMAR would be of relatively less importance in explaining fertility levels and differences than it is for younger women, although it was expected to be of some significance. The relatively low explanatory power of the model, and also the lack of importance of YRSMAR, are probably due in large part to relatively greater inaccuracy in reporting age data--and perhaps to some

extent, number of deceased children (NDIED) and hence NBORN--among women ages 40-49 than among younger women. It is interesting, however, that coefficients for both DHPOLY and DNIED are rather large-- -.691 and 0.752--with the former significant at the .05 level and the latter at the .01 level. The t-ratio for BRSTFED is almost significant at the .10 level.[1]

The lower half of Table 2 reports results for each of the two formulations for age groups 20-29 and 30-39. DHPOLY enters the equation quite differently for the two age groups. For ages 20-29, DHPOLY is of no importance; its coefficients are positive but quite low. However, for ages 30-39 it is negative and relatively (just under -0.7) and significant at the .01 level. This implies that for women ages 30-39, marriage to a polygynous husband has the effect of reducing total number of children born by about 0.7 on average.

Because of the apparently better data for younger women, subsequent analyses will be carried out only for women under age 40. The two estimation equations for age group 30-39 at the aggregate level are given below:

$$(2a)\quad NBORN_{ij} = 1.864 + (.244)WOMAGE_{ij} - (.207)AGEMAR_{ij} - (.770)DHPOLY_{ij} - (.038)BRSTFED_{ij} + (.686)NDIED_{ij}$$

$$(2b)\quad NBORN_{ij} = 2.872 + (.221)YRSMAR_{ij} - (.753)DHPOLY_{ij} - (.037)BRSTFED_{ij} + (.691)NDIED_{ij}$$

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[1] It is possible that reported length of lactation of women 40-49 is less representative of their overall breastfeeding experience as compared to the data for younger women.

where: i = each currently married woman, married once only, in age group j

j = ages 30-39

Some examples of the results produced by these models are as follows: For women age 36, married at age 17, married to monogamous husbands, having breastfed for 24 months each, and with no deceased children, the estimated number of children born per woman using model 2a is 6.22; for model 2b it is 6.18. For women married to polygynous husbands with otherwise identical characteristics, estimated numbers of children born are 5.45 and 5.43 respectively. For women married to polygynous husbands and having two deceased children each but with other characteristics unchanged, estimated numbers of births per woman are 6.82 and 6.81 respectively.

Regression Results at the District Level

Because there is the possibility that systematic differences exist between the Moshi and the Lushoto areas which are not adequately incorporated into the aggregate level equations, the basic models were expanded to include location dummy (0,1) variables, where each of the original independent variables is multiplied by either 0 or 1 depending on whether the woman is in Moshi district or Lushoto district. Any systematic differences in the original variables as compared to the variables in the original equation.

Results for both formulation 1a and 1b are given in Table 3 for age groups 20-29 and 30-39 and are compared to the results obtained with the basic (short) formulations from Table 2. The area (L-) dummies are given on the right side of the table. For all four comparisons, R^2 is slightly higher for this expanded model (higher by a range of .006 to .021).

For age group 20-29 the effect of the expanded model is to slightly reduce the size of the constant and to slightly increase the size of the coefficients for WOMAGE, AGEMAR, YRSMAR, and BRSTFED; none of the coefficients are changed by more than about 10 percent. For age group 20-29 the expanded model increases the coefficients for DHPOLY substantially (although t-ratios remain low) and reduces the coefficients for NDIED by about 25 percent. None of the L-dummy variables are statistically significant and t-ratios are quite low except for LNDIED.

For age group 30-39, coefficients for AGEMAR, YRSMAR and NDIED are essentially unchanged. The coefficient for WOMAGE declines about 10 percent. Coefficients for BRSTFED are increased by a little over 10 percent and the constants are increased by almost 70 percent in the first formulation. The coefficients for DHPOLY are increased greatly--from under -0.8 to almost -1.6. This is also reflected in the coefficients for LDHPOLY (right side of the table) which are significant at the .01 level. LDHPOLY is the only location dummy variable that is statistically significant in any of the expanded models.

Thus, Table 3 indicates that although there are some systematic differences between the two districts in the ways in which the independent variables relate to fertility (NBORN), with the exception of DHPOLY for ages 30-39 (and, to a lesser extent, NDIED for ages 20-29), the differences for age groups 20-29 and 30-39 are relatively minor.

Regression Results at the Area Level

Results for each study area are given in Table 4 for age groups 20-29 and 30-39 but only for formulation 1a (with WOMAGE and AGEMAR). The results show differences between the areas within each district which were

Table 3. Aggregate Level Regression Results: Inclusion of Geographic/Ethnic Dummy Variables (L-Dummies for Lushoto), Compared to Basic Models (Table 2), for Women (Currently Married, Once Only) Ages 20-29 and 30-39

Dep. Var.	j			Inter-cept	Independent Variables													R^2
					WOMAGE	AGEMAR	YRSMAR	DHPOLY	BRSTFED	NDIED	LUSHOTO	LWOMAGE	LAGEMAR	LYRSMAR	LDHPOLY	LBRSTFED	LNDIED	
NBORN	20-29	AGG	Coeff:	0.498	0.305*	-.258*		0.054	-.024*	0.674*								.562
			(t)	(0.817)	(13.70)	(12.87)		(1.059)	(4.682)	(7.842)								
	20-29		Coeff:	0.115	0.332*	-.271*		0.331	-.026*	0.514*	0.846	-.062	0.023		-.307	0.008	0.285	.568
			(t)	(0.141)	(11.30)	(10.14)		(0.969)	(4.000)	(3.861)	(0.685)	(1.386)	(0.553)		(0.785)	(0.738)	(1.625)	
	20-29		Coeff:	1.516*			0.278*	0.058	-.024*	0.678*								.558
			(t)	(8.970)			(16.94)	(0.371)	(4.698)	(7.870)								
	20-29		Coeff:	1.487*			0.298*	0.332	-.027*	0.515*	-.051			-.040	-.305	0.009	0.286	.564
			(t)	(7.281)			(13.68)	(0.971)	(4.079)	(3.864)	(0.133)			(1.201)	(0.778)	(0.806)	(1.633)	
	30-39		Coeff:	1.864/	0.244*	-.207*		-.770*	-.038*	0.686*								.450
			(t)	(1.827)	(8.295)	(8.697)		(3.662)	(4.228)	(8.168)								
	30-39		Coeff:	3.176#	0.215*	-.218*		-1.579*	-.042*	0.691*	-3.210	0.700	0.294		1.152*	0.011	0.039	.471
			(t)	(2.461)	(5.708)	(7.036)		(4.698)	(3.716)	(6.863)	(1.536)	(1.171)	(0.615)		(2.622)	(0.622)	(0.212)	
	30-39		Coeff:	2.872*			0.221*	-.753*	-0.37*	0.691*								.449
			(t)	(7.799)			(11.03)	(3.592)	(4.186)	(8.245)								
	30-39		Coeff:	3.075*			0.217*	-1.580*	-.043*	0.690*	-.400			0.006	1.225*	0.011	0.037	.467
			(t)	(6.776)			(8.373)	(4.695)	(3.731)	(6.869)	(0.516)			(0.147)	(2.795)	(0.608)	(0.207)	

*Significant t-ratio at .01 level #Significant t-ratio at .05 level /Significant t-ratio at .10 level

not apparent in the district level results. For example, for ages 20-29, although NDIED has the expected positive sign for all four areas, it enters with quite different coefficients and t-ratios; there are also differences for BRSTFED. For ages 30-39 there are differences for NDIED between the areas within each district, but they are much smaller than for ages 20-29. However, there are very large differences for DHPOLY. For M1 the coefficient is -1.1 and for M2 it is -2.5. For L1 both coefficient and t-ratio are almost zero while for L2 the coefficient is .73 and nearly significant at the .10 level. Despite these large differences, the overall impression produced by the district level results (Table 3) is not contradicted--i.e., in Moshi district polygyny is highly (negatively) correlated with fertility while in Lushoto district polygyny is of only modest importance.

The role of length of lactation for women 30-39 is very similar in the two Moshi areas. Both BRSTFED coefficients are about -.045 meaning, for example, that an increase of about 11 months in length of lactation is associated with a decrease of about one-half a birth. The coefficient for L2 is nearly identical to those for the Moshi areas, but in L1 there is no relationship between BRSTFED and NBORN.

For a woman age 27, married at age 17, married to a monogamous husband, having breastfed 24 months, with one deceased child, estimates of NBORN using the equations given in Table 4 for ages 20-29 are as follows: M1, 4.38; M2, 4.25; L1, 4.59; and L2, 4.34. Retaining the same characteristics except assuming that the woman has no deceased children produces the following estimates for NBORN: M1, 3.66; M2, 4.03; L1, 3.57; and L2, 3.83. All of these estimates seem highly plausible.

Table 4. Area Level Regression Results for Model of Determinants of Number of Children Born, Women (Currently Married, Married Once Only), Ages 20-29 and 30-39

Dept. Var.	j			Inter-cept	Independent Variables					N	R^2
					WOMAGE	AGEMAR	DHPOLY	BRSTFED	NDIED		
NBORN	20-29	M1	Coeff:	0.442	0.292*	-.246*	0.320	-.020#	0.718*	111	.533
			(t)	(0.392)	(7.069)	(6.290)	(0.899)	(2.030)	(4.183)		
	20-29	M2	Coeff:	-.149	0.367*	-.292*	Constant	-.032*	0.226	96	.525
			(t)	(0.105)	(7.321)	(6.828)		(3.022)	(0.915)		
	20-29	L1	Coeff:	1.771	0.257*	-.257*	0.280	-.032*	1.018*	74	.662
			(t)	(1.411)	(5.919)	(6.752)	(1.211)	(2.891)	(7.596)		
	20-29	L2	Coeff:	0.108	0.315*	-.273*	-.242	-.006	0.515*	69	.687
			(t)	(0.095)	(7.325)	(6.810)	(1.012)	(0.462)	(3.442)		
	30-39	M1	Coeff:	3.388/	0.193*	-.192*	-1.093#	-.045#	0.774*	101	.492
			(t)	(1.713)	(3.513)	(3.720)	(2.482)	(2.359)	(4.926)		
	30-39	M2	Coeff:	2.440	0.251*	-.236*	-2.502*	-.046*	0.620*	120	.510
			(t)	(1.348)	(4.604)	(5.968)	(4.436)	(3.048)	(4.567)		
	30-39	L1	Coeff:	-2.673	0.303*	-.148*	0.147	0.0	0.881*	70	.606
			(t)	(1.297)	(5.628)	(3.720)	(0.430)	(0.000)	(4.664)		
	30-39	L2	Coeff:	0.628	0.291*	-.202*	-.731	-.047/	0.643*	73	.350
			(t)	(0.239)	(3.778)	(3.143)	(1.546)	(1.932)	(2.788)		

*Significant t-ratio at .01 level #Significant t-ratio at .05 level /Significant t-ratio at .10 level

Results of the Demand Model

Various formulations of a model using demand characteristics as independent variables were tested; independent variables were proxies for income, relative prices and tastes. One of the formulations is specified below.

(3) $NBORN_{ij} = f(CROPVAL_{ij}, BLDQUAL_{ij}, HUSB\text{-}WAGE_{ij}, WOMADVLR_{ij}, WOMRELC_{ij}, WOMEDUC_{ij}, e)$

where: $NBORN_{ij}$ = the number of children born alive to woman i in age group j

$CROPVAL_{ij}$ = the estimated value of crops produced by the household of woman i during the 12 months preceding the survey (as a proxy for current income)

$BLDQUAL_{ij}$ = an index of the quality and value of housing of the household of woman i (a proxy for permanent income or wealth)

$HUSB\text{-}WAGE_{ij}$ = a dummy variable whose presence indicates that the husband of woman i has a wage-paying job (a proxy assumed to indicate that the price of children vis-a-vis other goods is relatively high)[2]

$WOMADVLR_{ij}$ = a dummy variable whose presence indicates that woman i thinks there are advantages to having a large family (a proxy for the price of children being relatively low)

$WOMRELC_{ij}$ = a dummy variable whose presence indicates that the religion of woman i is Christian (a proxy for preferences being relatively in favor of other goods vis-a-vis children--relative to preferences for non-Christians)

$WOMEDUC_{ij}$ = Number of years of formal schooling for woman i (a proxy for tastes as well as for relative price of children)

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[2]This is on the further assumption that the children of men with wage-paying jobs have relatively less opportunity to contribute to household income through their work on the household's agricultural holdings.

e = random error

i = each currently married woman, married once only, in age group j

j = woman i's age group

The directions of expected relationships between each independent variable and the dependent variable (NBORN) are as follows: CROPVAL (+), BLDQUAL (+), HUSB-WAGE (-), WOMADVLR (+), WOMRELC (-), and WOMEDUC (-).

The R^2s which are produced by various formulations are given in Table 5 for age groups 20-29, 30-39, and 40-49 at the aggregate, district and area levels. A few of the regression results of the demand models are reported in Tables 6, 7 and 8, and are compared in more detail to the results obtained with the basic supply models.

Table 5 shows that R^2s are very low for the demand models. The R^2s do not exceed about .04 at the aggregate and district levels (except for ages 40-49 in Lushoto where R^2 is about .14). At the area level, the R^2s range from less than .01 to about .13 except for ages 40-49 in L2 where they are around 0.2. The R^2s are generally larger when BDLQUAL is a proxy for income than when CROPVAL is the income proxy. Four of the lines in Table 5 give the R^2s produced when the natural log of CROPVAL--(LN)CROPVAL--is substituted for CROPVAL to see of this non-linear version of the proxy for current income performs better than the linear version. In most cases (LN)CROPVAL does perform better but in no case is its coefficient or associated t-ratio very large. In all cases the R^2s for these two alternative formulations are either identical or differ only slightly.

In Table 6 comparisons are made of the regressions for age group 20-29 at the aggregate level for eight of the regression models reported on in

Table 5. Comparison of R^2s for Various Supply Models and Demand Models for Age Groups 20-29, 30-39, and 40-49

Regression Model	Aggregate			Moshi			Lushoto			M1			M2			L1			L2		
	20-29	30-39	40-49	20-29	30-39	40-49	20-29	30-39	40-49	20-29	30-39	40-49	20-29	30-39	40-49	20-29	30-39	40-49	20-29	30-39	40-49
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Supply Models[1]																					
-WOMAGE & AGEMAR	.562	.450	.212	.519	.491	.225	.644	.434	.272	.533	.492	.165	.525	.510	.303	.662	.606	.373	.687	.350	.174
-YRSMAR	.567	.449	.192	.513	.491	.221	.643	.420	.267	.529	.408	.162	.523	.509	.281	.670	.569	.347	.676	.196	.183
Demand Models[2]																					
-CROPVAL, BLDQUAL, and HUSB-WAGE	.035	.013	.035	.060	.017	.022	.017	.024	.147	.129	.028	.051	.014	.038	.023	.080	.079	.102	.052	.119	.242
-(LN)CROPVAL, BLDQUAL & HUSB-WAGE	.038	.019	.036	.060	.016	.030	.014	.040	.141	.127	.047	.054	.019	.039	.044	.078	.088	.133	.065	.130	.220
-BLDQUAL & HUSB-WAGE	.035	.013	.034	.055	.015	.018	.014	.022	.141	.121	.028	.051	.013	.030	.016	.058	.079	.099	.052	.119	.211
-CROPVAL & HUSB-WAGE	.019	.009	.023	.030	.012	.019	.017	.015	.141	.089	.025	.038	.004	.025	.023	.062	.062	.100	.037	.039	.241
-(LN)CROPVAL & HUSB-WAGE	.024	.012	.023	.040	.008	.018	.014	.030	.137	.101	.037	.034	.012	.026	.041	.067	.073	.125	.045	.053	.217
-CROPVAL & BLDQUAL	.028	.013	.033	.047	.015	.022	.016	.023	.116	.100	.026	.036	.010	.032	.015	.076	.064	.098	.051	.104	.217
-(LN)CROPVAL & BLDQUAL	.033	.018	.034	.053	.013	.030	.013	.039	.108	.109	.043	.037	.016	.033	.038	.073	.074	.133	.065	.116	.161
-CROPVAL	.015	.009	.023	.023	.011	.019	.016	.012	.115	.073	.023	.029	.000	.024	.014	.056	.032	.093	.037	.008	.217
-(LN)CROPVAL	.021	.012	.023	.036	.007	.018	.013	.027	.108	.091	.035	.026	.010	.024	.033	.060	.045	.119	.043	.026	.161
-BLDQUAL	.028	.013	.032	.044	.013	.018	.013	.021	.108	.096	.026	.036	.010	.023	.008	.053	.063	.095	.051	.103	.151
-HUSB-WAGE	.019	.008	.023	.030	.008	.013	.013	.013	.137	.088	.025	.034	.003	.012	.015	.040	.060	.098	.037	.039	.209

[1]The variable(s) listed plus DHPOLY, BRSTFED, NDIED.

[2]The variable(s) listed plus WOMADVLAR, WOMRELC, AND WOMEDUC.

Table 6. Aggregate Level Regression Results: Comparison of Results for Selected Demand Models of Determinants of Number of Children Born, Women (Currently Married, Married Once Only), Ages 20-29

Dep. Var.	j		Inter-cept	Independent Variables							N	R^2
				CROPVAL	(LN)CROPVAL	BLDQUAL	HUSB-WAGE	WOMADVLR	WOMRELC	WOMEDUC		
NBORN	20-29	Coeff:	3.060*	- .001		0.127*	- .317	- .061	- .120	- .102*	427	.035
		(t)	(16.57)	(0.119)		(2.628)	(1.709)	(0.367)	(0.608)	(2.655)		
		Coeff:	2.669*		0.062	0.120#	- .280	- .063	- .112	- .100*	427	.038
		(t)	(6.985)		(1.122)	(2.494)	(1.505)	(0.376)	(0.573)	(2.598)		
		Coeff:	3.052*			0.127*	- .314/	- .062	- .118	- .102*	427	.035
		(t)	(17.74)			(2.646)	(1.712)	(0.373)	(0.600)	(2.667)		
		Coeff:	2.539*		0.076	0.108#		- .072	- .125	- .106*	427	.033
		(t)	(6.811)		(1.386)	(2.278)		(0.431)	(0.636)	(2.761)		
		Coeff:	3.014*	0.004				- .077	0.023	- .090#	427	.015
		(t)	(16.62)	(0.469)				(0.457)	(0.121)	(2.393)		
		Coeff:	2.509*		0.088			- .073	0.017	- .085#	427	.021
		(t)	(6.702)		(1.603)			(0.433)	(0.090)	(2.281)		
		Coeff:	2.999*			0.115#		- .072	- .133	- .110*	427	.028
		(t)	(17.68)			(2.418)		(0.435)	(0.679)	(2.873)		
		Coeff:	3.089*				- .244	- .065	0.041	- .081#	427	.019
		(t)	(17.89)				(1.335)	(0.390)	(0.216)	(2.149)		

*Significant t-ratio at .01 level #Significant t-ratio at .05 level /Significant t-ratio at .10 level

Table 5. The first is the initial demand model listed in Table 5 with CROPVAL, BLDQUAL, and HUSB-WAGE as income proxies; R^2 is .035. The second is the same model but with (LN)CROPVAL replacing CROPVAL; R^2 is .038. In the former, CROPVAL essentially enters as zero while the coefficient for (LN)CROPVAL in the second model is positive but low. Coefficients for BLDQUAL are positive and significant at the .01 level in the first fomulation and at the .05 level in the second. The only other statistically significant coefficient is for WOMEDUC (significant at the .01 level); the sign of the coefficient is negative.

In the third formulation only BLDQUAL and HUSB-WAGE are included as income proxies. The coefficient for HUSB-WAGE is now significant at the .10 level (and the sign is negative). In the fourth formulation in Table 5, (LN)CROPVAL is included and HUSB-WAGE omitted; R^2 drops slightly to .033. In the fifth through eighth sets of results only one income proxy is used; it is, respectively, CROPVAL, (LN)CROPVAL, BLDQUAL, and HUSB-WAGE. Consistent with the earlier results, only the coefficient for BLDQUAL is statistically significant (at the .05 level).

In Table 7, comparisons are made at the district level for age group 20-29 for the third, fifth, sixth, and seventh formulations shown in Table 6 (i.e., formulations in which income proxies are, respectively, both BLDQUAL and HUSB-WAGE, only CROPVAL, only (LN)CROPVAL, and only BLDQUAL). Results are generally similar to those at the aggregate level except that BLDQUAL is shown to have a negligible effect on NBORN in Lushoto but a considerable effect in Moshi district (significant at the .01 and .05 levels respectively in the two relevant formulations). In fact, none of the coefficients for the income proxies are even close to being

Table 7. District Level Regression Results: Comparison of Results for Selected Demand Models of Determinants of Number of Children Born, Women (Currently Married, Married Once Only), Ages 20-29

Dep. Var.	j			Inter-cept	Independent Variables							N	R^2
					CROPVAL	(LN)CROPVAL	BLDQUAL	HUSB-WAGE	WOMADVLR	WOMRELC	WOMEDUC		
NBORN	20-29	MOSHI	Coeff:	3.319*			0.135*	- .381/	- .193	- .309	- .105#	253	.055
			(t)	(6.193)			(2.568)	(1.668)	(0.880)	(0.575)	(2.374)		
		MOSHI	Coeff:	3.465*	- .005			- .324	- .196	- .196	- .078/	253	.030
			(t)	(6.356)	(0.407)			(1.398)	(0.882)	(0.360)	(1.766)		
		MOSHI	Coeff:	2.861*		0.121/		- .254	- .178	- .388	- .080/	253	.040
			(t)	(4.457)		(1.646)		(1.097)	(0.805)	(0.704)	(1.838)		
		MOSHI	Coeff:	3.247*			0.125#		- .212	- .327	- .116*	253	.044
			(t)	(6.056)			(2.380)		(0.964)	(0.607)	(2.636)		
		LUSHOTO	Coeff:	2.900*			0.045	- .159	0.160	- .152	- .080	174	.014
			(t)	(12.92)			(0.336)	(0.498)	(0.607)	(0.412)	(0.998)		
		LUSHOTO	Coeff:	2.844*	0.007			- .106	0.152	- .127	- .074	174	.017
			(t)	(11.87)	(0.737)			(0.337)	(0.575	(0.348)	(0.951)		
		LUSHOTO	Coeff:	2.805*		0.017		- .129	0.162	- .125	- .073	174	.014
			(t)	(4.655)		(0.035)		(0.164)	(0.373)	(0.115)	(0.869)		
		LUSHOTO	Coeff:	2.874*			0.032		0.157	- .143	- .081	174	.013
			(t)	(13.20)			(0.247)		(0.597)	(0.388)	(1.016)		

*Significant t-ratio at .01 level #Significant t-ratio at .05 level /Significant t-ratio at .10 level

statistically significant in the models for Lushoto district while for Moshi district the coefficients for both HUSB-WAGE (negative sign) and (LN)CROPVAL (positive sign) are significant at the .10 level. In all four formulations for Moshi district the coefficients for WOMEDUC are statistically significant (and negative). Nevertheless, the largest R^2 in Moshi district is only .055 while in Lushoto district the largest R^2 is only .017.

Area level results are given in Table 8 for the first two of the four formulations shown in Table 7 (i.e., with income proxies being, respectively, both BLDQUAL and HUSB-WAGE, and only CROPVAL). The models perform best for M1. For M1 coefficients for BLDQUAL are positive and significant at the .01 level; coefficients for HUSB-WAGE and WOMEDUC are negative and (in the first formulation) significant at the .10 and .01 levels respectively. In the other three areas, none of the coefficients for the independent variables are statistically significant (with the exception of WOMRELC in one of the formulations for L1 where the coefficient was significant at the .05 level--and negative as hypothesized.)

Summary of Findings

Table 9 compares the aggregate-level results obtained for the supply model to those obtained for the demand model, for age groups 20-29 and 30-39. As was also demonstrated by the preceding analysis in this chapter, Table 9 shows that the demand variables are capable of explaining very little about fertility levels and differentials. The R^2s for the demand models are low (0.035 and 0.013 for age groups 20-29 and 30-39 respectively) and very few of the coefficients for the independent variables are statistically significant, although most signs are in the expected directions.

Table 8. Area Level Regression Results: Comparison of Results for Selected Demand Models of Determinants of Number of Children Born, Women (Currently Married, Married Once Only), Ages 20-29

Dep. Var.	j			Inter-cept	Independent Variables						N	R^2
					CROPVAL	BLDQUAL	HUSB-WAGE	WOMADVLR	WOMRELC	WOMEDUC		
NBORN	20-29	M1	Coeff:	3.450*		0.149#	- .564/	- .319	- .246	- .146*	135	.121
			(t)	(6.701)		(2.202)	(1.923)	(1.110)	(0.480)	(2.777)		
		M1	Coeff:	3.633*	- .006		- .442	- .363	- .164	- .134#	135	.089
			(t)	(6.927)	(0.346)		(1.508)	(1.230)	(0.314)	(2.470)		
		M2	Coeff:	2.779*		0.094	- .221	- .043	Constant	- .029	118	.013
			(t)	(7.706)		(1.042)	(0.621)	(0.124)		(0.362)		
		M2	Coeff:	2.928*	0.001		- .219	- .027	Constant	0.005	118	.004
			(t)	(7.869)	(0.036)		(0.586)	(0.077)		(0.060)		
		L1	Coeff:	2.794*		0.305	- .299	0.141	- .897	0.037	92	.058
			(t)	(8.463)		(1.269)	(0.657)	(0.374)	(1.504)	(0.248)		
		L1	Coeff:	2.798*	0.024		- .320	0.061	-1.003/	0.083	92	.062
			(t)	(8.537)	(1.390)		(0.708)	(0.158)	(1.706)	(0.606)		
		L2	Coeff:	2.852*		- .198	0.114	0.393	0.537	- .119	82	.052
			(t)	(8.881)		(1.096)	(0.239)	(0.983)	(1.009)	(1.167)		
		L2	Coeff:	2.852*	- .000		- .069	0.350	0.346	- .139	82	.037
			(t)	(7.658)	(0.019)		(0.150)	(0.872)	(0.677)	(1.361)		

*Significant t-ratio at .01 level #Significant t-ratio at .05 level /Significant t-ratio at .10 level

Table 9. Regression Results for Supply and Demand Models of Number of Children Ever Born to Women Currently Married and Married Only Once in Rural Areas of Northeastern Tanzania, 1973*

Independent variables	Age group			
	20-29	20-29	30-39	30-39
(1)	(2)	(3)	(4)	(5)
Supply variables				
Number of years married		0.278# (16.94)		0.221# (11.03)
Number of deceased children		0.678# (7.870)		0.691# (8.245)
Length breastfed last baby weaned (months)		-.024# (4.698)		-.037# (4.186)
Polygynous marriage		0.058 (0.371)		-.753# (3.592)
Demand variables				
Value of household crop production	-.001 (0.119)		0.000 (0.120)	
Building quality index	0.127# (2.628)		0.092 (1.307)	
Husband held wage-paying job	-.317 (1.709)		-.088 (0.307)	
Woman thinks there are advantages to large family	-.061 (0.367)		-.006 (0.026)	
Woman's religion is Christian	-.120 (0.608)		0.289 (1.072)	
Woman's amount of formal education	-.102# (2.655)		-.036 (0.513)	
Constant	3.060# (16.57)	1.516# (8.970)	5.357# (20.42)	2.872# (7.799)
R^2	.035	.558	.013	.449

Notes: Regression coefficients are outside parentheses; t-ratios are inside parentheses
# Denotes significant t-ratio at .01 level
/ Denotes significant t-ratio at .10 level

Source: Kocher, 1977b, Table 1.

However, the supply model performs well; the R^2 for age group 20-29 is 0.558 and that for age group 30-39 is 0.449. In addition to producing relatively large R^2s, in nearly all cases the hypothesized relationships between the various independent variables and the dependent variable are supported at high levels of statistical significance.

5. NORTHEASTERN TANZANIA: THE EFFECTS OF RURAL DEVELOPMENT ON FERTILITY[1]

Data are presented in chapter 3 on a number of indicators of development in the study areas as of 1973 together with some discussion of the extent to which social and economic development occurred in the study areas between about 1900 and 1973. Many of these data are summarized in Table 1 in chapter 3.

One general conclusion is that considerable change and development has occurred in all four areas during this century, but that there are now substantial differentials both among and within the study areas in the extent to which individual families have participated in and benefited from the changes. The ordering of the study areas in Table 1 is L1, L2, M1, and M2; that is, from the area which has in general experienced the least development (L1) to the area which has experienced the most (M2). By most criteria, L1 and L2 are also the areas with the most unequal distribution of economic and educational improvements.

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[1] T. Paul Schultz has correctly questioned the use of regression techniques to estimate the model. In particular, the number of years married variable can be considered jointly determined. Some would argue that other variables may be jointly determined. Use of an endogenous variable as a regressor may lead to "simultaneous equation" bias in the coefficient. However, because of limited resources, the model was not reestimated. The coefficient of the variable is so highly significant that one can reasonably accept its importance. Furthermore, regression results generally have smaller variance than do simultaneous equations estimators. Thus, the estimate is believed reasonable until further evidence becomes available.

The major period of rapid economic gains in the Moshi areas probably occurred prior to the 1960s, and this is especially apparent in the levels of past expenditures on improved housing. This contrasts to the pattern of rising incomes in L2 (and to a lesser extent L1) which by some criteria has the highest level of current average income per household among the four areas. Economic gains in L2 have been concentrated much more within the last 10 years and especially the last few years. Hence, levels of wealth appear to be considerably lower in L2 than in the Moshi area; they are of course lowest of all in L1. There has been a similar pattern in the expansion of educational opportunities for women in recent decades as well as in the demise of polygyny, the reduction in the average length of breast-feeding, the utilization of medical facilities, and to some extent, in a rising age at marriage.

The Impact of Rural Development on Supply Variables and Fertility

The supply variables analyzed in chapter 4 were women's current age, her age at marriage, number of years married, whether or not the woman was married to a polygynous husband, length of lactation, and her number of deceased children. In most cases, there were high levels of statistical significance between each of these variables and number of children born. Current age, years married, and number of deceased children were positively related to fertility, while age at marriage, polygynous

marriages and length of lactation were negatively related to fertility. Women's age is probably the only variable unaffected by development.[2]

Age at Marriage

Of the independent variables in the supply model, the one which has the biggest overall effect on number of births (excluding woman's current age) is age at first marriage. The effect of development on age at marriage is not entirely unambiguous. In a regression analysis with age at first marriage as the dependent variable, BLDQUAL--assumed to be a proxy for household wealth--was generally negatively related to age at marriage implying that the independent effect of rising incomes over a long period of time would be a tendency for earlier marriage [Kocher, 1976a: 133-37]. However, other aspects of development may have the opposite effect on age at first marriage, particularly woman's education. This same analysis showed that in both M2 and L1 the relationship between the woman's amount of education and her age at marriage was positive, fairly strong and statistically significant. Women completing primary school married on average about two years later in M2 and 5 years later in L1 than women with no schooling. This implies a decline of about half a birth per woman in M2 and about one birth in L1, even net of the offsetting effect of shorter

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[2]Even age is likely to be affected by development if one consequence of development is declining mortality. In particular, to the extent that female adult mortality declines, this will increase the average number (and total number) of childbearing years of a group of women passing through those years. A higher proportion of those who reach age 15, for example, will also reach age 45. Hence, ceteris paribus, the average number of children eventually born to that group of women will be higher than would be the case under conditions of higher adult female mortality.

breast-feeding among educated women. However, there was essentially no relationship between education and age at marriage in M1 and L2.

The evidence indicates quite clearly that age at marriage has risen considerably in recent years in M2. M2 has the highest overall levels of educational achievement for women, and the biggest gains for women have been rather recent, apparently paralleling rises in average age at marriage. M2 is also the area which--based on most indicators of development available from this study--has experienced the most overall development while at the same time achieving probably the least unequal distribution of the benefits of development.

Number of Deceased Children

Improved living conditions, education, greater access to health services and better health care can all be expected to contribute to general declines in mortality. Mortality rates have certainly declined substantially in recent decades in all four areas. Analysis of reported age distributions produced estimates of female expectations of life at birth of 50 to 55 years in all four areas. Mortality rates have probably declined by 50 percent or more during this century. Reductions in mortality rates for infants and young children have certainly had the independent effect of reducing fertility somewhat, although it is not possible to estimate very precisely how much. The survival rates implied by the reported number of children born and number deceased are not helpful since they show that mortality rates are if anything higher among children of younger women than among children of women in their forties and older. This is certainly not the case and indicates that older women failed to mention a substantial proportion of their deceased children.

To the extent that mortality rates for infants and young children continue to fall as the result of on-going improvements in health and living conditions, the independent effect will be to lower fertility somewhat.[3] However, while declining mortality causes somewhat lower fertility, it also results in a somewhat higher average number of surviving children. For example, a coefficient of 0.7 for NDIED implies that for each child that does not die, the number of births will be reduced by 0.7; it also implies that the number of surviving children for that woman will be increased by 0.3, ceteris paribus. Hence, while rising fertility unambiguously implies a rising average number of surviving children, fertility decline caused by declining infant and young children mortality rates also results in a rising average number of surviving children.

Duration of Breastfeeding

In a regression model with length of breastfeeding (BRSTFED) as the dependent variable, woman's age and BLDQUAL were both positively related to length of breastfeeding while woman's education was generally negatively related to length of breastfeeding. Women whose husbands have wage-paying jobs also breastfed for shorter periods than other women [Kocher, 1976a: 137-39]. Husband's wage-paying job may be a proxy for income (with which to buy breast-milk substitutes) as well as a proxy for outside or

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[3] Rising incomes and education and improved living conditions will not necessarily cause infant and young child mortality rates to decline further. To the extent that these changes lead to substitution of bottle-feeding for breastfeeding--especially if it's unhygienic bottle-feeding which it often is in low income areas--mortality rates of young children could rise [Kocher, 1976a: 140].

non-traditional influences, including the notion that it is fashionable to wean earlier and use breast-milk substitutes. Although the relationship with BLDQUAL is positive--perhaps because women in households with better housing are also more likely to be older and more traditional, almost all other evidence indicates that the secular trend in these four areas is for substantially shorter average lengths of lactation. In addition to the negative relationships with education and wage-paying jobs, it is also probably the case that many other types of outside and/or non-traditional influences encourage shorter periods of breastfeeding. Again, the shortest reported breastfeeding--particularly for younger mothers--is in M2 (with M1 a close second and L2 a close third for women under age 30).

In most cases, the relationship between duration of breastfeeding and fertility is negative and statistically significant. Most of the coefficients imply that the reduction of about a year in breastfeeding is associated with an increase of up to half a birth per women for women in their 30's.

Polygyny

In the Moshi areas and in L2 polygyny is negatively related to fertility and statistically significant for women in their thirties.[4] Coefficients are -1.1 in M1, -2.5 in M2 and -0.73 in L2. The incidence of polygyny has declined greatly in the Moshi areas in recent years; there were no women ages 20-29 in M2 married to polygynous husbands, and

[4]According to Caldwell [1975: 12] most evidence from West Africa also shows that fertility is lower in polygynous than in monogamous marriages.

only 7 percent of those ages 30-39 were married to polygynous husbands compared to 19 percent in M1, 29 percent in L1 and 41 percent in L2. Certainly in the Moshi areas the spread of the Christian religion has been a major cause of the decline in polygyny. However, some aspects of development--particularly education of women--but also non-traditional influences in general contribute to attitudes which view polygynous marriages increasingly less favorably.

In any event, the evidence is clear that the incidence of polygyny has declined sharply in the Moshi areas and that this has had the independent effect of causing a rise in average number of children born per woman. For example, if women married to monogamous husbands have an average 1.5 more births than women married to polygynous husbands, and if in the past about one-third of the women were married to polygynous husbands while now there are no polygynous marriages, the net effect is an average increase of one-half birth per woman.

Improved Health

Due to an inability to obtain appropriate data, health status was not used as an independent variable in the regression models (with the exception of data on number of deceased children and pregnancy-related medical care). However, one would expect that improved health--especially among women of childbearing ages--would also increase fecundity and result in higher fertility. Moreover, only women currently married and married only once were included in these regression analyses. Women who are divorced, separated or who have been married more than once are also more likely to have sterility problems since in traditional African societies

barrenness is usually adequate grounds for divorce. General health improvements could be expected to reduce the proportion of women who are divorced or separated due to barrenness (it might also reduce the incidence of widowhood) and cause a rise in average fertility.

Evidence from a few other African studies suggests that overall fertility does increase as a consequence of improved health. Henin [1969] found this to be the case in rural Sudan. Analysis of data from West Lake region in Tanzania suggests that the total fertility rate has apparently increased from about 4-5 in the early 1950s to about 6-7 in the early 1970s, and general improvements in health and a lower incidence of sterility and childlessness seem to be important causes [Ewbank, 1977b]. The incidence of childlessness in the study areas among women ages 35-44 was about 3 percent. This implies an extremely low incidence of sterility for rural Africa, and it is possible that the incidence has declined in recent years (although this cannot be ascertained) which would then have caused a rise in fertility in these areas, ceteris paribus. Among the 18 regions in Tanzania, regional level percentages of childlessness among women ages 35-44 in 1973 ranged from 3.6 to 17.4 [Ewbank, 1977: 3].

In summary, the probable effects of rural development on the supply variables--at least in these rural areas--is some rise in average length of lactation, a decline in the incidence of polygyny (with religion probably being, however, the single most important determinant of the rate at which polygyny becomes less common) a general improvement in health and fecundity, and a net decrease in infant and child mortality although this may be partially offset by the adverse consequences of unhygienic bottle-feeding of babies. It is really not possible to know what the net effect

on fertility will be because this depends largely on the "mix" of the various changes taking place. Rising age at marriage reduces both fertility and number of surviving children, ceteris paribus. Earlier weaning increases both, except to the extent that it causes somewhat higher young child mortality (i.e., due to bottle-feeding), in which case average number of surviving children would be lower. Declining incidence of polygyny and better health of women increase both fertility and number of surviving, ceteris paribus. Finally, reduction in average number of children dying (per woman) reduces fertility but increases average number of surviving children.

The net effect of the above changes in supply variables (resulting from development) is probably a rise in the average number of surviving children since of the above changes only rising age at marriage definitely reduces number of surviving children. This conclusion--that the net effect of changes in supply variables is likely to be an increase in the average number of surviving children while the net effect on fertility could be change in either direction or no change whatsoever--is of course what was postulated in the theoretical framework developed in chapter 2 and incorporated into Figures 1 and 4.

Rural Development and Changes in Demand Characteristics

Parental demand for children is expected to be positively related to income, negatively related to the relative price of children, and positively related to tastes or preferences which are relatively in favor of children vis-a-vis other consumer goods. Average household

incomes have increased in the study areas during the past few decades, although in the Moshi areas they may not have increased during the past 20 years or so. Average incomes have without doubt increased substantially in L2 in recent years.

It is not certain what has happened to the relative price of children in recent years although it seems likely that the price of children vis-a-vis other goods has risen, at least in the Moshi areas, and in L2 (at least in comparison to L1). The main price proxies used were respondents' opinions about whether there were advantages to having large and small families respectively. Over half of the women under age 50 in M1 said there were advantages to having small families; this compares to about 40 percent in M2, and 30 percent in L2 and 20 percent in L1. Percentages for men under age 50 were almost 60 in M1, almost 50 in M2 and about 40 in L2 and 35 in L1. It is certainly the case that Moshi residents have spent much more on other consumer goods--particularly expensive housing--than have Lushoto residents, and hence perhaps feel relatively more competition between children and other goods for their financial resources than do Lushoto residents.

For similar reasons, it seem plausible that in recent years tastes in the Moshi areas have shifted relatively in favor of other goods vis-a-vis children. Most (perhaps all) of the very substantial rise in average houshold income occurred prior to the 1960s in the Moshi areas, while the big jump in average household income in L2 occurred only in recent years, and average income is still much lower in L1 than in the other three areas. This earlier increase in incomes in the Moshi areas means that residents there have been earning and spending more money for

a longer period of time (than have Lushoto residents) and have experienced the acquisition of certain modern consumer goods--especially good housing--by many of their neighbors and relative, if not themselves. Aspirations to acquire non-traditional goods have had more time and opportunity to develop in the Moshi areas. These include aspirations for (and by) children (such as for education and better clothing) which increase the price of children and (eventually at least) make their price positive and probably continuously rising. These changes have probably also affected aspirations for non-traditional consumption goods which compete with children for the household's financial resources.

Put another way, reference group standards have for some time been rising and are undoubtedly now much higher in the Moshi areas than in the Lushoto areas. Not all households have fine homes and/or children with secondary education in the Moshi areas, but enough do that these seem potentially within the reach of nearly all families. This has not been the case in the Lushoto areas, although the relatively high incomes which have recently started to accrue to some residents of L2 may soon result in increases in types of expenditures similar to those made earlier in the Moshi areas.

Hence, incomes have certainly risen in recent decades in all four areas, although much less so in L1 than in the other three areas, and among the other three areas the timing and distribution (within the areas) of the rises, and the effects on permanent incomes (wealth) are certainly different. Probably both relative and absolute prices of children have risen, for at least some parents in the Moshi areas, although this conclusion is more speculative than that for incomes. It is even less

certain, however, what has happened to preferences for children vis-a-vis other goods, although it seems probable that in the Moshi areas preferences may have shifted relatively in favor of non-child goods vis-a-vis children.

Thus, in the Moshi areas (and perhaps to a lesser extent, L2) incomes have risen, the relative and absolute prices of children have probably risen, and if preferences have changed, it is likely they have shifted away from children. Rising incomes should increase the demand for children while the latter two effects should reduce demand for children.

There is certainly evidence that demand for children is present and operative among parents in these areas. Data presented in Appendix Table A14 on proportion of parents who said they want more children and proportions who say they do not want more make sense in several ways. First, for both mothers and fathers the proportions who say they do not want more children are very small among those with relatively few surviving children, and the proportions wanting no more rise systematically (with a few, interruptions in some groups) as the number of surviving children increases. (Only parents presumably still capable of having children are included in the analysis.) For women and husbands, respectively, the percentages with three surviving children who said they want more children are 71 and 100 in M1, 96 and 86 in M2, 92 and 91 in L1 and 96 and 100 in L2. This compares with the following percentages for those with more than seven surviving children who said they want more: 12 and 48 in M1, 43 and 41 in M2, 60 and 63 in L1 and 62 and 64 in L2.

Second, a higher proportion of parents in the Lushoto areas want more children than in the Moshi areas. All available data indicate that socioeconomic development has been more widespread and occurred earlier

in the Moshi areas. It is therefore to be expected that Lushoto district residents would hold relatively more traditional values than Moshi residents, including the traditional value of wanting as many children as possible.

Finally, the results of a discriminant analysis showed a high level of consistency between both respondents who said they wanted more children and those who said they wanted more and their respective responses to questions as to whether they thought there were advantages to large families and advantages to small families [Kocher, 1976a: 159-172]. That is, a much higher percentage of respondents who want more children thought there were advantages to large families than for those who want no more children. Similarly, a much higher proportion of those who want no more children thought there were advantages to small families as compared to those who want more children.

Altogether this seems to be fairly strong evidence that demand for children (as measured by whether parents want more children) is present for individual parents, and that within a given community, a given age group and for parents with a similar number of surviving children, there are some who do and others who do not want more children.

Thus, the patterns of responses to the question, "do you want more children?" and the relationships between these responses and the proxy variables used for relative prices in the discriminant analysis were all quite plausible and in general what would be expected. However, analysis of the relationships between the responses to this question and both income and taste proxies was much less satisfactory. It was expected that both current income and permanent income (wealth) would be

positively related to the demand for children. However, the relationships were in some cases positive and in others negative with no consistent patterns. When demand proxies were included in regression models of fertility, only BLDQUAL (proxy for permanent income) consistently had the expected positive sign and only in a few formulations was it statistically significant, and the coefficient was invariably small.

Inclusion of proxy variables for relative preferences in both the regression and the discriminant models resulted in no significant or even consistent results. Inclusion--in the discriminant analysis model of demand--of the responses of parents to actual or anticipated mortality among their children produced, if anything, results opposite to what were hypothesized. This is in contrast to the findings of some other studies which indicated that parents seem to respond to actual or expected mortality among their children by increasing the number of children wanted, as a hedge against future deaths. This was implied, for example, by a study of Taiwan [Schultz, 1971] and a study in the Philippines [Harmon, 1970] although in these studies the responses to mortality were not formulated in a strictly demand context as they were here.

In summary, results of analysis of demand for children are much less satisfactory than results of analysis of supply.[5] There is evidence that differential demand for children is present among parents and that they can express it in terms of whether or not they want more children. It is also certain that incomes have risen in recent decades; it is likely that relative prices of children have risen; and it is possible that preferences have shifted somewhat away from children. Theory indicates that rising incomes should reduce demand for children. The higher proportions of both mothers and fathers who want no more children in L2 and the Moshi areas compared to L1 are consistent with some decline in demand for children in recent years, but the evidence is far from conclusive.

Summary Observations: Supply, Demand and Fertility

Thus, the most likely effects of development on supply of and demand for children would appear to be as follows: Changes in the supply variables have probably on balance resulted in some increase in the average number of surviving children per woman although the net effect on fertility is unknown. Changes in demand variables have probably had the net

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[5] This is in contrast to the conclusion of Snyder [1974: 625] that the results of his regression analysis of data from Sierra Leone supported the demand theory of the determinants of fertility. While it is true that the coefficients of his proxies for income (husband's education) and prices (wife's education) had the expected signs, the t-ratios were small and most were not statistically significant even at the .10 level. In the same model he had the "supply" variables of woman's current age, her age at the birth of her first child, and the mortality experience among her children. For all age groups almost without exception, the t-ratios for all three of these variables were considerably larger than those for the demand proxies, and they no doubt accounted for much of the R^2s (which ranges from .16 to .49). It appears that from his results one could justifiably conclude that supply characteristics are more important than demand characteristics in determining fertility in his sample of Sierra Leonean women.

effect of reducing the desired number of surviving children. There is no evidence in these data of a strong positive relationship between incomes and the demand for children. There is evidence of a negative relationship between the price of children and demand for children, at least as the price of children is perceived by mothers and fathers, and there is evidence of probable increases in the proportions of parents wanting no more children in both Moshi areas and, to a lesser extent, in L2. It seems likely that if preferences have changed, they would have shifted in favor of other goods vis-a-vis children, although there is no real evidence that they have done so.

Hence, the absence of much of a relationship between incomes and demand for children means a weak or non-existent income effect, even though incomes have been rising in the last few decades in the study areas. On the other hand, the apparently stronger negative relationship between price of children and demand for children suggests that on balance, if demand for children has been changing in response to development, it has been declining.

The theoretical formulation presented in chapter 2 postulated that in response to development, supply would rise and demand would fall although the timing and rates of changes might differ. This seems to be what has been happening in these areas. It was also postulated that when a mother's (or father's) number of surviving children (supply) equaled or exceeded the number desired (demand), the person would prefer to have no more children and would indicate so in response to the appropriate question. Certainly the patterns in the responses to this question are consistent with this expectation. If the responses are valid, it implies that a substantial number--although not a majority--of parents with more

than about four surviving children are at the point where supply equals or exceeds demand. The patterns further suggest that a smaller proportion are in an excess supply situation in the Lushoto areas than in the Moshi areas. All of these results are consistent with the theory.

It was postulated further in chapter 2 that because of the dominant role of supply variables in determining actual fertility, parents and rural communities generally would probably experience a considerable period of excess supply before demand variables would become important enough to motivate parents to actually do something about preventing future births--e.g., practice contraception or abortion. Again, although questions about practice of contraception or abortion were not put to the respondents, there is no evidence from non-survey sources that either are found in these areas. In fact, modern contraceptives were not available to residents of these areas, and abortion is considered taboo. It is not known whether any respondents have experienced sufficient socioeconomic transition and have sufficient excess supply of children that they would actually want to use modern contraceptives if they were readily available (and hence, the person would then be in Stage 4 of the transition model in Figure 1). However, the analysis strongly suggests that a sizable proportion of respondents have experienced some excess supply and are in Stage 3 of the theoretical framework shown in Figure 1.

Implications for Future Population Growth in Moshi and Lushoto Districts

The populations of Moshi and Lushoto districts are estimated to have been growing at between 3.0 and 3.5 percent annually in the early 1970s.

It was noted earlier that Moshi district has experienced more socioeconomic change than almost any other rural area of Tanzania. Thus, it seems likely that rural people in most other areas of Tanzania are not as far along in the socioeconomic and demographic transition (Figures 1 and 4) as are Moshi district residents. Although there is no evidence that fertility has yet declined in the Moshi study areas, there is evidence of a general decline in desired family size (demand for children). It seems quite likely that there will be some decline in fertility in rural Moshi within the next few decades, but it is not possible to guess the speed or extent of the decline. It is much more problematic whether fertility will decline in Lushoto district within the next few decades.

There is also scope for further mortality decline in these two districts. For example, although crude death rates are currently in the range of 12-15 per thousand population, due to the young age structures of these populations, crude death rates could decline to as low as 5 per thousand. (for comparison, the crude death rates of Sri Lanka and Taiwan are currently 8 and 5 per thousand respectively.) Thus, a decline in fertility between now and the year 2000 could be offset by continued mortality decline.

Because of internal migration, population projections for subnational units in tropical Africa are much more difficult and potentially much less reliable than are national-level projections. Thus, in interpreting projections for rural areas of Moshi and Lushoto districts, one must realize that substantial changes in net out-migration rates could significantly affect future rural growth rates and population sizes. Table 10 gives actual rural populations for Moshi and Lushoto districts

in the census years of 1948, 1957 and 1967, and gives four different population projections to the year 2000 using annual growth rates of 2.5, 3.0, 3.5 and 4.0 percent during the period 1967-2000. It seems highly probable that the actual average annual population growth rate will be within the range of 2.5 to 4.0 percent in both districts during this period.

Table 10 shows that the rural population of Lushoto district is projected to increase from 210,000 in 1967 to between 475,000 and 768,000 in 2000. The rural population of Moshi district is projected to increase from 362,000 in 1967 to between 818,000 and 1.3 million. This is quite a wide range and represents an increase of between about 125 and 265 percent over a 33 year period.[6]

Projections beyond the year 2000 are even more problematic; they would require assumptions about fertility, mortality and internal migration in the post-2000 period, as well as assumptions about the population sizes and age structures as of about the year 2000. What is certain is that the rate of natural increase in these areas will continue to be high well into the 21st century (again, barring a devastating catastrophe).[7]

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[6]Similar projections backward from 1948 to 1900 indicate that the population of Lushoto district was probably in the vicinity of 50,000 to 60,000 in 1900 and the population of Moshi district was probably about 75,000 to 100,000 in 1900. This is on the assumption that the average annual population growth rate was between 1.5 and 2.0 percent during the period 1900 to 1948. Thus, over this 100 year period (1900 to 2000) the probable increase in population size in these two districts is expected to be in the range of about 8 to 15 fold.

[7]The rate of natural (population) increase is the crude birth rate minus the crude death rate; it does not take account of net migration. The population growth rate is the rate of natural increase minus the net migration rate.

Table 10. Actual and Projected Total Populations for Lushoto and Moshi Districts, 1948 to 2000

Year	Lushoto District		Moshi District	
	Actual			
	Population (000)	Average Annual Growth Rate	Population (000)	Average Annual Growth Rate
1948	128		197*	
		2.1%		3.4%
1957	154		267*	
		3.2%		3.1%
1967	210		362	

	Projected Populations (000)							
	Average Annual Growth Rate				Average Annual Growth Rate			
	2.5%	3.0%	3.5%	4.0%	2.5%	3.0%	3.5%	4.0%
1970	227	230	233	237	390	395	401	407
1980	290	309	329	350	499	531	566	603
1990	371	415	464	519	639	714	798	892
2000	475	558	655	768	818	960	1126	1320

*Assumes that in 1948 and 1957 Moshi district accounted for 76.0 percent of the total population of the former Kilimanjaro district, as was the case in 1967.

Sources: Respective Census volumes of 1948, 1957 and 1967.

As discussed earlier, for populations with the demographic characteristics currently present in Moshi and Lushoto districts, the birth rate will continue to exceed the death rate (i.e., producing a positive rate of natural increase) for about 50 years after replacement-level fertility is first reached. It would be unreasonable to expect replacement-level fertility to be achieved even in Moshi district before early in the 21st century, and it could take much longer.[8] Thus, while it would be inappropriate to attempt population projections for these districts beyond the end of this century, one can assert with great confidence that the crude birth rate will continue to exceed the crude death rate at least to the mid-21st century.[9]

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[8]With current mortality rates in Moshi district, replacement-level fertility would be a total fertility rate of between 2.5 and 3; the current total fertility rate is between 6 and 7.

[9]Because migration is an insignificant component of most national-level projections (and is completely insignificant for multi-national populations such as "tropical Africa"), meaningful projections can be made to well beyond the year 2000 for such populations. For projections for major regions of the world including selected African countries, see Frejka, 1973b. For projections for Tanzania to the year 2050, also see Kocher, 1976b.

6. SOME IMPLICATIONS FOR POLICY AND RESEARCH IN TROPICAL AFRICA

Two of the dominant international development objectives of our times are rural development and the achievement of rapidly declining birth rates. Evidence has steadily mounted in recent years that people in traditional rural societies--including those in tropical Africa--will not voluntarily reduce fertility and have smaller families. In traditional rural societies, by and large women and their husbands want high fertility. Substantial and sustained reduction in fertility has not preceded--and cannot be expected to precede--significant socioeconomic development. Thus, real rural development achieves these two very important objectives simultaneously: (1) It results in meaningful improvement in the material well-being of the large proportion of people who are part of basically traditional and economically impoverished societies, and it provides them with access to resources and skills which enable them to continually improve their well-being. In the process, it inevitably results in the breakdown of many traditional aspects of these societies--aspects which may be highly valued but which in themselves are (were) crucial obstacles to development. (2) Rural development, by (a) breaking down the traditional socioeconomic system which causes people to attach relatively high values--both economic and sociopsychological--to large numbers of children, and by (b) greatly reducing the high child mortality rates caused by the traditional socioeconomic system, results in parents finding it in their own best interests--both economic and

otherwise--to have fewer children and smaller families. This desire for fewer children is in turn an essential precondition to sustained and substantial fertility decline in rural areas, including rural tropical Africa. Some important implications for policy and research are discussed below.

Policy Implications

Two types of policies can be distinguished. One is those which enhance the prospects and process of development, including all three development criteria identified at the beginning of Chapter 1. The second is population policies, in particular those which are specifically intended to speed the onset, and subsequent rate, of fertility decline (e.g., family planning programs).

The first set encompasses a whole host of policies, including those affecting education, health, and social services and amenities generally, incomes, prices, employment, fiscal, foreign exchange, urban development, geographic and ethnic priorities, research, and many others--all of which impinge in important ways on the process of development in rural areas, including the distribution of development benefits within and among rural areas. All of these policies can together be viewed as also being, in part, a population policy to the extent that they bring changes in rural areas which in turn cause changes in mortality, fertility and migration.

When the goal is fertility reduction, it is not necessarily helpful to distinguish between those policies which affect demographic variables through the intermediaries of education, health, incomes, consumption, etc., from more narrowly construed population policies--such as family planning programs--which presumably affect fertility more directly. The

remaining brief comments will refer to aspects of both types of population policies.

Differentiating Between Supply-Affecting and Demand-Affecting Policies

The preceding analysis indicates quite clearly that at least for current and earlier stages of development in these rural areas of Tanzania, policies which affect determinants of the supply of children potentially have more immediate effect on fertility than policies intended to affect demand for children. That is, policies which bring about rising age at first marriage, discourage early weaning and reduce infant and young child mortality rates will all contribute to lower fertility. Presumably education--especially for women--and health care which reaches essentially the entire population (again, especially women and children) would be likely to have the greatest favorable effects on these three supply variables. But educational content is perhaps as important as school enrollment itself. Curricula for upper level primary school students should include instruction on the value of prolonged breastfeeding, on simple and effective family health care, and on family nutrition, particularly maternal and young child. Moreover, at least in some areas increased education is likely to cause some offsetting rise in fertility, even with proper educational content, because it seems probable that better educated women will be less enthusiastic about being part of polygynous marriages, and to the extent that the incidence of polygyny declines as a consequence of increased education of women and other changes taking place in these rural areas, this will probably have the independent effect of some rise in

fertility. Despite this, the demise of polygyny would resumably represent an enhancement of the status and roles of women--which would contribute to the long term process of development and fertility decline--and hence is desirable in its own right.

Policies intended to reduce fertility by affecting supply variables should be considered essentially short run with relatively modest potential fertility effect since there are limits to the extent to which marriage age is likely to rise, mortality to fall and weaning to be delayed, and these limits are such that the maximum resulting decline in fertility is small (e.g., 10 to 15 percent). This means that any long run, sustained and substantial fertility decline--e.g., a reduction of half in average number born--can only come about by reducing demand for children accompanied or followed by parental use of effective means for more nearly matching actual number born with number desired--e.g., the effective use of modern contraceptives.

The earlier analysis indicated that demand for children apparently does decline as the consequence of development. However, even in the Moshi study areas where demand for children has apparently been declining, the desired number of surviving children per woman probably still averages about 5 or 6. The effect of development on demand and eventually on fertility is a much longer run effect than that of development on supply. The study data suggest a lack of direct relationship between income and desired number of children, but they indicate that higher incomes are associated with changing perceptions of the advantages of large and small families (used here as proxies for relative prices). The results suggest that rising incomes and development generally cause relative prices and

perhaps preferences to shift against children, at least against the quantity of children desired. That is, the analysis indicates that development does cause demand for children to decline, but that it probably takes a rather long time for this decline to result in parental action to prevent further births. Policies which raise education levels, raise incomes and improve access to consumer goods which compete with children for parents' time and income will all speed the decline in demand for children.

These results reinforce the view that development is a very long term process and that the time required for development to cause sustained fertility decline is probably at least several decades and necessarily encompasses at least two or three generations. Development is complex and multifaceted, and it does affect determinants of fertility--primarily supply variables initially, and later and more importantly in terms of long run fertility decline, demand variables. These results suggest that we must carefully specify the stage of socioeconomic and demographic change or transition which the target population is in before deciding what types of policy interventions may be most suitable.

The Role for Family Planning Programs

Can this long term process be circumvented or speeded up by introducing into these communities programs which provide family planning services and promote the values associated with their use? The tentative answer suggested by this analysis is, "perhaps yes, but only to a limited extent and the timing has to be right." It appears that some development would have to take place before changes in supply of and demand for children are sufficient to cause a sizable proportion (e.g., one-fourth to

one-third) of parents in later childbearing ages to experience excess supply and want no more children. Family planning programs introduced into rural areas which have experienced little or no socioeconomic transition will probably find little demand for their values, they may generate an adverse response and perhaps be counterproductive by making it more difficult to successfully promote their values at a later, more suitable, time.

On the other hand, once a considerable amount of socioeconomic transition and development--which is likely to be causing supply to rise somewhat and demand to decline--has taken place in a rural area, there may very well be substantial and increasing numbers of parents--particularly women--who could be persuaded to use contraceptives. A well designed and implemented program which results in a satisfied first group of participants might find the demand for services increasing as a growing proportion of women with excess supply (of children) want to prevent additional births and are persuaded by the success other women are having with family planning.

It seems unlikely that a family planning program could create feelings of excess supply of children. It seems quite possible that a well designed and implemented program could exploit existing feelings of excess supply. Such a program might very well now find acceptors in the Moshi areas. It seems unlikely that there would be much market for services in the Lushoto areas, and particularly in Ll.

However, even a program promoting the advantages of family planning for proper child spacing--as Tanzania's family planning program now does--would have the salutary effect of increasing birth intervals over what they

would otherwise be, thereby causing lower fertility. If material and child health care services which successfully promote the values of breast-feeding (and discourage bottle-feeding), later weaning and better maternal and child nutrition practices are coupled with these services, this will have the further salutary effect of reducing infant and young child mortality--and thus reducing fertility--while increasing the average number of surviving children. This in turn would cause parents to reach the point of excess supply of children relatively earlier, thereby making it more likely that they would eventually want to use contraceptives to prevent future births.

Research Implications

The importance of further research on relationships between rural development and fertility change in tropical rural Africa is heightened by at least three features of rural Africa: (1) The tremendous diversity both within rural Africa and between rural Africa and other areas of the low income world; (2) The absence of evidence that fertility has yet declined anywhere in rural tropical Africa in response to a desire for lower fertility (the evidence presented in this paper is only that desired--not actual--fertility has apparently declined in Moshi district); and (3) The tremendous significance of earlier rather than later fertility decline in rural Africa from the perspective of enhancing the long run achievement of development objectives.

Although several research topics and categories might be discussed and recommended, the one question which clearly emerges from this analysis also is the one to which this analysis was directed--i.e., what are the

determinants of fertility change and fertility decline in rural Africa? It is clear from this analysis that the determinants are very complex--in fact, far more complex than is generally appreciated, even by students of this topic. This analysis has shown that there are frequently interrelated and multiple links between a given socioeconomic change and its ultimate effect on fertility.

For example, education of rural women may delay marriage and thereby reduce fertility by delaying the onset of childbearing; this is a supply effect. At the same time, education may lead women to adopt various non-traditional practices including bottle-feeding of infants and shorter breastfeeding. The shorter breastfeeding will lead to earlier resumption of ovulation, earlier pregnancy and higher fertility--again a supply effect. Other possible supply effects of education include increases in fertility due to better health and an increase in the incidence of monogamous--rather than polygynous--marriages. Bottle-feeding may cause a higher incidence of infant and young child mortality, thereby reducing the number of surviving children which is another way of increasing number of births desired (demand). Education may, however--and probably does--also bring changes in women's lives and in the values they attach to having large numbers of children which then <u>reduces</u> their demand for children. Thus, in the case of the effect of women's education on fertility, this analysis has shown that at least in the initial period of increases in schooling for rural women, education affects several determinants of fertility in various ways and the net effect on fertility is uncertain. This does not contradict the widely-accepted view that <u>over the long run</u>, more education for women reduces fertility.

The role of education is a particularly interesting example, but there are similar complications in trying to sort out the effects of several other aspects of socioeconomic changes on fertility in rural Africa. These include the effects of better health, reduced mortality, presence of and access to health services per se (as distinguished from their fertility effects resulting from actually changing the health status of both children and adults), income, wealth, possible differential effects between traditional and nontraditional sources of income and wealth accumulation, etc.

Thus, while this research agenda may be fuzzy in its particulars due to the complexities involved, it should be clear in its general objective which is to learn much more about the effects of rural socioeconomic change on fertility, including the "time" dimensions. Because a larger proportion of the population of tropical African is rural than in any other sizable area of the world, it is particularly important that such research be conducted in rural (as well as urban) areas of Africa. It is also important that such research be conducted in many different countries and regions within countries.

Micro-level data are required. That is, because the causal relationships of interest take place at the individual or family level, it is necessary to gather data on socioeconomic and demographic characteristics at the individual or family level. District, regional or national data simply cannot be used to establish the probable presence of causal relationships between socioeconomic characteristics (and changes) and fertility. This means that census data will not do for this purpose. It also means that household data collected for other purposes (e.g., household budget

surveys; agricultural surveys) probably also will not be suitable, because they are unlikely to collect (sufficient) data on relevant socioeconomic and demographic characteristics, unless the questionnaires are intentionally designed to collect this information as well.

This also means that appropriate studies will be relatively expensive because they will include all the costs of generating the necessary primary data.[1] It also means they will necessarily be time-consuming, because design and implementation of household surveys in rural Africa cannot be adequately arranged and carried out in a matter of weeks. Preparation and implementation will require many months at a minimum, even if local collaboration and full governmental cooperation is obtained.

Another implication of this analysis is that this research should be designed and carried out by broad-based social scientists rather than by narrow specialists, regardless of their disciplines (e.g., the social sciences, demography, medicine, etc.). The complexity of the micro-level relationships has already been discussed at great length; suffice it to note that at the level of the person or family, understanding the relationships of interest requires substantial knowledge from many of the

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[1] This does not mean that one must start "from scratch", however. A considerable body of experience has already been accumulated in rural Africa, at least some of which can be tapped by almost any potential researcher. This experience includes questionnaires, guidelines for recruiting and training interviewers, data analysis techniques, etc., much of which could be adapted for use elsewhere in rural Africa. In addition to my own work (about which more information can be obtained by writing to me), excellent work has been done in West Africa by Professor John C. Caldwell and his colleagues. (For published results on some of their work, see Caldwell, 1976a, 1976b, 1977.) Further information can be obtained by writing directly to Professor Caldwell, Department of Demography, Australian National University.

conventional disciplines, including anthropology, sociology, economics, geography, medicine, public health, and the history of the local area.

Any perspective researcher also requires at a minimum an official affiliation with an institution within the research country (e.g., university, government department). This is absolutely essential. It is also only a necessary pre-requisite; it may not even assure one of obtaining the necessary official governmental research approval and clearance as well as governmental and local community support for the field work.

Finally, although not always an absolute essential, if the researcher is not a citizen of the country in which the research is to be conducted, the collaboration of a reputable (national) scholar in the host country is well-advised, and in some cases will be essential. In addition to the sensitivity of host governments and institutions to non-nationals conducting this type (and many other types) of research, there are many potential obstacles--substantive, administrative, cultural--which can be dealt with most effectively (and perhaps only) through the collaboration of a host scholar. In recent years the number of African scholars who are well trained and professionally interested in these issues has increased enormously. Particularly in some countries, these scholars are to be found in several (or all) of the relevant disciplines mentioned above.

REFERENCES

Attems, Manfred. 1968. "Permanent Cropping in the Usambara Mountains: The Relevance of the Minimum Benefit Thesis," pp. 138-74 in Hans Ruthenberg, ed., Smallholder Farming and Smallholder Development in Tanzania, Munich: Weltforum Veglag.

Becker, Gary S. 1960. "An Economic Analysis of Fertility," in Universities-National Bureau Committee for Economic Research, Demographic and Economic Change in Developed Countries, Princeton: Princeton University Press.

_____. 1965. "A Theory of the Allocation of Time," Economic Journal 71 (299), September, pp. 493-517.

Becker, Gary S., and Lewis, H. Gregg. 1973. "On the Interaction Between the Quantity and Quality of Children," Journal of Political Economy 81(2), Part III, March/April, S279-S288.

Caldwell, John C. 1975. "Introduction: Some Important Issues," in John C. Caldwell, et al., eds., Population Growth and Socioeconomic Change in West Africa, New York and London: Columbia University Press.

_____. 1976a. "Toward a Restatement of Demographic Transition Theory," Population and Development Review 2(3/4), September and December, pp. 321-66.

_____. 1976b. "Fertility and the Household Economy in Nigeria," Journal of Comparative Family Studies, special issue.

_____. 1977. "The Economic Rationality of High Fertility: An Investigation Illustrated with Nigerian Survey Data," Population Studies 31(1), pp. 5-27.

Cleave, John H. 1974. African Farmers: Labor Use in the Development of Smallholder Agriculture, New York: Praeger, 253 p.

Coale, Ansley J. 1973. "The Demographic Transition Reconsidered," 1973 National Population Conference, Liege, Belgium: IUSSP, Vol. 1, pp. 53-72.

Easterlin, Richard A. 1969. "Towards a Socio-economic Theory of Fertility: A Survey of Recent Research on Economic Factors in American Fertility," in Fertility and Family Planning: A World View, ed., S.J. Behrman, et al., Ann Arbor: University of Michigan Press.

_____. 1973. "Relative Economic Status and the American Fertility Swing," pp. 170-223 in Eleanor Bernert Sheldon, ed., Family Economic Behavior: Problems and Prospects, Philadelphia: J.B. Lippincott Co.

_____. 1975. "An Economic Framework for Fertility Analysis," Studies in Family Planning 6(3), March, pp. 54-63.

Easterlin, Richard A. 1976. "Population Change and Farm Settlement in the Northern United States," Journal of Economic History 96(1), March, pp. 45-75.

Ewbank, Douglas C. 1977a. "Indicators of Fertility Levels in Tanzania: Differentials and Trends in Reported Parity and Childlessness," paper presented at the 1977 Population Association of America Meeting (St. Louis), 24 p.

_____. 1977b. Personal communication.

Frejka, Tomas. 1973a. The Future of Population Growth: Alternative Paths to Equilibrium, New York: John Wiley and Sons, 268 p.

_____. 1973b. Reference Tables to the Future of Population Growth, New York: The Population Council, 943 p.

Harmon, Alvin J. 1970. Fertility and Economic Behavior of Families in the Philippines, Santa Monica: The Rand Corporation.

Henin, Roushda A. 1969. "The Patterns and Causes of Fertility Differentials in the Sudan," Population Studies 23(2), July, pp. 171-98.

Iliffe, John. 1971. Agricultural Change in Modern Tanzania: An Outline History, Nairobi: East Africa Publishing House.

Kocher, James E. 1973. Rural Development, Income Distribution and Fertility Decline, New York: The Population Council.

_____. 1975. "Rural Development and Fertility Change: Preliminary Results From a Study in Lushoto and Moshi Districts, Tanzania," Proceedings of the East African Agricultural Economics Conference, Kampala, Uganda.

_____. 1976a. A Micro-Economic Analysis of the Determinants of Human Fertility in Rural Northeastern Tanzania, Michigan State University, Ph.D. dissertation.

_____. 1976b. Tanzania: Population Projections and Primary Education, Rural Health and Water Supply Goals, Harvard University: HIID Development Discussion Paper No. 17, 36 p.

_____. 1976c. "Rural Development and Demographic Change in Northeastern Tanzania," pp. 53-93 in New Perspectives on the Demographic Transition, Washington, D.C.: Interdisciplinary Communications Program (Smithsonian Institution), Occasional Monograph No. 4.

_____. 1977a. A Bibliography on Rural Development in Tanzania, Harvard University: HIID Development Discussion Paper No. 30, 30 p.

_____. 1977b. "Socioeconomic Development and Fertility Change in Rural Africa," Food Research Institute Studies 16(2), November.

Leibenstein, Harvey. 1957. Economic Backwardness and Economic Growth, New York: John Wiley.

_____. 1974. "An Interpretation of the Economic Theory of Fertility: Promising Path or Blind Alley?" Journal of Economic Literature 12(2), June, pp. 457-79.

Maro, Paul S. 1974. Population and Land Resources in Northern Tanzania: The Dynamics of Change, 1920-1970, University of Minnesota, Ph.D. dissertation.

Morgan, Robert W. 1975. "Nigeria: Fertility Levels and Fertility Change," pp. 186-235 in John C. Caldwell, et al., eds., Population Growth and Socioeconomic Change in West Africa, New York and London: Columbia University Press, 763 p.

Mwakalasi, A.L. 1975. "Education and Population Change in Tanzania," pp. 43-48 in Social and Economic Development and Population Change in Tanzania, ed. J.E. Kocher, University of Dar es Salaam: BRALUP Research Paper No. 36.

Population Reference Bureau. 1977. World Population Data Sheet.

Preston, Samuel H. 1975. "Health Programs and Population Growth," Population and Development Review, 1(2), pp. 189-200.

Sanderson, Warren C. 1976. "On Two Schools of the Economics of Fertility," Population and Development Review 2(3 and 4), September/December, pp. 469-78.

Schultz, T. Paul. 1971. "An Economic Perspective on Population Growth," pp. 148-74 in National Academy of Sciences, Rapid Population Growth, Baltimore: Johns Hopkins Press.

_____. 1973. "A Preliminary Survey of Economic Analyses of Fertilty," American Economic Review 63(2), May, pp. 71-78.

_____. 1976. "Determinants of Fertility: A Micro-economic Model of Choice," pp. 89-124 in Ansley J. Coale, ed., Economic Factors in Population Growth, New York: Halsted Press.

Snyder, D.W. 1974. "Economic Determinants of Family Size in West Africa," Demography 11(4), November, pp. 613-27.

Tanzania, Government of. 1969. 1967 Population Census, Vol. 1: Statistics For Enumeration Areas, Dar es Salaam: Government Printer.

_____. 1971. 1967 Population Census, Vol. 3: Demographic Statistics, Dar es Salaam: Government Printer.

Teitelbaum, Michael. 1974. "Population and Development: Is a Consensus Possible?" Foreign Affairs 4(52), July, pp. 743-60.

Teitelbaum, Michael. 1975. "Relevance of the Demographic Transition Theory for Developing Countries," Science 188, May 2, pp. 420-25.

Thomas, I.D., and Mascarenhas, A.C. 1973. Health Facilities and Population in Tanzania, Part One: Hospitals in Tanzania and Population Within Given Distances of Their Sites, Dar es Salaam: BRALUP Research Paper No. 21.1.

Van Ginneken, Jeroen K. 1974. "Prolonged Breastfeeding as a Birth Spacing Method," Studies in Family Planning 5(6), pp. 201-06.

Ware, Helen. 1976. "Motivations for the Use of Birth Control: Evidence from West Africa," Demography 12(4), November, pp. 479-93.

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