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ECONOMICS OF FAMILY SIZE: THE CASE OF THE DEVELOPING
ECONOMIES OF KENYA AND NIGERIA

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ECONOMICS OF FAMILY SIZE: THE CASE OF THE DEVELOPING ECONOMIES OF KENYA AND NIGERIA

by

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Abstract

ECONOMICS OF FAMILY SIZE: THE CASE OF
THE DEVELOPING ECONOMIES OF
KENYA AND NIGERIA

by

Nnamdi Ken Amobi

Adviser: Professor Michael Grossman

In this thesis, models based on the theory of human fertility behavior pioneered by Becker and others, is constructed and tested in a multivariate context on survey data sets from Kenya and Nigeria. These models are however modified wherever possible to capture behaviors which are peculiar to the developing economies of Africa.

In these economies child rearing by the mother tends to be carried out simultaneously with labor market activities. Also parents transform part of their present income into future consumption opportunities by old age support from their children. Marriage patterns of polygamy exist and household units tend to have the extended-family influence.

Using static models, the effects on desired fertility of family income, duration of marriage, age of wife, education of wife, labor force participation of wife,

infant mortality, polygamy, sex composition of the family, and the interaction variable (of lifetime family income and value of wife's time) are investigated. In a simultaneous equations context the determinants of the quality and quantity of children are also investigated. A sequential model, in which the dependent variable becomes the additional number of children desired, is constructed and tested.

The following findings are noteworthy:

1. Family income exhibits a positive and strong influence on family size.

2. Education of the wife has a negative effect on fertility.

3. Duration of marriage has a positive influence on family size; while age of wife shows a positive effect on family size when duration of marriage is omitted.

4. Infant mortality rate has an inverse influence on fertility.

5. Polygamy has no significant effect on fertility.

6. As the proportion of sons increases family size increases thus indicating that the 'price' influence is stronger than the 'taste' influence of the sex composition of the family on fertility.

7. Migration; Family Planning Practices; and Separate Habitation of Married Couples all depress fertility.

8. The interaction variable of wife's education and lifetime family income has negative while the individual variables have positive effects on family size. Thus the interaction model explains the non-linear effects of family income and wife's education on fertility.

9. The income elasticity of quantity of children and the income elasticity of quality of children are both positive, but the former is larger.

10. From the sequential model analysis of additional number of sons desired, the motive of a least one son is found to be quite strong.

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Chapter I

INTRODUCTION

That family size responds to social and economic variables is common knowledge.[1] That the demographic transition which is being experienced in the more developed countries (and which is incipient in the less developed) has its roots in social and economic development is also generally accepted. However the exact underlying mechanisms and functional relationships are still debatable. Some scholars maintain that evolving social structures are the root cause of demographic change while others tend to favour the notion that the now more prevalent small family sizes are the consequence of rational optimising of household economic decisions. A third group of theorists believe that the access and knowledge of contraception is the dominating factor. In the developing economies of Africa this third view for the cause of the shrinking family size has had a great deal of influence in population policy. Family planning programmes have received great emphasis. Nevertheless people are beginning to realize, in these areas, that family planning will produce less than desired declines in fertility, if the demand for children

[1]See a United Nations publication: The Determinants and Consequences of Population Trends. United Nation, New York, 1973.

and quality of children are considered without regard to economic and social influences.

After that long spell during which population theory was more or less absent from economics (perhaps due to the apparent contradiction of the predictions of Malthusian Theory by empirical evidence), economists[1] have contributed significantly to the explanation of the determination of family size in developed countries.

Although a lot of work has been done on the economics of family size in developed countries employing modern techniques in microeconomics and multivariate analysis, very little has been done using African data sets. Often times, researchers have wondered whether the well-known theories of fertility and household economics would survive when tested with data from developing economies of Africa. The present study will attempt to answer such a question. In instances where these accepted theories have not been confirmed by African data, the effort herein will attempt to explain why, and perhaps modify the theories or develop appropriate alternative models.

Basic Model

In this study, the driving force is the theory of human fertility behavior pioneered by Becker (1960-1962) and

[1]Work by these economists include Becker (1960, 1962), Mincer (1962a, 1963), Easterlin (1969), Willis (1969, 1971), Becker & Lewis (1973).

Mincer (1962a, 1963), and further employed by Robert J. Willis (1972) and Yoram Ben-Porath (1973a). The household is the decision making unit which is assumed to maximize one intertemporal utility function composed of several commodities produced through their separate household function productions. These commodities are produced within the household from the application of time inputs (from husband and wife) and market inputs, and are consumed only by the household itself and not traded in the market. The utility maximization is, however, subject to constraints on available resources (money-income and time-budget constraints) and the ability to convert these resources into the components of the utility function (the household production-function constraint).

Static Models

In applying the above framework, we make further simplifying assumptions namely: analysis is confined to a single period, fertility decisions are made at the beginning of this period and adhered to right through the entire period. Consequently;

$U = U(N,Q,C)$ where N,Q,C represent commodities produced through the household production functions.

The production function of one child of quality Q is given by:

$$Q = F(Xq,Tq,e)$$

while the production function of parents standard of living, C, is given by

$$C = Gt(Xc,Tc,e)$$

where N is the number of children

Q is the quality[1] of children

C is the parents' own consumption or standard of living

X is market purchased goods

T is parents' time used in the production of the commodities

e is environmental variable to which the household is exposed[2]

Thus in the Static Model each household chooses the values of N,Q,C simultaneously and sticks to this choice thereafter.

Sequential Models

The Static Fertility Models can be useful in studying the determinants of fertility; however, they are mere simplifications of the behavior exhibited by many households.

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[1]Quality of children is defined as properties of children which yield utility (or disutility) to parents: Childs quality may be household-produced like health, intellectual development, school attainment, social adjustment, lifetime (future) income; however child's quality may also be endowed for example sex, natural intelligence, beauty. In this study emphasis will be placed on household-produced child qualities.

[2]The environmental variable, e, represents the level of technology utilized in household production functions. Thus the households produce these commodities with varying degrees of efficiency, and the efficiency is assumed to be strongly related to the environmental variables like parents' education, duration of marriage, age, religion, etc.

dynamic. These households continuously modify their fertility decisions during their childbearing years. For them the system is dynamic and exhibits feedback. The status of N,Q and C at any point in time is employed in rearranging previously desired levels of N, Q and C, by rearranging the variables which determine N, Q and C. The sequential models perhaps govern family size decisions in African economies more than in the developed countries. Motives of at least one boy or higher boy-to-girl ratios are quite prevalent in African fertility behavior.

In this present study, Sequential Models developed[1] by Welch and Ben Porath and Anne Williams will be the cornerstone.

Need for Adapted Model

It is true that the basic model, described above, has been applied with agreeable results in the developed economies, but caution should be exercised in using it or in interpreting its results when employed for the developing economies of Africa. In fact certain modifications might be necessary before applying it to Africa. The environmental variables would invariably need a lot of attention. Factors like the type of marriage (whether polygamous or monogamous) would affect family size in this case. Also factors like the type of marriage ceremony (whether Court,

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[1]See; Williams, Anne D. "Fertility and Reproductive Loss," Ben-Porath, Yoram and Welch, Finis "Do Sex Preferences Really Matter?" Quarterly Journal of Economics 90 (May 1976).

religious or traditional) and type of religion become relatively important in determining family size in these areas.

The basic model as applied in the developed countries, regards the quality of children as one of the commodities in the utility function of households, but although intergenerational transfers do occur, they are perhaps excessively discounted by young couples.[1] In the African setting intergenerational wealth flow from children to parents is common,[2] and therefore unless the basic model is modified[3] to take account of this phenomenon, a serious error is likely to arise in the analysis.

The production function for the number of children, and quality of children, uses time input of the mother or father as one of the important factors. In the developed countries mother's time input is very crucial, but in the developing countries, the use of time inputs of older children and other relatives as surrogate mothers is quite common. This could result in child rearing in these areas being relatively less intensive as to the mother's time.

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[1]This is perhaps because of programmes like 'welfare' scheme, Medicare, developed old age pension schemes, and retirement benefits.

[2]See John C. Caldwell, Introduction, The Persistence of High Fertility, part I.

[3]Dov Chernichovsky in Ph.D. dissertation, "Fertility Behavior in Developing Economics: An Investment Approach" develops and tests such a model.

To really capture the true effect of these surrogate mothers, the basic model needs to be modified.[1]

The work in this thesis is based primarily on the basic model as applied in the developed countries, to enable a means of discovering the differences in results that occur when model is now applied to developing countries. Minor modifications were also built into the basic model for analyses that are appropriate for developing economies alone.

Scope of Study

Analytical Techniques

This effort employs Multivariate Analysis (MVA). Multiple Regression Analysis is used primarily. Ordinary Least Squares Regressions are employed most of the time, although some Simultaneous Equations Models are constructed, and in those cases Two Stage Least Squares is the method of estimation used.

It is perhaps noteworthy that this study is among the few that employ MVA techniques on African Fertility data sets, and it should therefore provide interesting comparisons with previous similar studies, based on cross-tabulation

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[1]A reasonable modification would entail including the combined number of relatives and surrogate mothers as variables in the Quality and Quantity equations.

For a modified model see James L. McCabe and Mark R. Rosenzweig, "Female Employment Creation and Family Size," Population and Development: The Search for Selective Interventions (Baltimore: John Hopkins University Press).

methods. The pitfalls of cross-tabulation studies are obvious. Apart from the arduous task of wading through cross-tabulated data in hopes of finding significant correlations between explanatory variables and the dependent variable, the researcher is faced with the need to isolate the effects of large numbers of predictor variables, all acting at once.

The MVA technique is no doubt a more sensitive and superior method.

Models in this Study

The following classification of models were constructed.

1. Static-Single Equation: This model is a one period, static single equation model in which a dependent variable of interest (namely number of children) is modelled as a function of explanatory variables, all assumed exogenous. No feedback between the explanatory variables and the dependent variable is considered. In constructing such models the direction of causality between the dependent and explanatory variable is specified a priori. In this model parents plan completed fertility once and for all at the beginning of the reproductive period.

2. Static-Simultaneous Equations: This model is also a one-period static model in which the values of the current endogenous variables are determined once-and-for-all

at the beginning. However this model incorporates the simultaneous determination of the values of current endogenous variables. These values of course, will depend on on the values of the predetermined variables in the model. For example: although a child quality variable is used to determine desired fertility; desired fertility is also necessary in planning the level of child quality. In this model desired fertility and child quality are simultaneously determined.

3. Sequential-Single Equation: Sequential models make it possible to adjust future fertility for sex and other genetic features of quality of past births. For simplicity this model will be confined to a single equation with the explanatory variables all assumed exogenous.

Clearly, sequential models will best capture human fertility behavior. However, a lot of fertility studies have been based on static models because they are simple to apply and also it is easier to find appropriate data for testing them.

Data Quality and Source

An obvious difficulty encountered in embarking on this kind of study on African economies is the poor quality or non-availability of data. Census figures are also of poor quality. Below is an extract from a recent paper "Family Size Preferences and Fertility in South-Western Nigeria" written by Ghazi M. Farooq, I. I. Ekanem and M. A. Ojelade and published by the World Population Programme, ILO (May 1977).

Three censuses with complete coverage of the nation have been undertaken. Only the first census of 1952/53 provides a plausible age-sex structure for deriving indirect estimates or vital rates, although the total population was undercounted by about 10-15 percent. The 1973 census age reporting was found to be very erroneous. I. I. Ekanen, The 1963 Nigerian Census: A Critical Appraisal (Ethiopia, 1972, chap. 7). The most recent census of 1973 has been officially declared null and void following a controversy over the validity of very diverse population growth rates obtained from it from different regions of the country.

In the present work two cross-sectional household surveys are used as data sets. The first data set used is from the Kenyan Survey. This is a Knowledge Attitude Practice (KAP) survey carried out (1969-1970) among urban Kenyan families. This 'African Family Study' survey conducted in small cities of Mombasa, Kisumu, Nakura Thika, Eldoret, Nanyuki sponsored by the Population Council received institutional support from the Department of sociology and school of Medicine both of the University of Nairobi, Kenya. The survey was supervised by Dr. Charles Ejiogu. In this survey the respondent is the married woman (ages from 15 to 50) in approximately 1,000 different households.

The second data set used is the Nigerian survey. This is also a KAP survey, "The Changing African Family Nigerian Segment-Project 1: The Beginning of Family Limitation." This survey, conducted in 1973, was funded by the Population Council and the Australian National University. It received institutional support by the Department of Sociology University of Ibadan, Nigeria and was directed by John C.

Caldwell. This is an urban survey covering the Greater Ibadan City, in Western Nigeria. The respondent are Yoruba tribe females, 15-59 years of age, in approximately 1,000 different households.

Empirical Analysis

The following chapter of this thesis is based on the static basic model using the Kenyan data set. The demand function for number of children discussed earlier is estimated using Ordinary Least Squares method. Here the different permutations of this basic model are investigated using the different environmental variables like type of marriage (whether polygamy or monogamy), knowledge of family planning, and sex of existing children. This chapter also tests the Willis Interaction model and demonstrates that this hypothesis is supported using an African data set.

Chapter 3 delves into the Basic Static Quality Models and Quality/Quantity Models involving both the Ordinary Least Squares and Two Stage Least Squares estimation methods. The data used is Kenyan. Also, using this data set a modified sequential model is estimated to explan the determinants of the additional number of children desired, and the additional number of sons desired. In this chapter, the importance of the motive of having at least one son for family size is investigated.

Chapter 4 returns to the Basic Static Quantity models with alternative specifications due to the inclusion of other environmental variables like type of religion, and type of living arrangement of husband and wife (i.e. whether they live together or apart). The data utilized in chapter 4 is the Nigerian data set. The results of chapter 4 are also stronger than those of chapter 2 due mainly to the better quality of the Nigerian data.

Chapter II

DETERMINANTS OF FAMILY SIZE--KENYAN DATA SET

The object of this chapter is to construct and test a model necessary for obtaining the determinants of family size and estimate how significant they are. The determinants being referred to here are non-physiological, namely the economic, social and cultural factors.

One handicap of the data set used in this study is the lack of several important variables. To improvise, proxy and dummy variables have been employed where necessary.

Although the basic static model is specified using 'desired' family size, number of children ever born, B, and number of children surviving, N, are used as proxies.

A table of the variables used and their statistical analyses is given in table 1.

In this study, D, number of dead children, is the number of infants dying before one year of age.[1] It is not uncommon to find errors in this variable, for many African women loathe to talk about their dead children. Some even forget or refuse to count them. MRI, the

[1]There is a problem in ascertaining that this variable does not include foetal deaths. We can only hope that foetal deaths do not count, since it is not uncommon to ignore foetal deaths in the African tradition because many believe life does not begin until the child is successfully born.

TABLE 1

MEANS, STANDARD DEVIATIONS AND VARIANCES OF VARIABLES[1] USED IN REGRESSIONS--KENYAN DATA SET

Variable	Mean	Variance	Standard Dev.
AW	31.93	248.18	15.75
AWEW	71.75	1934.80	43.97
B	2.98	5.93	2.43
D	0.38	1.01	1.01
DEW	0.32	0.22	0.47
DEW1	0.61	0.23	0.49
DEW3	0.002	0.002	0.04
DFFP	0.46	0.25	0.50
DFPL	0.52	0.25	0.50
DLFWAM	0.19	0.16	0.39
DMIGR	0.72	0.20	0.45
DMIGU	0.28	0.20	0.44
DNOSON	0.28	0.20	0.45
DPGMY	0.12	0.11	0.32
DPW2	0.11	0.10	0.32
EHX	7.18	10.95	3.31
MD	12.48	463.11	21.52
MRI	0.11	0.15	0.39
N	2.60	5.98	2.45
Q	16.50	7.23	2.69
Y	3.85	1.95	1.40

[1]For description of variables see appendix 2.

infant mortality rate, has been calculated here as the ratio of dead infants to number of children ever born.

Basic Quantity Model

From the household production function

$Q = f(X,T,e)$, and utility function

$U = U(N,Q,C)$,

the model $y_j = \beta_0 + \sum_{i=1}^{m} \beta_i X_{ij} + u_j \qquad (j = 1, \ldots n)$

is constructed. In this model, y_j is either the number of children ever born or the number of children surviving.[1] The vector X_j is established by a priori theoretical considerations including variables that capture purchased inputs, time inputs of parents and environmental variables. $\{ u_j\}$ is the vector of error terms. The equation is for the jth household where there are n households.

The following two equations were estimated. These follow directly from the Basic Quantity Model.

$$B = b_0 + b_1 D + b_2 AW + b_3 MD + b_4 DEW + b_5 DLFWAM + b_6 DPGMY + b_7 Y \quad \ldots\ldots (1)$$

$$N = b_0 + b_1 MRI + b_2 AW + b_3 MD + b_4 DEWI + b_5 DLFWAM + b_6 DPGMY + b_7 Y \quad \ldots\ldots (2)$$

---

[1]The variable 'desired' family size is obviously most appropriate here, since the model is a static one. However, the data does not contain this variable. 'Desired' family size is generally difficult to observe.

The results of an OLS Regression on equations (1) and (2) above is given in table 2. The results are basically similar. The difference in specification lies in using number of dead children, D, as an explanatory variable when the number of children ever born, B, is the dependent variable and substituting D for infant mortality rate, MRI, when number of surviving children, N, is the dependent variable. The results are generally as expected and significant. The only grossly insignificant explanatory variable is the dummy variable for the labour force participation of wives, which is also not surprising. This result will be discussed later in this chapter.

Effect of Income

The basic model predicts a positive 'true' income effect on fertility. This is particularly so in Africa, where in contrast to more developed economies, family size is deemed somewhat more important than wealth. There is an Ibo tribe proverb which has it that the larger family has the bigger influence in society. Second, parents are assumed to use children as a source of old age pensions by transferring part of their present income into future consumption opportunities to be provided through support by their children.

The 'observed' income elasticity of quantity of children is predicted by the basic model to be usually very small and positive or sometimes even negative.[1] This

[1]For more details see appendix 3.

TABLE 2

OLS REGRESSION COEFFICIENTS--KENYAN DATA SET
(t-STATISTIC IN PARENTHESES)

Explanatory Variable	Dependent Variable, B (Children Ever Born)	Dependent Variable, N (Children Surviving)
D (infant deaths)	0.35487 (3.7983)	--
MRI (infant mortality rate)	--	-1.9619 (-8.2338)
AW (Wife's Age)	0.02469 (3.8006)	0.02299 (3.6379)
MD (Marriage Duration)	0.02318 (5.1244)	0.02114 (4.7527)
DEW (dummy for wife who has at least secondary education)	-0.70234 (-3.0748)	-0.67417 (-3.0003)
DLFWAM (dummy for wife who worked after marriage)	0.13345 (0.5159)	0.10132 (0.3977)
DPGMY (dummy for polygamous household)	-0.28459 (-1.3872)	-0.33723 (-1.2024)
Y (family income)	0.15394 (2.1400)	0.16137 (2.2783)
Constant	1.5133 (4.3940)	1.42925 (4.2195)
R^2	0.149	0.183
F-Statistic	14.83	18.93
Number of Observations	600	600

prediction would seem to have been confirmed in this study.[1] The income elasticity of family size in equation (1) above is positive (0.198). The income coefficient is positive indicating a positive income effect on family size. This finding is in consonance with evidence in less developed countries. In these economies correlation between family size and income is positive and rather stronger,[2] for reasons mentioned earlier. Although results depend on the specification of the model, the following results about the effect of income on family size have been reported. Rele reported lower fertility rates among lower income groups in an analysis involving caste schedules (which in general account for variation in social-economic status) in India.[3] Kogut reported a positive, though weak, income effect on fertility in a Brazilian study.[4] Dov Chernichovsky found a positive

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[1]To state categorically that the prediction of the basic model has been confirmed, we have to show that the true quality income elasticity is greater or equal to the true quantity income elasticity.

[2]The following authors report stronger correlation between family size and income in developing economies: I. I. Ekanem, "A Further Note on the Relation Between Economic Development and Fertility," Demography, Vol. 9, No. 3 (August 1972), and David M. Heer, Society and Population (New York: Prentice-Hall, Inc., 1968), pp. 59-60.

[3]Rele, "Fertility Differentials in India."

[4]Kogut, Edy Luiz, "The Economic Analysis of Fertility: A Study for Brazil." World Employment Programme, ILO, Working Paper, No. 7, September 1974.

income effect on fertility using data from two Indian villages.[1] Nerlove and Schultz using a Two Stage Least Squares estimation method on a Puerto Rican data set obtained a strong positive influence of income on crude birthrate, as a proxy for fertility rate.[2] Farooq, Ekanem and Ojelade, reported an inverse relationship between fertility rate and income,[3] in a cross tabulation analysis, using data from the 1971 Survey of Fertility, Family, and Family Planning in Nigeria. This survey received institutional support from the University of Ife. However, they attributed their somewhat surprising result to the fact that wife's own income is larger than husband's income in the reported household income.

In some studies, it has been found that income has a negative,[4] or zero effect[5] on family size; and a reason for this can be found in appendix 3. But in most cases

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[1]Dov Chernichovsky, "Fertility Behavior in Developing Economies: An Investment Approach" (unpublished Ph.D. dissertation, Dept. of Economics CUNY Graduate Center).

[2]Marc Nerlove and T. Paul Schultz, Life and Love Between the Censuses: A Model of Family Decison-Making in Puerto Rico, 1950-1960 (Rand, Santa Monica, Ca., September 1970), p. 45.

[3]Farooq, Ghazi M., I. I. Ekanem and M. A. Ojelade, "Family Size Preferences and Fertility in South-Western Nigeria," World Employment Programme, WEP2-21/WP.54.

[4]Work based on Philippine data. World Bank, Population Policies and Economic Development (Johns Hopkins, Baltimore, 1974), p. 47.

[5]Driver, E. Differential Fertility in Central India, (Princeton, N.J., Princeton University Press, 1963), p. 96.

observed income elasticity of family size in developing economies is positive, and this would seem to be borne out by the Kenyan data set which I have used.

Effect of Wife's Education

An important determinant of family size is educational attainment of the mother. Following the underlying assumption that market wage of mothers correspond to their education level, and that child production makes use of mother's time, the Basic Model postulates that mother's education should have a negative impact on fertility due to the price effect associated with increasing mother's time in market activities.[2] Other behavioral effects affecting this phenomenon are: reflection of substitution of quality for number of children and better knowledge and practice of contraception. While the Willis Interaction Model[1] agrees with the above postulate, it implies that it is mostly true at the lower level of education of mothers. The Willis Interaction Model explains[3] why a U-type effect of wife's education on family size is possible. Thus whereas additional schooling has a negative effect on family size at lower levels of mother's education, at higher levels additional education could have a positive effect on family size.

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[1]Robert J. Willis, "Economic Theory of Fertility Behavior," Economics of the Family, Marriage, Children & Human Capital, ed. T. W. Schultz, pp. 25-75.

[2] Id.

[3]Ibid., p. 58 and p. 63.

The U-type effect of wife's education on fertility was reported by Ben Porath using data from Israel; and Kogut[1] using data from Brazil.

T. Paul Schultz in an analysis of fertility in rural Egypt found no differentials in fertility among various educational classes.[2] Dov Chernichovsky[3] found no effect of mother's literacy in one village of India.

Zikry[4] using a United Arab Republic census data found an inverse relation between educational attainment of women and fertility. Also Farooq, Ekanem and Ojelade (op. cit.) in a cross-tabulation analysis reported a negative effect.

Evidence in Present Study

In the present study, wife's education is entered as a 2-category dummy variable. DEW takes the value 1 for wives with at least secondary school education (which is about thirteen years of formal schooling) and zero otherwise.

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[1]Kogut, op. cit.

[2]T. Paul Schultz, Fertility Patterns and Their Determinants in the Arab Middle East, RM-5978-FF (Santa Monica, Calif.: Rand Corp., 1970).

[3]Dov Chernichovsky, op. cit.

[4]Zikry, Abdel-Khalik Mo, Fertility Differentials of U.A.R. Women. Paper No. 201 presented at the United Nations World Population Conference, Belgrade, 1965, 9 P-(WPC/WP201).

The Kenyan data set is taken from an urban survey. Sixty-one percent of the respondents have at least elementary school education (about six years of formal schooling) while 32 percent have at least secondary school education. Less than one tenth of 1 percent have university education and less than 6 percent have less than elementary school education. There are therefore two main categories: wife with at least elementary but not completed secondary and those with at least secondary education.

The result of equations (1) and (2), tablulated in table 2, show a negative effect on fertility for higher educational attainment of women.

The data in this study does not allow for the investigation of the U-type effect of wife's education on family size. But the prediction of the Basic Model is once again confirmed here: wife's education has an inverse relationship with family size according to Kenyan data.

Effect of Labor Force Participation of Wives

Labor force participation rate of married women (LFPRW) has been on the increase in the twentieth century in both developed and developing countries.

Incorporating the assumption of causality from LFPRW to fertility in the Basic Model, this model predicts an inverse relationship between these two variables.[1]

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[1]Michael, Robert T., "Causation Among Socioeconomic Times Series." NBER Working Paper No. 246, May, 1978.

And numerous studies have confirmed this.[1] However this inverse relationship has been found to be more pronounced in the industrialized than in the non-industrialized countries.[2]

McCabe and Rosenzweig[3] explain why a positive relationship might in fact exist between LFPRW and family size in developing economies. They argue that in those areas, compared with developed economies, child production is likely to be far less intensive in mother's time. This, they say, is due to the use of older children and relatives as surrogate mothers and also the compatibility of certain occupations with household child production (which allow for simultaneous labor market activity and child rearing). In their model, an increase in the wife's wage rate will decrease the price of children relative to prices of other household commodities if children are less intense in wife's time. This substitution effect will increase family size. Also the associated income effect due to this increase in wife's wage rate will increase family size

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[1]Works by Vostrikova (1967), Henripin (1968), Collver (1968) and Langlois (1967).

[2]See Jaffe, Abram J. and K. Azumi. "The Birth Rate of Cottage Industries in Underdeveloped Countries," Economic Development and Cultural Change 9 (October 1970): 52-63. Also see works by Gendell, Maraviglia, and Kreitner (1970) on Guatemala and Miro and Mertens (1968).

[3]James L. McCabe and Mark R. Rosenzweig, "Female Employment Creation and Family Size," Population and Development: The Search for Selective Interventions, ed. Ronald G. Ridker, pp. 332-52.

as a result of increased full income. Thus an exogenous rise in wife's wage rate, which will invariably increase LFPRW, will also unequivocally increase family size if children are less intensive in mother's time. Hence a positive relationship between LFPRW and family size! Using a 1970 survey data for Puerto Rico, McCabe and Rosenzweig (op. cit.) reported a postive relationship between LFPRW and family size. Also Bindary, Baxter and Hollingsworth (1973),[1] and Goldstein (1972)[2] obtained the same results for urban Egypt and rural Thailand respectively.

Farooq, Ekanem and Ojelade,[3] in cross-tabulation analysis on a household survey data from South-West Nigeria concluded that there is no significant relationship between LFPRW and fertility.

Evidence from Kenyan Data

The effort herein showed a positive relationship between LFPRW and family size. However the estimated coefficient is not significant.[4] It is not surprising

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[1]Bindary, Aziz, Collin B. Baxter and T. H. Hollingsworth, "Urban-Rural Differences in the Relationship Between Women's Employment and Fertility: A Preliminary Study," Journal of Biosocial Science 5 (April 1973):159-67.

[2]Goldstein, Sidney. "The Influence of Labour Force Participation and Education on Fertility in Thailand," Population Studies 26 (November 1972):419-36.

[3]Farooq, Ghazi M., I. I. Ekanem and M. A. Ojelade, op. cit., p. 28.

[4]See table 2.

that the relationship obtained is positive. Only 20 percent of married women in the sample are employed in the labor market and at least 88 percent of these working wives were employed as craftspersons, household workers (maids, cooks, etc.) and farm workers. It is therefore conceivable that their type of work in addition to the widespread use of older children and relatives as surrogate mothers helped to make child rearing less intense in a wife's time.

An obvious conclusion regarding LFPRW using Kenyan data is that LFPRW is not inversely related to family size. It is only appropriate to conclude from the results of the regressions that LFPRW has no significant influence on family size.

Effect of Child Mortality

This section seeks to investigate the effect of infant or child mortality on family size. Infant mortality is generally defined as deaths occurring before one year of age while child mortality refers to deaths in the entire childhood period extending to the age of eighteen. Oftentimes, child mortality is loosely substituted for infant mortality since infant mortality makes up approximately 85 percent of child mortality.[1]

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[1]See table on Age-specific death rates for male and females in selected countries in The Determinants and Consequences of Population Trends, vol. 1, United Nations, 1973, p. 119.

The effect being investigated is primarily the behavioral or demand effects of child mortality on desired family size as opposed to the biological or supply effects. For this work, it is assumed that family size is not affected by fecundity (biological effects) because empirical evidence suggest that biological effects are not important.

The Basic Model cast in a single period risk-neutral framework[1] predicts that a positive relationship[2] will exist between number of children ever born and child mortality if the demand for surviving children is price-inelastic. This same model also predicts that the child mortality rate is inversely related to the number of surviving children.

Donald O'Hara[3] has shown why it is possible to have a positive relationship between number of surviving children and child mortality. He shows that lower mortality might, through investment in human capital, cause a shift from quantity towards quality of children if quantity and quality are good substitutes.

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[1]For discussion on a risk and uncertainty model see: Paul T. Schultz, "Interrelationships Between Mortality and Fertility," Population and Development: The Search for Selective Interventions, ed. R. G. Ridker, pp. 239-87. Also for a discussion on a sequential model see: Donald J. O'Hara, "Mortality Risks, Sequential Decisions on Births, and Population Growth," Demography 9 (August 1972): 285-98.

[2]For detailed analysis of this prediction see appendix 4.

[3]O'Hara, Donald J., "Changes in Mortality Levels and Family Decisions Regarding Children," The Rand Corporation R-914-RF (Santa Monica, Calif. 1972).

Empirical Evidence: Elsewhere

Snyder (1974) using a 1966-68 sample of 717 married women ages 15-49 in Sierra Leone obtained an elasticity of Completed Fertility[1] with respect to own child mortality (measured by the reciprocal of the survival rate) greater than one. This study confirms a positive relationship between number of births and child mortality.

Using 1960 census figures, DaVanzo (1972) also obtained a similar positive relationship between completed fertility and infant mortality for Chile.

T. Paul Schultz (1973) found a positive relationship between age-specific birth rates and reciprocal of child survival rate in a Taiwan study.

Empirical Results in Present Study

The results are given in table 1. Number of children ever born is positively related to the number of dead infants, whereas number of surviving children is negatively related to ratio of infant mortality (MRI). In this study MRI is ratio of dead infants to number of children ever born[2]. The relative coefficients in the regressions

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[1]Completed Fertility is defined the cumulative fertility of a cohort at the time when all its living members (in the case of a birth cohort) or its youngest living members (in the case of a marriage cohort) reach the end of the reproductive period.

[2]Infant mortality rate is usually calculated as the number of deaths occurring to infants under one year of age in a given calendar year per 1,000 live births in the same year.

reported in table 1 are both significant at the 5 percent significance level.[1] The influence of child mortality on family size in the Kenyan data set consequently conform to the predictions of the Basic Model.

Effect of Duration of Marriage

One of the principal determinants of family size is the duration of marriage (MD). The longer the duration of marriage during the reproductive period, the more the number of children born.

In a Brazilian Study by Kogut (op. cit.) duration of marriage is not only found to be positively related to family size, but it is the most significant explanatory variable.

In the present study duration of marriage[2] is positively related to family size and also is the most significant explanatory variable. It is however noteworthy

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[1]The results of table 1, show that at a 5 percent significance level, the coefficient of infant deaths (D) is significantly less than one. Thus the coefficient of D is biased towards zero, if there is measurement error (omissions) in D. The coefficient of the infant mortality rate (MRI, which is D/B) is biased away from zero when the dependent variable is number of surviving children (N, which is B-D). This means that if D is too small, B-D is too large. However this problem is alleviated when then there is measurement error in same direction in both B and D.

[2]If it is desired to incorporate the natural life cycle effects on fertility, the natural logarithm of duration of marriage (in MD) should be used instead of MD. This in MD form, assumes that the timing of children is concentrated at earlier stages of the marriage.

that whereas family size is the number of surviving children from all marriages, the duration of marriage refers to the duration of the current marriage. This could produce some inconsistency in the analysis. But since incidence of divorces and remarriages is quite low in this data set, any inconsistency is greatly attenuated.

Age at marriage is another variable that has an appreciable effect on family size. The age at marriage exerts a negative effect on family size, since for a given duration of marriage, younger women would have to marry earlier and in effect have a longer reproductive span.

The effect of age at marriage on family size is stronger in the high-fertility developing countries than in the low-fertility developed countries.[1]

For the Kenyan Study undertaken in this chapter the available variable is the age of women at survey time, not the age at marriage. The prediction of the Basic Model calls for an inverse relationship between current age of wife and family size, for a fixed duration of marriage. (See appendix 1.) It is therefore surprising to find according to table 2 that the coefficient of AW (age of woman at survey time) is positive. The only plausible

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[1]Leasure J. William, "Malthus, Marriage and Multiplication," Milbank Memorial Fund Quarterly 41 (October 1967):419-35. Ascardi, Gyorgy, "Demographic Variables as a Source of Differences in the Fertility of Low Fertility Countries," United Nations: Proceedings of the World Population Conference 2 (1965):181-85.

explanation would be serious error in reporting this variable. The coded data is a combination of what the respondents remember of their age and what the interviewers estimate. This variable cannot be relied upon.

Effect of Polygamy

One of the environmental variables in the Basic Model, which is believed to affect fertility in developing countries (where this type of marriage pattern is practiced) is polygamy. Polygamy is the marriage of one man to more than one wife.

This pattern of marriage often begins by a man marrying his first wife and then later acquiring other wives. Usually new wives are younger than existing ones. Younger ones tend to spend more mating-time with their husbands than the older wives. The fertility of the polygamous male is generally proportional to the number of available wives. There is however no special selection of more fertile men (or women) into polygamy. The household task distribution is a hybrid of collective and parallel enterprises, however it is weighted more towards the former. There is expense sharing for main household transactions. In most part the wives help each other in childrearing activities.

African polygamous families will normally have anywhere from two to seven wives. An average of three wives per polygamous family may be prevalent in different communities.

There is no evidence that contraceptive use have different efficiency in polygamous families as compared with monogamous ones.

The general expectation is that polygamy reduces fertility, the reason being the apparent lower coitus rates per wife and the probable stricter observance of sexual abstinence customs. This hypothesis of inverse relationship between polygamy and family size has been supported by Lorimer (1954) and Culwick and Culwick (1939). Other researchers[1] like Muhsam and Dorjahn have arrived at similar conclusions. It is also noteworthy that data[2] in a 1968 Economic Commission for Africa (ECA) regarding eight African countries seem to confirm the above hypothesis.

On the contrary however, two Nigerian researchers[3] working with survey data from different parts of the country do find seemingly alarming results: that fertility appears to be positively related to polygamy.

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[1]See H. V. Muhsam, "Fertility of Polygamous Marriage," Population Studies 10 (July 1956):3-16 and Vernon R. Dorjahn, "Fertility, Polygamy and Their Interrelations in Temne Society," American Anthropologist 60 (October 1958):838-60.

[2]The data referred to is in Demographic Handbook for Africa (UN, 1968), pp. 83-84, table 18.

[3]Works of these researchers are as follows: P. O. Ohadike, "A Demographic Note on Marriage, Family and Family Growth in Lagos, Nigeria," The Population of Tropical Africa, eds. J. C. Caldwell and C. Okonjo (Longmans Green and Co., 1968), pp. 379-92. P. O. Olusanya, "The Problem of Multiple Causation in Population Analysis with particular reference to the Polygamy--Fertility Hypothesis," Sociology Review 19 (May 1971):165-78.

I. I. Ekanem in a study[1] utilizing data from Eastern Nigerian however reached a conclusion different from all of the above. He writes; "there seems to be no statistically significant difference between the fertility of the two groups of women," referring of course to women from monogamous and polygamous marriages. "There is only some apparent difference--the monogamously married women appear to be slightly more fertile."

Empirical Evidence in Present Study

Using the Kenyan data the relationship between family size and Polygamy is modelled[2] in equations (1) and (2), with results outlined in table 2. Although the coefficient of DPGMY (dummy variable for group of wives in polygamous families) is negative and therefore suggests an inverse relationship between fertility and polygamy, the inescapable conclusion is that polygamy does not affect family size significantly. The coefficient of DPGMY variable in these two regressions, and for all other regressions using the Kenyan data set, is not significant at the 5 percent level of significance. This finding tends to concur with the result of Ekanem discussed above.

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[1]I. I. Ekanem, "Correlates of Fertility in Eastern Nigeria," The Nigerian Journal of Economic and Social Studies.

[2]The unit of observation for testing this model is still the married woman.

Family Size and Sex Composition

This section seeks to investigate the effect of sex composition on family size. Sex composition is postulated[1] to influence family size in two ways: as a taste phenomenon and as a price-effect mechanism. The taste influence of sex composition of families may take the forms of at least one boy, at least one girl, more boys than girls or a balanced composition. The sex difference in economic costs and benefits on the other hand, does provide a price-effect influence of sex composition of family size.

Ben Porath and Welch (op. cit.) have shown that (a) "a concern for the sex of children, which is rooted in tastes, would generate higher fertility among those who were unlucky in the past, assuming inelastic demand and mild learning," and (b) "a lower 'price' for boys (girls) will tend to create a direct relationship between the propensity to have more children and the proportion of boys (girls) in previous births." They went on to state that in "societies where the differential market productivities of boys (men) and girls (women) are important and children play an important economic role in the family," the price-effect mechanism would blur the taste phenomenon or even dominate it. Their model predicts that the taste phenomenon becomes

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[1]See Ben Porath, Yoram and Welch, Finis, "Do Sex Preferences Really Matter?" Quarterly Journal of Economics 90 (May 1976) and the references cited therein.

more important in developed societies "where children are desired mostly as consumption goods and where 'prices' (of both boys and girls) are more equalized."

It therefore follows that price-effect influences of sex composition on family size would be expected in studies involving data from developing African countries. Robert Repetto in a 1972 study[1] involving data from Bangladesh and Morocco found a positive relationship between total live births and the ratio of living sons to surviving children.

Evidence from Studies Herein

In the Kenyan Study PROPS (proportion of sons) is the ratio of the total number of sons born to total number of children born. The result of three Ordinary Least Squares results on the subject is reported on table 3. The regressions were run on the following equations:

$$N = b_0 + b_1MRI + b_2AW + b_3MD + b_4DEW + b_5DLFWAM + b_6DPGMY + b_7Y + b_8PROPS \quad ..... \quad (3)$$

$$N = a_0 + a_1MRI + a_2AW + a_3MD + a_4DEW + a_5DLFWAM + a_6DPGMY + a_7Y + a_8DNOSON \quad ..... \quad (4)$$

$$B = c_0 + c_1D + c_2AW + c_3MD + c_4DEW + c_5DLFWAM + c_6DPGMY + c_7Y + c_8DNOSON \quad ..... \quad (5)$$

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[1]The study referred is contained in Repetto, R., "Son Preference and Fertility Behavior in Developing Countries," Studies in Family Planning 3 (April 1972).

TABLE 3

COEFFICIENTS FROM OLS REGRESSIONS WITH NUMBER OF SURVIVING CHIDREN (N) AND NUMBER OF CHILDREN BORN (B) AS DEPENDENT VARIABLES (t-RATIOS IN PARENTHESIS)

	N	N	B
MRI (infant mortality rate)	-2.3107 (-11.3335)	-2.1379 (-8.9212)	-- --
D (No of dead infants)	--	--	0.2439 (3.0135)
AW (age of wife at survey time)	0.0164 (3.0402)	0.0227 (3.6353)	0.0150 (2.7116)
MD (duration of marriage)	0.0138 (3.6322)	0.0209 (4.7628)	0.0164 (4.1789)
DEW (dummy variable for wives with at least secondary education)	-0.7431 (-3.8888)	-0.7303 (-3.2827)	-0.7744 (-3.9312)
DLFWAM (dummy for working wives)	0.1522 (0.7026)	0.1307 (0.5188)	0.1888 (0.8465)
DPGMY (dummy for wives in polygamous household)	-0.2387 (-0.7478)	-0.3821 (-1.3777)	-0.2504 (-1.0197)
Y (family income)	0.0932 (2.5436)	0.1619 (2.3130)	0.0861 (1.3850)
DNOSON (dummy for families with no son)	-2.6661 (-15.1011)	--	-2.6017 (-14.3356)
PROPS (proportion of sons)	--	0.70281 (3.9299)	--
Constant	2.7759 (9.2078)	1.1506 (3.3634)	2.8418 (9.1365)
R-squared	0.41	0.21	0.37
F-Statistic (8,591)	51.43	18.90	43.15
Number of Observations	600	600	600

PROPS exhibits a strong positive relationship to number of surviving children. This empirical result is akin to that obtained by Repetto for Bangladesh and Morocco and seem to confirm the Ben Porath hypothesis of the price-effect influence of sex composition of the family. Because in the developing economies of Africa the economic benefits of boys do make the 'price' of boys lower than that of girls, the higher the proportion of sons the higher the demand for children.

Equations (4) and (5) with results on table 3, is an attempt to test the taste phenomenon of 'at least one son.' It was found that the group of households with no sons (grouped by the dummy variable DNOSON) showed a lower family size. A fair interpretation of this result can only mean that even if this taste influence is true for the Kenyan survey, the stronger price-influence of higher proportion of sons has dominated the former.

A word of caution is appropriate here; the model in this section is only a simple one-period static model A sequential model should be more appropriate. Also the completed family size is not the only important decision variable, the timing of births is also crucial to the more appropriate dynamic model. An attempt at such a sequential/ dynamic model is contained in the following chapter.

Willis Interaction Model

Robert J. Willis in his "Economic Theory of Fertility Behavior" developed a Mixture Model[1] for the demand for fertility. A slightly modified version of the Willis Mixture Model is as follows: for non-working women;

$$N = a_0 + a_1 H \quad \ldots\ldots \quad (6a)$$

for working women

$$N = b_0 + b_1 H + b_2 K \quad \ldots\ldots \quad (6b)$$

and

$$L = c_0 + c_1 H + c_2 K \quad \ldots\ldots \quad (6c)$$

where

N = fertility demand

H = lifetime family income

K = value of wife's time

L = probability that wife works

In equations 6a, 6b and 6c: $a_1 > 0$ due to the effects of income on family size in developing economies as outlined earlier in this chapter.

$b_1 > 0$, $b_2 > 0$ and $|a_1| > |b_1|$;

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[1]For details of the Mixture Model see Robert J. Willis, "Economic Theory of Fertility Behavior," <u>Economics of the Family Marriage, Children & Human Capital</u>, ed. T. W. Schultz, pp. 52-64.

$|b_1| > 0$ due to effects of income on family size; however, the magnitude of this effect is somewhat attenuated in families where wife works, hence $|a_1| > |b_1|$. $b_2 > 0$ because a rise in wife's wage rate is more likely to increase family size in developing economies as outlined earlier in this chapter in the discussion of labor force participation rate of wives.

$c_1 < 0$, since the probability of wives working is higher when family income is low.

$c_2 > 0$ is obvious. Wives are more likely to work when the value of their time in the labor market are higher.

By combining equations 6a, 6b and 6c we obtain the Mixture Model given below:

$$E(N) = (1 - L)\ (a_0 + a_1H) + L(b_0 + b_1H + b_2K)$$

which can be written as:

$$N = d_0 + d_1H + d_2K + d_3HK + d_4H^2 + d_5K^2 + u \quad ..... \quad (6d)$$

where

$$d_0 = c_0b_0 + a_0(1 - c_0) \gtrless 0$$

$$d_1 = c_0\ (b_1 - a_1) + (b_0 - a_0)\ c_1 + a_1 \gtrless 0$$

$$d_2 = c_0b_2 + (b_1 - a_1)\ c_2 \gtrless 0$$

$$d_3 = c_1b_2 + (b_1 - a_1)\ c_2 < 0$$

$$d_4 = (b_1 - a_1)\ c_1 > 0$$

$$d_5 = c_2b_2 > 0$$

There are no a priori expectations for the signs of d_0, d_1, and d_2, but theory does predict a priori expectations of signs for d_3, d_4 and d_5 as indicated above.

Note however that the Willis Mixture Model constructed here for a developing economy does lead to signs of the quadratic terms and interaction term which are opposite to those for developed economies.

To simplify empirical analysis the truncated Mixture Model given below in equation (6e) is used.

$$N = d_0 + d_1 H + d_2 K + d_3 HK + u \quad \ldots\ldots \quad (6e)$$

where u is the error term. This is the Willis Interaction Model.

Regardless of the signs of d_1 and d_2, d_3 (the coefficient of the interaction term) would be determined a priori. Using data from the USA 1960 Census 1/1000 sample, Prof. Willis obtained an empirical result which confirmed the above hypothesis. In that study, husband's income (H) is used to measure lifetime family income while wife's years of schooling (ED) is used to measure K. He found that both d_1 and d_2 are negative while d_3 is positive.

$$\frac{\partial N}{\partial H} = d_1 + d_3 ED \quad \ldots\ldots \quad (7)$$

$$\frac{\partial N}{\partial ED} = d_2 + d_3 H \quad \ldots\ldots \quad (8)$$

Thus because d_3 is opposite in sign to both d_1 and d_2, equations (7) and (8) help explain the possibility of a U-type relationship between fertility and family income and also between fertility and wife's education.

Evidence from Kenyan Data Set

The result of an attempt to investigate the Willis Interaction Model is given in table 4.

In this framework, EW, the number of wife's years of schooling is used as a proxy for K in equation (6). EH, the number of husband's years of schooling, is used to measure lifetime family income.

The coefficient of EW is positive[1] and significant at the 5 percent level of significance. This result is not surprising for the set of data being used. This is data from a developing country. Since child production is not as intensive in wife's time as in the developed countries (for reasons discussed earlier) the coefficient of EW is not negative but positive.

The coefficient of EH is also positive. EH, husband's years of schooling, is a good proxy for family income. Family income has been found, using this data set, to have a positive effect and the explanation for this has been given earlier in the chapter.

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[1]The coefficient of the corresponding variable, DEW is negative when the interaction variable EHEW is omitted. See tables 2 and 3.

TABLE 4

COEFFICIENTS FROM OLS REGRESSION WITH NUMBER OF CHILDREN BORN (B) AS DEPENDENT VARIABLE (t-RATIOS IN PARENTHESIS)

D (No. of dead infants)	0.3725 (3.9483)
AW (Age of wife at survey time)	0.0257 (3.8725)
MD (duration of marriage)	0.0246 (5.4876)
EW (years of wife's schooling)	0.5116 (2.7537)
EH (years of husband's schooling)	0.3009 (2.7537)
EHEW (interaction variable)	-0.1384 (-3.4058)
Constant	0.7386 (1.4857)
R-squared	0.148
F-Statistic (7,592)	14.73
Number of observations	600

The interesting finding is therefore that the coefficient of the interaction variable, EHEW, is negative, according to an a priori determination by the mixture model. Also sign of EHEW is opposite to those of EW and EH. This conforms with the empirical results obtained by Willis while employing the Interaction Model.

This evidence from the interaction model using Kenyan data shows that:

$$\frac{\partial B}{\partial EW} = a_1 + a_3 \text{ EH} \qquad \ldots\ldots \qquad (10)$$

where $a_1 > 0$ and $a_3 < 0$

The coefficient of DEW in equations (1) and (2) is negative. That is, for the group of families with wives having at least secondary school education family size is smaller. A plausible reconciliation of this result and the positive coefficient of EW in equation (9) can be found by inspecting equation (10). From equation (10), we can derive $B = a_o + a_1 \text{ EW} + a_3 \text{ EWEH}$ . . . (10.a). If EWEH is omitted from (10.a), since EWEH is positively related to EW, the coefficient of EW could be negative.

Summary

Employing the one-period, static fertility model pioneered by Becker and others, on a Kenyan data set, it has been found that family size is inversely related to infant mortality rate. This Basic Model has also shown that family size is directly related to duration of marriage, and family income. For households with wives having at least secondary education family size is found to be lower. Labor force participation of married women has been found to have no significant effect on family size. Although polygamy exhibits a somewhat depressing effect on family size, the inescapable conclusion is that it does not affect it significantly.

This study has also shown that the higher the proportion of sons the higher the demand for children. For households with no sons, demand for children was found to be lower. This clearly demonstrates that 'price-effect' influence of sex composition on family size outweighs the 'taste' influence.

The Willis Interaction Model has been demonstrated to work with this data set. The interaction variable of wife's education and lifetime family income has been found to be negative and opposite to the separate effects of wife's education and lifetime family income.

The above results have been obtained using Kenyan data. A similar study using Nigerian data is reported in chapter 4. Chapter 3 will continue to make use of the Kenyan data and presents analyses based on Quality of Children Models, Quantity/Quality Simultaneous Equations Models and some aspects of Sequential Fertility Models.

Chapter III

QUALITY AND QUANTITY OF CHILDREN--KENYAN DATA

In the previous chapter the determinants of quantity of children in a household were investigated. In the present chapter a great deal of attention will be focused on the determinants of the quality of children, consequently the Quality-Quantity Model will be tested using data from a developing economy. This work will be based on a static model to be estimated by both ordinary least squares and two stage least squares techniques.

The last section of this chapter will test sequential models which seek to determine the additional number of children or sons desired. Using this type of model, the motive of at least one son will be revisited. This same motive was tested in the previous chapter in the context of a static model.

Quantity and Quality

Quality of children is defined in this study as those characteristics of the child that generate utility (or disutility) to parents. They include health, sex, intellectual development, school attainment, social adjustment and future income. Child quality is generally equated with aggregate parental expenditures on children;

some of these expenditures are forms of human capital (child care, schooling and medical care) while others are non-human capital in nature (gifts and bequests of wealth). In the empirical work using the Kenyan data set, the number of years of schooling of children (which mothers think sons should have) is used as a measure of the quality of children.[1]

The Quality-Quantity Model

We assume that the household utility function is

$$U = U(N,Q,C)$$

where

N = number of children

Q = quality of each child[2]

and C = aggregate amount of all other commodities.

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[1]Non-endowed child quality is usually equated with total parental expenditures on the child. Such expenditures may be broken down into child care, schooling and medical care (human capital expenditures) and gifts and bequests of material wealth (non-human capital expenditures). Oftentimes schooling expenditure is used as an approximate measure of child quality in empirical work.

In the Kenyan data set, due to lack of appropriate data, the number of years of schooling which mothers think sons should possess, has been used as a proxy for child quality.

[2]The quality of each child is assumed to be the same because the endowment of each child is assumed to be the same and parental contribution for each child is also assumed to be equal. For models in which these assumptions are relaxed see: Gary S. Becker and Nigel Tomes, "Child Endowments and the Quality and Quantity of Children," Journal of Political Economy 84 (August 1976):8143-62.

If demand function for N holds Q constant and if it is linear in the logs and fixed cost is ignored; we can write

$$\ln N = a_0 + a_1 \ln R + a_2 \ln Pn + a_3 \ln Pq \qquad \ldots\ldots (1)$$

and

$$\ln Q = b_0 + b_1 \ln R + b_2 \ln Pq + b_3 \ln Pn \qquad \ldots\ldots (2)$$

where

$Pq = \pi N$ is shadow price of number of children.

$Pn = \pi Q$ is shadow price of quality of children.

π = price of one unit of Q.

R = full family income.

But

$$\ln Pn = n\,\pi + \ln Q \qquad \ldots\ldots (1.a)$$

$$\ln Pq = n\,\pi + \ln N \qquad \ldots\ldots (2.a)$$

By substituting equations (1.a) and (2.a) in equations (1) and (2) and rearranging, we obtain:

$$\ln N = \frac{a_0}{1-a_3} + \frac{a_1}{1-a_3} \ln R + \frac{a_2 + a_3}{1-a3} \ln \pi + \frac{a_2}{1-a_3} \ln Q \qquad \ldots\ldots (3.a)$$

$$\ln Q = \frac{b_0}{1-b_3} + \frac{b_1}{1-b_3} \ln R + \frac{b_2 + b_3}{1-b_3} \ln \pi + \frac{b_2}{1-b_3} \ln Q \qquad \text{..... (3.b)}$$

Equations (3.a) and (3.b) are 'quasi' structural demand functions. For example, in equation (3.a) as R varies the shadow price of numbers ($Pn = \pi\ Q$) is held fixed, but the shadow price of quality ($Pq = \pi\ N$) is not held fixed.

By solving equations (3.a) and (3.b) simultaneously, we obtain an equation of the form:

$$\ln N = d_0 + d_1 \ln R + \ln \pi \qquad \text{..... (3)}$$

Equations (1) and (2) are 'pure' structural forms from which (3), the reduced form, is obtained.

The Regression Equations in the empirical analysis of chapter 2 could be reduced form equations like equation (3) where price of Q is taken to be unity. The results yielded 'observed' quantity elasticities of income. In this chapter the structural form equations like (1) and (2) will be estimated using Ordinary Least Squares (OLS) estimation method. The results will be obviously biased and inconsistent since the relationship among variables is simultaneous. OLS is a single equation estimation method and will therefore yield biased and inconsistent[1] results when used in a simultaneous equation system. To reduce

[1]For more detailed explanation of the causes of this bias and inconsistency see: J. Johnston, Econometric Methods (McGraw Hill), pp. 342-44.

these problems, Two Stage Least Squares (TSLS) estimation methods will be used. TSLS will also yield biased results, but the results will be consistent.

OLS Regressions and Results

OLS regressions were performed on the following structural equations:

$$N = a_0 + a_1AW + a_2MRI + a_3MD + a_4Y + a_5DEW + a_6EHX + a_7DMIGR + a_8Q \quad \ldots\ldots \quad (4)$$

$$Q = b_0 + b_1AW + b_2MRI + b_3MD + b_4Y + b_5DEW + b_6EHX + b_7DNOSON + b_8N \quad \ldots\ldots \quad (5)$$

The results are given in table 5.

Before discussing the results of equations (4) and (5), a word about the reliability of the variable, Q, is in order. Q, the quality of a child, assumed constant for each family, is measured by the number of years of education which the mothers think a son should have. No doubt it would have been better to use the actual number of years of education the child received. This data was not available. Nevertheless, it is hoped that the variable used will help to investigate the behavior of the quality-quantity fertility model for the developing economies.

Quantity Equation Results

The results of equation (4), which has 'N, quantity of children,' as a dependent variable, is not much different from its 'reduced form' counterpart in equation (2) discussed

TABLE 5

OLS REGRESSION COEFFICIENTS (STRUCTURAL QUANTITY AND QUALITY DEMAND EQUATIONS) KENYAN DATA SET (t-STATISTIC IN PARENTHESIS)[1]

Explanatory Variable	Equation 4 Coefficients (Dependent Variable Quantity of Children, N)	Equation 5 Coefficients (Dependent Variable Quality of Children, Q)
AW (Wife's Age)	0.02278 (3.5707)	0.0103 (1.353)
MRI (Infant mortality rate)	-1.9858 (-8.2443)	0.6818 (2.164)
MD (duration of marriage)	0.2151 (4.8292)	-0.00395 (-0.733)
Y (family income)	0.1591 (2.2297)	0.2866 (0.3371)
DEW (dummy for wives who have at least secondary education)	-0.6316 (-2.7050)	0.4314 (1.541)
DMIGR (dummy for family without son)	0.8315 (0.6712)	-- --
EHX (years of husband's education)	0.0337 (0.9938)	0.1245 (3.113)
DNOSON (dummy for family without son)	-- --	-0.2231 (-0.768)
N (Number of surviving children)	-- --	-0.0086 (-0.1502)
Q (years of schooling of child)	-0.0105 (-0.3017)	-- --
Constant term	1.2100 (2.8859)	15.0837 (30.9684)
R^2	0.18	0.0475
F-Statistic	18.67	3.68
Number of Observations	600	600

[1]t-statistic and F-statistic do not convey the usual meaning here, because OLS is used on a simultaneous equation system.

earlier in the previous chapter. One variable that deserves some comment is family income in the structural form of equation (4); this variable entered the fertility equation positively, although not quite as effectively as in equation (2). Thus the 'true' quantity elasticity of income, ηQ, is greater than zero, confirming that quantity of children is not an inferior good. The coefficient for the quality of children came out negative. It is hard to interpret this finding. Although the measure of quality in this analysis cannot be heavily relied on, one is tempted to conclude that the substitution between quantity and quality in the developing countries might be a very weak one.

An interesting point illuminated by the result of equation (4) is that education of husband has a weak effect on quantity of children. It is generally accepted that child production is more intensive in mother's time than father's time and hence is influenced more by mother's education than father's education.

Equation 4 is a structural demand function for quantity of children. Since Q is held constant in this equation the negative effect of mothers education cannot reflect substitution between N and Q. It might reflect better birth control knowledge. Also, it may well be that mother's education is a more important determinant of non-market productivity than father's education and that the efficiency effect is larger in the production of parents standard of living than in the production of child quality, Q. Hence the relative price of N rises with mothers education.

Quality Equation Result

The Quality equation showed positive relationship between child's schooling (Q) and age of wife (AW), infant mortality rate (MRI), family income (Y).

As the age of wife increases, the resultant increase in her efficiency results in an increase in the quality of children demanded. As mortality rate increases, and number of children is held fixed, the increased number of dead infants will tend to increase the quality of children demanded by parents.

From results of equation (5), increased family income does increase quality of children as expected. Thus the true income elasticity of quality (η_Q) is positive. The income elasticity of quantity from equation (4), η_N is 0.131; while η_Q from equation (5) is 0.067. This result is noteworthy. In the developed economies it is generally found that η_Q is greater than η_N. Using a data set from a developing country, the result here shows η_N greater than η_Q.

The dummy variable, DEW, for wives who have at least secondary education showed a positive influence on Q, although this influence is weak. The education of husband variable, EHX, however showed a positive and strong influence on child quality. A rather interesting pattern is detectable here. Whereas in the quality equation the husband's education has a strong effect on quality and the wife's education does not; in the quantity equation the reverse is the case. It is therefore tempting to conclude that the husband probably has more influence in determining the quality of the children while the wife has a greater influence in determining the quantity of children in developing countries. Personal observation seems to concur with this conclusion.

For the group of families with no son, the quality of children is lower. Also the coefficient of the quantity variable in equation (5) is negative, but weak, perhaps confirming the apparently weak substitution between the quantity and quality of children in the utility function of households in developing countries.

Two Stage Least Squares Regressions (TSLS)[1] On Quantity/Quality Models

An attempt to reduce the analytical errors inherent in the above OLS Regressions for Quantity and Quality equations prompted the use of TSLS Regressions. Although TSLS Regressions would yield biased estimates of coefficients, their results are consistent.

A practical problem usually difficult to handle in connection with TSLS is to determine the 'identifying'

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[1]TSLS is presented here to show whether it improves the results or whether it taxes the data due to somewhat arbitrary identification restrictions, low R^2 in first stage and perhaps multicollinearity.

variables. These are variables which enter as predetermined variables in one equation, but do not appear in the other equations. In tackling this problem Nigel Tomes[1] identifies by omitting father's education from the Quantity equation and fathers age from the Quality function. Nancy Birdsall[2] on the contrary enters an interaction variable between mother's age and mother's schooling in the Quantity function but not in the quality function. Dennis DeTray[3] has yet a different approach from those of Tomes and Birdsall.

Using the Kenyan data set, it was not possible to adopt any one of the above identifying methods without modification. The data set simply does not contain some of the variables needed. The following models were therefore constructed and used:

Model 1:

$$N = a_0 + a_1 AW + a_2 MD + a_3 MRI + a_4 Y + a_5 DEW + a_6 DPGMY + a_7 Q \quad \ldots\ldots \quad (6)$$

$$Q = b_0 + b_1 AW + b_2 MD + b_3 MRI + b_4 Y + a_5 DEW + a_6 EHX + a_7 N \quad \ldots\ldots \quad (7)$$

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[1]Nigel Tomes, "A Model of Fertility and Children's Schooling." Research Report 7826, Department of Economics, University of Western Ontario, London, Ontario, Canada, July 1978.

[2]Nancy Birdsall, 'A Cost of Siblings: Child Schooling in Urban Colombia,' Paper for presentation at annual meeting of Populaton Association of America, Atlanta, 1978.

[3]Dennis DeTray; "Child Schooling and Family Size: An Economic Analysis," R-2301-NICHD Rand, Santa Monica, Ca. 90406, April 1978.

Model 2:

$$B = a_0 + a_1D + a_2Y + a_3DNOSON + a_4AWEW + a_5DMIGR + a_6Q \quad \ldots\ldots \quad (8)$$

$$Q = b_0 + b_1D + b_2Y + b_3DNOSON + b_4EHX + a_5B$$

Model 1 uses N, number of surviving children, as the quantity variable. DPGMY (dummy variable for polygamous families), and EHX (education of father) are the identifying variables.

Model 2 uses B, the number of children ever born, as the quantity variable. AWEW (interaction variable between wife's wage and education), DMIGR (migration dummy variable) and EHX (education of father) are used as identifying variables.

Results of Models 1 and 2 are given in table 6.

The results of table 6 using TSLS on a simultaneous equations system are fairly similar to those of table 5, in which OLS was used to estimate the structural equations for both quality and quantity of children.

The main points to note are as follows: In the Quality equation, AW (wife's age) and Y (family income) are both positive and significant. The reason for the positive relationship between Y and N has been discussed earlier and also in appendix 3. The reason that the coefficient of AW is positive is still not quite certain. Appendix 1

TABLE 6

TSLS REGRESSION COEFFICIENTS FOR QUANTITY/QUALITY SIMULTANEOUS EQUATIONS MODELS, KENYAN DATA SET (t-STATISTIC IN PARENTHESES)

	Model 1		Model 2	
Explanatory Variable	Endogenous Variable N	Endogenous Variable Q	Endogenous Variable B	Endogenous Variable Q
AW (Wife's age)	0.0230 (3.4337)	0.0090 (0.3041)	-- --	-- --
MD (marriage duration)	0.0217 (4.5439)	-0.0219 (-0.8109)	0.0226 (4.2848)	-0.0084 (-0.9650)
MRI (infant mortality rate)	-1.9748 (-6.6238)	2.4198 (0.9913)	-- --	-- --
D (number of dead children)	-- --	-- --	0.4612 (3.4992)	0.1868 (1.2604)
Y (family income)	0.1667 (2.2115)	0.1031 (0.4675)	0.1419 (1.5747)	0.00416 (0.4352)
DEW (dummy for wives having at least secondary education)	-0.6581 (-2.1890)	0.9837 (1.1748)	-1.2011 (-3.7865)	0.5546 (1.6155)
AWEW (interaction variable wife's age and education)	-- --	-- --	0.0129 (4.0820)	-- --
EXH (years of husband education)	-- --	0.1189 (2.4138)	-- --	0.1182 (2.9196)
DPGMY (dummy for polygamous family)	-0.3319 (-1.1109)	-- --	-- --	-- --

TABLE 6--Continued

Explanatory Variable	Model 1: Endogenous Variable N	Model 1: Endogenous Variable Q	Model 2: Endogenous Variable B	Model 2: Endogenous Variable Q
Constant	1.2223 (0.2781)	13.7969 (7.8521)	6.7169 (1.1661)	14.8263 (21.9306)
Q (years of child's schooling)	0.0122 (0.0435)	-- --	-0.3212 (-0.8408)	-- --
DMIGR (dummy for migrants from rural area)	-- --	-- --	0.0114 (0.3272)	-- --
N (number of surviving children)	-- --	0.8560 (0.7009)	-- --	-- --
B (number of children ever born)	-- --	-- --	-- --	-0.2228 (-0.8634)
Number of Observations	600	600	600	600

predicts that for a fixed duration of marriage, AW should have an inverse relationship with N. However the results of OLS on the 'Reduced Form' Equations in table 2, the OLS on Structural Form Equation in table 5 and TSLS on Structural Form Equations using the Simultaneous Equations System in table 6 all show positive and significant coefficients for AW in the Quantity Equations. On the contrary, Nancy Birdsall (op. cit.) obtained a different result for a similar study on urban Colombia. Her result agrees with the prediction of appendix 1 in which AW enters positively with MD (the duration of marriage) omitted in the Quantity Equation. The inescapable conclusion is that the variable AW must be grossly in error as pointed out in chapter 2.

Another important result is weak association between the Quantity (N) and Quality (Q) in both tables 5 and 6. Although a causal effect of investment per child on number of children (and vice versa) exists, it is not significant. Here again the poor quality of the data on quality of children is to blame.

The results for the Quality Equations in tables 5 and 6 are somewhat identical. AW (wife's age) enters the Quality Equation positively (although insignificantly), reflecting the efficiency of the mother during the course of the life cycle. Y (family income) also enters positively but not significantly. Education of husband (EHX) enters positively and significantly and seems to have a greater influence than the education of wife dummy (DEW) which although also positive is hardly significant.

Sequential Models

All the fertility models so far constructed and tested are static in nature. In these models it is assumed that each household optimally chooses the components of its utility functions (namely, the number of children, the quality of children and the standard of living of the parents, N, Q, C respectively) and adheres to this choice thereafter. Static Models can only represent simplifications of the behavior exhibited by many households. In many households fertility decisions are sequential and dynamic, and are continuously reevaluated during the childbearing years.

Sequential Fertility Models have been constructed and tested by several economists.[1] However, due to the restrictions of the Kenyan data set a much simplified model is being used here. The model employed is a single-equation sequential model in which all explanatory variables are assumed exogenous.

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[1]Anne D. Williams, "Fertility and Reproductive Loss" and Ben Porath, Yoram and Welch, Finis, "Do Sex Preferences Really Matter?" Quarterly Journal of Economics 90 (May 1976).

Sequential Models

Model 3

$$ADDN^{1} = f(AW, MD, Y, DNOSON, MRI, DEW, DN2, DN3, DN4, DN5, DN6, DN7, DN8, DN9) \quad \ldots\ldots \quad (9)$$

$$ADDS = f(AW, MD, Y, DNOSON, MRI, DEW, DN2, DN3, DN4, DN5, DN6, DN7, DN8, DN9) \quad \ldots\ldots \quad (10)$$

The results of Model 3 are given in table 7.

Additional Number of Children Desired (ADDN)

The results of equation (9) in table 7 for ADDN shows MRI and DEW are negatively related to ADDN while MD is positively related to ADDN. These results although insignificant are as expected.[2] However the signs for the coefficients of Y and DNOSON need more examination and comment.

The results obtained here should be interpreted with a lot of caution. These results were statistically weak.

In all previous static equations with N (number of children) as dependent variable, the coefficients of Y were all positive. The explanation for the negative sign of the coefficient of Y here is an indication that whereas in the developing countries the number of children could be

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[1]ADDN is number of additional children desired by parents. ADDS is number of additional sons desired by parents.

[2]Anne Williams (op. cit.) obtained corresponding results using ADDED (number of additional pregnancies) as a dependent variable in a similar OLS regression.

TABLE 7

OLS REGRESSIONS COEFFICIENTS FOR ADDITIONAL CHILDREN (ADDN) AND ADDITIONAL SONS (ADDS) EQUATIONS (t-STATISTIC IN PARENTHESES)

Predictor Variables	Coefficients (Dependent Variable ADDN)	Coefficients (Dependent Variable ADDS)
AW (wife's age)	0.0083 (0.5761)	0.0022 (0.4380)
MD (marriage duration)	0.0018 (0.1781)	-0.0049 (-1.3807)
Y (family income)	-0.2603 (-1.6619)	-0.1054 (-1.9481)
DNOSON (dummy for family without son)	0.0980 (0.1740)	0.0992 (0.5098)
MRI (infant mortality rate)	-0.3313 (-0.5751)	-0.1443 (-0.7249)
DEW (dummy for wives who have at least secondary education)	-0.0671 (-0.1368)	-0.1018 (-0.6011)
DN2 (dummy for families with 2 children)	-0.6367 (-0.9765)	-0.2609 (-1.1585)
DN3 (dummy for families with 3 children)	-0.4438 (-0.6068)	-0.2904 (-1.1491)

TABLE 7--Continued

Predictor Variables	Coefficients (Dependent Variable ADDN)	Coefficients (Dependent Variable ADDS)
DN4 (dummy for families with 4 children)	-0.1678 (-0.2188)	-0.7466 (-2.8171)
DN5 (dummy for families with 5 children)	-1.8177 (-2.0890)	-0.8216 (-2.7334)
DN6 (dummy for families with 6 children	-1.7531 (-1.6170)	-0.7758 (-2.0715)
DN7 (dummy for families with 7 children)	-2.0778 (-1.7871)	-1.3400 (-3.3362)
DN8 (dummy for families with 8 children)	-2.7998 (-1.9230)	-1.0585 (-2.1045)
DN9 (dummy for families with 9 children)	-3.4689 (-1.3453)	-1.5123 (-1.6978)
Constant term	4.6617 (5.3168)	2.4446 (8.0713)
R-Squared	0.03	0.07
F-Statistic	1.282	3.23
Number of Observations	600	600

considered a normal good, the additional number of children may well be an inferior good.

For the group of families with no sons the completed family size equation result in table 3 showed a negative coefficient for DNOSON, reflecting a stronger price-mechanism effect as opposed to a taste effect influence of the sex composition of families. In table 7 the coefficient of DNOSON is positive although insignificant. The explanation is probably that the ADDN equation affords us an opportunity to determine the existence of the taste effect of sex composition even though this effect can be observed to be dominated in the N equation.

The signs and magnitudes of the DNi variables in table 7 show that families with more children desire fewer additional children.

Additional Number of Sons (ADDS)

The results of the determinants of the ADDS equation in table 7 is similar in many ways to its counterpart, the additional number of children (ADDN) equation. The relationship betwen ADDS and family income is also negative.

The results obtained here should be interpreted with a lot of caution. These results were statistically weak.

One interesting difference between the ADDS and the ADDN equations is their separate relationships with the duration of marriage, MD. From table 7, MD entered the ADDS equation negatively. This indicates that as reproductive span increases the proportion of sons becomes less important. The reason is probably because the price-mechanism effect of sex composition of children dominates the taste effect.

Motive of At Least One Son

The coefficient of DNOSON in the ADDS equation is also positive as in the ADDN equation but this factor has a much stronger effect--its *t* statistic is much higher and also is significant at the 10 percent level of confidence, while that in the ADDN equation is not. A reasonable inference from this is that the motive of at least one son is strong according to the Kenyan data set, since for the group with no sons (DNOSON) the demand for additional sons (i.e., for future male births) is higher.

Summary

In this chapter the Quality of children has been studied using the Kenyan data set. For want of a better measurement, the measure of Quality of children has been the number of years of schooling parents would like their sons to have. The quality equations were analysed in structural forms by both Ordinary Least Squares (OLS) and Two Stage Least Squares (TSLS) Regressions. The results obtained are as expected. From these results one might conclude that father's education plays a higher role in determining the quality of children than mother's educational attainment.

In this chapter the structural forms of Quantity of children equations were constructed and tested by both OLS and TSLS. The results were similar to their 'reduced form' counterparts in chapter 2. A few points are worthy of note: the quality income elasticity, η_Q, is positive but less than the quantity income elasticity, η_N: the education of mothers seem to have a stronger influence on the quantity of children than the education of fathers; and the substitution between the quality and quantity of children in the parents' utility function appear to be only a weak one.

The sequential models using additional number of children (ADDN) and additional sons (ADDS) showed a negative relationship with family income (Y). It should be recalled that previous regressions with number of children (N), showed a positive relationship between N and Y. The group of families with no sons showed a higher desire for both additional number of children and additional sons. This desire is, however, much stronger for additional sons thus confirming that motive of at least one son is strong according to the Kenyan data set.

Chapter IV

DETERMINANTS OF FAMILY SIZE--NIGERIAN DATA SET

This chapter will dwell mainly on the Nigerian data set. The objective of this chapter is to construct and test a model necessary for obtaining the economic, social and cultural determinants of family size and estimate how significant these determinants are. Several important variables are lacking in the Nigerian data set therefore proxy and dummy variables have been employed where necessary.

A table of variables used and their statistical analyses is given in table 8. D, the number of dead children, is the number of infants dying before one year of age. Although the questionnaire used in collecting data is not explicit on this, it can safely be assumed that foetal deaths are not regarded as infant deaths. This is because in the African tradition many believe life does not begin until the child is successfully born.

MRI, the infant mortality rate, has been calculated here as the ratio of dead infants to number of children ever born.

DYHS, DYHM, and DYHL are the dummy variables describing lower, medium and large income families. The fourth category represents the other families whose income are not

TABLE 8

MEANS, STANDARD DEVIATIONS AND VARIANCES OF VARIABLES[1] USED IN REGRESSIONS--NIGERIAN DATA SET

Variable	Mean	Variance	Standard Deviation
B	2.89	6.13	2.48
D	0.39	1.03	1.02
N	2.49	3.93	1.98
MRI	0.08	0.03	0.17
DEW1	0.68	0.22	0.47
DEW2	0.20	0.16	0.40
DOCUP1	0.56	0.25	0.50
DOCUP2	0.23	0.17	0.42
DMIGU	0.11	0.10	0.31
DMIGR	0.30	0.21	0.46
DYHS	0.20	0.15	0.39
DYHM	0.26	0.19	0.44
DYHL	0.12	0.10	0.32
DFP	0.96	0.03	0.18
DPGMY	0.31	0.21	0.46
DLAPT	0.21	0.16	0.40

[1]For description of variables see appendix 2.

reported. This methodology has been employed because the Nigerian data set, although it possesses high quality data, does not have a continuous family income variable.

Basic Quantity Model

Similar basic quantity equations estimated in chapter 2 are given below:

$$B = a_0 + a_1AW + a_2D + a_3EDEW1 + a_4DEW2 + a_5DPMGY + a_6DYHS + a_7DYHM + a_8DYHL \quad ..... \quad (1)$$

$$N = b_0 + b_1AW + b_2MRI + b_3DEW1 + b_4DEW2 + b_5DPMGY + b_6DYHS + b_7DYHM + b_8DYHL \quad ..... \quad (2)$$

Equations (1) and (2) are 'reduced form' equations. The results of their OLS Regressions are given in table 9.

Effect of Wife's Age (AW)

The Nigerian data set does not contain information on duration of marriage (MD), thus MD has been omitted in equations (1) and (2). AW is however present and has a positive coefficient as expected--see appendix 1. It is obvious from this result that the quality of the AW variables in the Nigerian data set is superior to that in its Kenyan counterpart. The empirical result from the Kenyan data set regarding AW is contrary to the predictions of the basic model outlined in appendix 1.

TABLE 9

OLS REGRESSION COEFFICIENTS--NIGERIAN DATA SET
(t-STATISTIC IN PARENTHESES)

Explanatory Variable	Dependent Variable, B (Children Ever Born)	Dependent Variable, N (Survival Children)
AW (wife's age)	0.1994 (27.2235)	0.1991 (29.2036)
D (infant deaths)	0.8015 (14.8311)	-- --
MRI (infant mortality rate)	-- --	-1.7524 (-5.7485)
DEW1 (dummy for wives having at least elementary school education)	-0.1709 (-1.4227)	-0.1796 (-1.5190)
DEW2 (dummy for wives having at least secondary school education)	-0.4434 (-3.3281)	-0.4736 (-3.6083)
DPGMY (dummy for polygamous household)	0.0531 (0.4549)	0.0671 (0.5837)
DYHS (dummy for small income families)	0.0005 (0.0035)	0.0208 (0.1505)
DYHM (dummy for medium income families)	0.1968 (1.5972)	0.1593 (1.3106)
DYHL (dummy for large income families)	0.3860 (2.3560)	0.3876 (2.4048)
Constant term	-2.9954 (-12.4283)	-2.9144 (-12.5830)
R^2	0.77	0.65
F-Statistic	252.49	142.39
Number of Observations	600	600

Effect of Infant Mortality

In this section the effect of infant mortality on family size is investigated. The effect being investigated is the behavioral or demand effects of child mortality on desired family size. Biological or supply effects are ignored, thus it is assumed that family size is not constrained by fecundity.

The Basic Model as outlined earlier in this chapter predicts an inverse relationship between, N, the number of surviving children and MRI, the infant[1] mortality rate. For a detailed analysis of this prediction consult appendix 4. However Donald O'Hara[2] has shown why it is possible to have a positive relationship between number of surviving children and child mortality. He argues that lower mortality might, through investment in human capital, cause a shift from quantity towards quality of children if quantity and quality are good substitutes.[3]

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[1]Infant mortality rate is sometimes substituted for child mortality. Infant mortality makes up approximately 85 percent of child mortality.

[2]Donald J. O'Hara, "Changes in Mortality Levels and Family Decisions Regarding Children," The Rand Corporation R-914-RF (Santa Monica, Calif., 1972).

[3]By good substitutes, a high and positive cross-substitution effect is meant, i.e., $\left(\frac{\partial Q}{\partial Pn}\right) > 0$ and high. U = constant.

Empirical Results

The results of the Nigerian data set are given in table 9. The number of children ever born, B, is positively related to the number of dead infants, D; while the number of surviving children is negatively related to infant mortality, MRI. The coefficients of D and MRI are both significant at the 5 percent significance level. The empirical results of the effect of infant mortality on family size therefore conform to the predictions of the Basic Model.

The results of the influence of MRI on N, in a similar study using the Kenyan data set in chapter 2 of this work, is the same as obtained above.

Snyder (1974), using data from Sierra Leone, obtained a result which confirmed a positive relationship between number of births and child mortality. DaVanzo (1972) and T. Paul Schultz (1973) obtained similar results for Chile and Taiwan respectively.

Effects of Wife's Education

The Basic Model postulates that mother's education has a negative effect on fertility.

The Willis Interaction Model,[1] however, explains why a U-type effect of wife's education on family size is possible.

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[1]Robert J. Willis, "Economic Theory of Fertility Behavior," Economics of the Family, Marriage, Children and Human Capital, ed. T. W. Schultz, pp. 25-75.

Empirical Evidence

In the Nigerian study, the wife's education is entered as a 3-category dummy variable system. DEW1 takes the value 1 for group of wives with at least elementary school education (about eight years of formal schooling but not secondary school) and zero otherwise. DEW2 is the corresponding dummy variable for wives with at least secondary school education.

Table 9 shows negative coefficients for DEW1 and DEW2 for both equations (1) and (2). Thus the predictions of the Basic Model is confirmed. The absolute value of the coefficients of DEW2 is higher than that of DEW1 in both equations, showing a large decrease in family size for the more educated mothers. This phenomenon suggests a monotonically decreasing relationship between family size and wife's education (the first part of the U-type effect). Lack of appropriate data prohibits testing the Willis Interaction Model to investigate the entire U-type effect.

Results of chapter 2 on Kenyan data set are similar to the above results.

Zikry,[1] using United Arab Republic census data, found an inverse relationship between educational attainment

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[1]Abdel-Khalik M. Zikry, Fertility Differentials of U.A.R. Women. Paper No. 201 presented at the United Nations World Population Conference Belgrade, 1965, 9 P-(WPC/WP 201).

of women and fertility. Also Farooq, Ekanem and Ojelade[1] in a cross-tabulation analysis reported a negative influence of wife's education on family size.

Effect of Polygamy

Polygamy[2] is the marriage of a man to more than one wife. This type of marriage pattern is fairly common in Africa and therefore would seem to be an important household environmental variable affecting fertility there.

A hypothesis of inverse relationship betwen polygamy and family size was propounded and proved in developed countries by Culwick and Culwick (1939) and Lorimer (1954). The reasoning behind this is the apparent lower coitus rates per wife and the probable stricter observance of sexual abstinence customs.

Empirical Evidence

The Nigerian data set showed positive but grossly insignificant coefficients for DPGMY (the dummy variable for group of wives in polygamous families). This result therefore suggests that there is no significant relationship between polygamy and family size.

A similar result was obtained in chapter 2 with the

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[1]Ghazi M. Farooq, I. I. Ekanem and M. A. Ojelade, "Family Size Preferences and Fertility in South-Western Nigeria," World Employment Programme, WEP2-21/WP. 54.

[2]A discussion of how this marriage pattern is organized has been given in chapter 2.

Kenyan data set. I. I. Ekanem in a study[1] using Eastern Nigerian data arrived at the same conclusion of non-statistically significant influences of polygamy on fertility.

On the contrary Ohadike[2] and Olusanya[3] working with survey data from different parts of the country do find that polygamy appears to be positively related to fertility.

Effect of Income

The Basic Model predicts that the observed income elasticity of quantity of children in developed economies is usually very small or sometimes even negative.[4] In developing countries it has been shown[5] that the correlation between family size and income is positive and stronger than the case with developed economies. This is believed to be so because parents tend to use children as a source of old age pensions in developing countries.

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[1]I. I. Ekanem, "Correlates of Fertility in Eastern Nigeria," The Nigerian Journal of Economic and Social Studies.

[2]P. O. Ohadike, "A demographic Note on Marriage, Family and Family Growth in Lagos, Nigeria," The Population of Tripical Africa, eds J. C. Caldwell and C. Okonjo, (Longmans Green and Co., 1978), pp. 379-92.

[3]P. O. Olusanya, "The Problem of Multiple Causation in Population Analysis with particular reference to the Polygamy-Fertility Hypothesis," Sociology Review 19 (May 1971):165-78.

[4]For more details consult appendix 3.

[5]I. I. Ekanem, "A Further Note on the Relation Between Economic Development and Fertility," Demography 9 (August 1972) and David M. Heer, Society and Population (New York: Prentice-Hall, Inc., 1968), pp. 59-60.

Empirical Evidence

The income effect in the Nigerian study was carried out by entering a 4-category dummy variable system. The categories are for small, medium, large, and finally for households where income was not reported. The coefficients of DYHS, DYHM and DYHL in table 9 show a positive influence of family income on family size.

The result parallels that obtained for the Kenyan data set in chapter 2. It also tends to support the hypothesis that income elasticity of quantity of children is positive for developing economies. Kogut[1] reported a positive relationshp between income and fertility in a Brazilian study. Nerlove and Schultz[2] obtained a positive influence between crude birth rate (a proxy for fertility rate) and income. Rele[3] also concluded that there exists a lower fertility among lower income groups in an analysis involving caste schedules in India.

Results of studies exist for which income has negative or no effect. For example Farooq, Ekanem and Ojelade (op. cit.) reported an inverse relationship between fertility

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[1]Edy Luiz Kogut, "The Economic Analysis of Fertility: A Study for Brazil." World Employment Programme, ILO, Working Paper, No. 7., Sept. 1974.

[2]Marc Nerlove and T. Paul Schultz, Life and Love Between the Censuses: A Model of Family Decision-Making in Puerto Rico 1950-1960

[3]E. Driver, Differential Fertility in Central India (Princeton, N.J., Princeton University Press, 1963), p. 96.

rate and income, but they explained that their result may have been influenced by poor family income data. Driver[1] found no significant influences on family size by family income.

The positive effect of family income on family size found with the Nigerian data set is typical of results expected of developing economies. It is perhaps noteworthy that this finding has been obtained not by using a continuous family income variable but a dummy variable system.

Effect of Migration

In this section, the effect of migration as a household environmental variable on fertility is investigated.

A popular hypothesis is that "the families of socially mobile couples are smaller than those of socially non-mobile couples of comparable status" (Whelpton and Kiser, 1951, p. 1355). Several authors have evidence supporting this hypothesis in developed economies.

To test the above hypothesis with data from the Nigerian study the following equation was employed.

$$N = a_0 + a_1AW + a_2MRI + a_3DEW1 + a_4DEW2 + a_5DYHS + a_6DYHM + a_7DYHL + a_8DMIGU + a_9DMIGR \quad \ldots\ldots \quad (3)$$

[1]E. Driver, *Differential Fertility in Central India* (Princeton, N.J., Princeton University Press, 1963), p. 96.

DMIGU and DMIGR are dummy variables for migrants from urban and rural areas respectively.

Empirical Evidence

The results of the effect of migration on fertility is given in table 10. Migration depresses family size. Migrants from rural areas have more children than migrants from urban areas.

Kogut (op. cit.) using data from Brazil reported the same inverse relationshp between migration and fertility and also higher fertility for migrants from rural areas.

Effect of Wife's Occupation

The fertility of the working mother in developed economies is found to be inversely[1] related to labour force participation rate of women (LFPRW). In the developing countries it can be found that LFPRW has positive effect on family size. McCabe and Rosenzweig,[2] explain that child production is likely to be far less intensive in mother's time in these developing areas than in the advanced countries. The use of older children and relatives as surrogate mothers and the compatibility of certain

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[1]The following researchers found an inverse influence of LFPRW on fertility: Vostrikova (1967), Henripin (1968), Collver (1968) and Langlois (1967).

[2]James L. McCabe, and Mark R. Rosenzweig, "Female Employment Creation and Family Size, Population and Development: The Search for Selective Interventions, ed. Ronald G. Ridker, pp. 332-52.

TABLE 10

OLS REGRESSION COEFFICIENTS--NIGERIAN DATA SET
(t-STATISTIC IN PARENTHESES)

Explanatory Variable	Equation 3 Dependent Variable, N	Equation 4 Dependent Variable, B
AW (wife's age)	0.2110 (30.0628)	0.2004 (28.0037)
D (infant deaths)	-- --	0.7986 (14.8151)
MRI (infant mortality rate)	-1.7656 (-5.8117)	-- --
DEW1 (dummy for wives having at least elementary school education)	-0.1489 (-1.2565)	-0.1607 (-1.3581)
DEW2 (dummy for wives having at least secondary school education)	-0.4906 (-3.8010)	-0.4613 (-3.5306)
DYHS (dummy for small income families)	0.0335 (0.2424)	0.0072 (0.0514)
DYHM (dummy for medium income families)	0.1432 (1.1799)	0.1896 (1.5447)
DYHL (dummy for large income families)	0.3750 (2.3358)	0.3835 (2.3514)
DMIGU (dummy for migrants from urban areas)	-0.3754 (-2.3121)	-- --
DMIGR (dummy for migrants from rural areas)	-0.0191 (-1.7710)	-- --
DFP (dummy if wives ever used family methods)	-- --	-0.5106 (-1.9326)
Constant Term	-2.9383 (-12.6837)	-2.5173 (-7.3349)
R^2	0.66	0.77
F-Statistic	128.05	254.43
Number of Observations	600	600

occupations with household child production (which allows for simultaneous labour market activity and child rearing) reduces the intensity of child production in mother's time in these areas.

In this section the influence of type of occupation of working mother on family size is being investigated. A three-category dummy variable system was employed: DOCUP1, and DOCUP2 are dummy for wives working as petty traders or craftspersons and professionals respectively.

Equation (5) below (which is a 'reduced form' quantity of children function) was employed in an OLS regression analysis.

$$N = a_0 + a_1 AW + a_2 MRI + a_3 DEW1 + a_4 DEW2 + a_5 DYHS + a_6 DYHM + a_7 DYHL + a_8 DOCUP1 + a_9 DOCUP2 \quad \ldots\ldots \quad (5)$$

Empirical Evidence

The result of OLS regression on equation (5) is given in table 11. The coefficient of DOCUP1 is positive and significant at the 10 percent significance level. Thus, working mothers employed as petty traders or craftspersons do indeed have a higher family size than others (including non-working mothers)! This phenomenon is however not that surprising. It confirms the hypothesis that LFPRW could in fact be positively related to family size as propounded by McCabe and Rosenzweig (op. cit.). The explanation here is

TABLE 11

OLS REGRESSION COEFFICIENTS--NIGERIAN DATA SET
(t-STATISTIC IN PARENTHESIS)

Explanatory Variable	Equation 5 Dependent Variable, N	Equation 6 Dependent Variable, N
AW (wife's age)	0.1980 (29.0254)	0.1993 (29.8373)
MRI (infant mortality rate)	-1.7438 (-5.7284)	-1.7253 (-5.6624)
DEW1 (dummy for wives having at least elementary school education)	-0.1782 (-1.5062)	-0.1831 (-1.5740)
DEW2 (dummy for wives having at least secondary school education)	-0.3802 (-2.4308)	-0.4984 (-3.8597)
DYHS (dummy for small income families)	-0.0332 (-0.2394)	-0.0270 (-0.1952)
DYHM (dummy for medium income families)	0.1478 (1.2158)	0.1643 (1.3562)
DYHL (dummy for large income families)	0.4004 (2.4892)	0.4028 (2.5057)
$DOCUP^1$ (dummy for wives working as petty traders and craftspersons)	0.1751 (1.3977)	-- --
$DOCUP^2$ (dummy for wives working as professionals)	-0.0342 (-0.2032)	-- --
DLAPT (dummy for families where wife and husband live apart)	-- --	-0.1776 (-1.4942)
Constant Term	-2.9692 (-12.6303)	-2.8576 (-12.2340)
R^2	0.66	0.66
F-Statistic	127.18	143.09
Number of Observations	600	600

perhaps due to the simultaneous labor market and child rearing activities of these group of working mothers.

The coefficient of DOCUP2 is negative although not significant. Thus the effect of labor market activity by mothers employed as professionals has no significant effect on family size although it tends to reduce it. For this group of mothers, their type of occupation and household child production cannot be carried out simultaneously.

McCabe and Rosenzweig,[1] using Puerto Rican 1970 census figures found that "wives with high wages, and thus high-fertility levels, tend to enter" occupations that are more compatible with raising children.

Effect of Family Planning and Couples Living Apart

Effect of these two household environmental variables were tested with the Nigeria data set. Equations (4) and (6) were employed:

$$B = a_0 + a_1AW + a_2D + a_3DEW1 + a_4DEW2 + a_5DHYS + a_6DHYM + a_7DHYL + a_8DFP \quad \ldots\ldots \quad (4)$$

$$N = b_0 + b_1AW + b_2MRI + b_3DEW1 + b_4DEW2 + b_5DYHS + b_6DYHM + b_7DYHL + b_8DLAPT \quad \ldots\ldots \quad (6)$$

[1]McCabe, James L., and Rosenzweig, Mark. Op. cit., p. 335.

DFP is the dummy variable for groups of couples who have ever used family planning methods, while DLAPT represent those couples who live apart from each other.

The results for equations (4) and (6) are given in tables 10 and 11 respectively.

The coefficient of DFP in table 10 is negative and significant at the 5 percent level. Family planning practices do reduce fertility. For this reason, there are increasing government efforts in developing countries towards family planning as a means to curb excessive explosions in population. One criticism of this effort is that some governments tend to neglect other economic determinants of fertility.

The coefficient of DLAPT in table 11 is also negative and significant at the 5 percent level of significance. The practice of couples living apart is only acceptable among few African peoples; for example, the Ashanti and Yoruba tribes of Ghana and Nigeria respectively. However, the issue here is that, when it exists, its impact on family size is negative.

Summary

In a multivariate context, employing a static fertility model on a microdata set on Nigeria, it has been found that family size responds positively to family income. This model has also shown that age of wife is positively related to family size when the duration of marriage is not kept constant. Households in which wives have higher education have a small number of chidren. Polygamy exhibits no significant effect on family size. Working women employed in non-professional occupations, where market activities are more compatible with child production, tend to be more fertile. Higher infant mortality rates reduce the number of surviving children.

Using the Nigerian data set it was also found that migration lowers fertility and that migration from urban areas is more effective in doing so than migration from rural areas. Family planning practices and separate habitation of married couples both have inverse influences on family size.

The results obtained in this chapter are somewhat similar to those reported in chapter 2 on the Kenyan data set. These results to a large extent confirm that the Basic Fertility model pioneered by Becker and others can in most part be applied directly to African data sets. The results generally parallel those reported for developed countries but sometimes are different due to some peculiar fundamental behavior and practices namely; simultaneously labor market and child rearing activities, and more pronounced use of children for old age support by parents.

Chapter V

SUMMARY AND CONCLUSION

The effort herein has sought to construct and test the basic fertility model (pioneered by Becker, Willis, Mincer and others) using microdata sets from Kenya and Nigeria.

This study investigated the determinants of family size on the developing economies of Kenya and Nigeria on a purely micro level.[1] Aggregation of data for the two countries was not feasible and hence omitted.

In this thesis it was found that family income exhibits a positive and strong influence on family size. The Model predicts an opposite effect for developed countries. The rationale for this phenomenon may be due to the use of children as a means of old age security by parents. It is however appropriate to suggest that this effect is a direct short-run effect of income on fertility in the less developed countries of Kenya and Nigeria. The overall long-run effect of income on family size has not been investigated. However, it can be shown,[2] that even for

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[1]For a macro level model on fertility in developing countries, see: Richard Anker, "An Analysis of Fertility Differentials in Developing Contries," World Employment Programme, ILO, Working Paper No. 16, April 1975.

[2]For more details consult: Julian L. Simon, "Income, Wealth, and Their Distribution as Policy Tools in Fertility Control," Population and Development, The Search for Selective Interventions, ed. Ronald G. Ridker, pp. 36-76.

developing economies, that there is an inverse long-run effect of family income on fertility.

Education of wives, as predicted by the basic fertility model for both developed and less developed countries, was found to have a negative effect on fertility. However contrary to the prediction for developed economies, the labor force participation rate of married women showed no significant influence on fertility and sometimes even showed a tendency towards a positive effect. This result is not surprising. In developing economies, use of older children and relatives as surrogate mothers and the existence of types of women in occupations which allow for simultaneous labor market activity and child rearing, make child production less intense in mother's time than in the developed countries.

The duration of marriage was found to have a positive effect on fertility. This is true everywhere. It should also be true that for a constant duration of marriage, the age of wife should enter the fertility equation negatively (see appendix 1). The positive influence of wife's age on fertility when duration of marriage is constant, obtained for the Kenyan data set, must be due to serious error in the age of wife (AW) variable. The Nigerian data set produced a positive influence of AW on family size, as expected when duration of marriage variable is omitted (see also appendix 1).

Infant mortality rate (MRI) and number of dead children (D) were found in both data sets to relate negatively and positively to number of surviving children and number of children ever born respectively. This result is predicted for both developed and less developed countries, by the basic model. Donald O'Hara[1] has shown why it is possible to have a positive relationshp between number of surviving children and child mortality. He showed that lower mortality might, through investment capital, cause a shift from quantity towards quality of children if quantity and quality are good substitutes. Apparently, the O'Hara conditions do not exist in the data used for this study. In chapter 3, it was found that the income elasticity of quantity (η_N) is higher than the income elasticity of quality (η_Q). Moreover, an appropriate conclusion also reached in that chapter is that quantity and quality of children in the Kenyan data set do not have positive and high cross-substitution effects.

Polygamy, using the Kenyan data set, suggests an inverse relationship. In the Nigerian data set a weak positive effect exists. However, for both data sets, these results are grossly statistically insignificant. The inescapable conclusion is that polygamy has no significant influence on fertility in these areas.

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[1]Donald J. O'Hara, "Changes in Mortality Levels and Family Decisions Regarding Children," The Rand Corporation R-914-RF, Santa Monica, Calif., 1972.

The proportion of sons (PROPS) was found to have a positive effect on fertility. Also the group with no sons possessed a lower family size. The explanation is that perhaps the taste-influence of sex composition of children is dominated by the price-influence, because in these areas the superior economic benefits of boys make the 'price' of boys lower than that of girls.

Other household environmental variables investigated were migration, use of family planning methods, and the practice of separate habitation of married couples. Migration depresses fertility, particularly when migrants are from urban areas. Both the use of family planning and the practice of couples living apart have inverse relationships with fertility.

The often puzzling U-type effects of family income and wife's education on fertility can be explained by the Willis Interaction Model. In the Kenyan study the interaction variable of wife's education and lifetime family income have been found to be negative according to an a priori determination of the Interaction model. Also the sign of the interaction variable is opposite to those of the individual variables. Thus the Willis Interaction Model was demonstrated to work using the Kenyan data set. A corollary to this is that given adequate data the U-type effect of wife's education and family income on fertility can be tested for African economies. Both data sets employed in this thesis were deficient in the data required for measuring the U-type effect.

The Quality/Quantity Fertility Models were constructed and analyzed for the Kenyan Survey. Both the Ordinary Least Squares and Two Stage Least Squares estimation methods were used on the structural equations of the model. The resultant 'true' income elasticity of quantity (η_N) and the income elasticity of quality (η_Q) were both positive. However, η_N was found to be larger than η_Q.

The education of fathers seemed to have a greater influence in determining the quality of children while the education of mothers exhibited a stronger effect on the quantity of children.

By analyzing the Quality/Quantity simultaneous equations model, one point became cardinal; the substitution between the quality and quantity of children in the parents utility function appear to be only a weak one.

Analysis of the Sequential Models using additional number of children (ADDN) and additional number of sons (ADDS) led to some interesting results, namely: although number of children might be a normal good, additional number of children seem to exhibit some properties of an inferior good; also the motive of at least one son was found to be strong in the Kenyan Survey.

In intepreting any of the above results caution must be exercised. It might be improper to generalize the results for an entire country, since the data used is from a survey in specific sections of these countries.

The fertility model as it now stands has not been constructed to allow for constraints peculiar to low-income countries. In these countries, human time is cheap, simultaneous market activity and child production by women exists, illiteracy is high, infant mortality is high, knowledge of family planning is low, children tend to be used as old age supports by their parents. Considerable work aimed at producing a general fertility model incorporating the above constraints is recommended for future work. However before that task is accomplished, the effort in this thesis has shown that deep and reliable insights in the fertility behavior in developing African countries can be determined by the basic fertility models and multivariate analytical tools comparable to those used in developed economies.

Appendix I

FERTILITY AND CURRENT AGE OF WIFE

Suppose

$$N = a_0 + a_1 \text{ MD} + a_n \{X\} \qquad \ldots\ldots \qquad (1)$$

where

N = number of surviving children
MD = duration of marriage
{X} = Vector of other explanatory variables

Generally $a_1 > 0$ because the higher the value of MD, the larger the reproductive span, and hence the greater the N. By definition

$$MD = AW - AM$$

where

AW = Current age of wife
AM = Age of wife at marriage

from (1)

$$N = a_0 + a_1 AW - a_1 AM + a_n\{X\} \qquad \ldots\ldots \qquad (2)$$

Now suppose the basic specification is

$$N = a_0 + a_1 MD + a_2 AM + a_n\{X\} \qquad \ldots\ldots \qquad (3)$$

$a_2 < 0$ since for a given duration of marriage, women who marry later in life have a shorter reproductive span.

But AM = AW - MD

$\therefore$ from (3)

$$N = a_0 + (a_1 - a_2) \text{ MD} + a_2 AW + a_n\{X\}$$

since $a_2 < 0$, the coefficient of AW is negative. Thus

AW has an inverse relationship with N, for a fixed duration of marriage.

If however the specification of the basic model is

$$N = a_0 + a_2\ AW + a_n\ \{X\} \qquad \ldots\ldots \qquad (4)$$

with MD omitted, a_2 should be positive, since correlation between AW and MD is usually positive, and the higher the MD, the higher the N.

Appendix II

LEGEND FOR VARIABLES USED IN THE ANALYSIS

Variable	Description
ADDN	Number of additional children desired by husbands
ADDS	Number of additional sons desired
AH	Age of husband
AW	Age of wife at survey time
AWEW	interaction variable between wife's age and wife's education
B	Number of children ever born
C	Constant term in regression
D	Number of infant deaths
DEW1	1 = if wife has at least elementary education o = otherwise
DEW or DEW2	1 = if wife has at least secondary education o = otherwise
DEW3	1 = if wife has at least University education o = otherwise
DFFP	1 = if family planning is free o = otherwise
DFH	1 = if head of household is farm owner or manager o = otherwise
DFP	1 = if wife ever used any family planning methods o = otherwise
DFPL	1 = if wife knows location of family planning clinic o = otherwise
DLFWAM	1 = if wife worked after marriage o = otherwise
DLFWBM	1 = if wife worked before marriage o = otherwise
DMIGR	1 = if wife migrated from rural area o = otherwise
DMIGU	1 = if wife migrated from urban area o = otherwise
DN3	1 = when household has three children at survey time o = otherwise

Variable	Description
DNj	1 = when household has j children at survey time o = otherwise
DNOSONS	1 = when household has no sons o = otherwise
DOCUP1	1 = for petty traders/craftspersons o = otherwise
DOCUP2	1 = for white collar/professionals o = otherwise
DPGMY	1 = when husband has more than one wife o = otherwise
DPW1	1 = if wife's occupation is professional, doctor, engineer o = otherwise
DPW2	1 = if wife's occupation is clerical worker o = otherwise
DYHL	1 = for large husbands income o = otherwise
DYHM	1 = for medium husbands income o = otherwise
DYHS	1 = for small husbands income o = otherwise
EHEW	Interaction variable between husband education (here a proxy for family income) and wife's education
EHX	Number of years of schooling of husband
EW	Education of wife
EWX	Number of years of schooling of wife
MCST	Marginal cost of raising children (measured by the education of wife)
MD	Duration of present marriage of female
MRI	Mortality rate of infants (D/B)
N	Number of children surviving
NSON	Total number of sons born to respondent
PROPS	Proportion of sons
Q	Child's quality (Number of years of schooling which mothers think a son should have)
Y	Income (household)
YEW	interaction variable between family income and wife's education

Appendix III

TRUE AND OBSERVED QUANTITY/QUALITY INCOME ELASTICITY

True quantity (quality) income elasticity is the percentage change in quantity (quality) consumption per 1 percent change in full income, S, with quantity (quality) shadow price, P_n (P_q) held constant

η_n (true or pure quantity income elasticity) =

$$\left.\frac{dN}{N} \Big/ \frac{dS}{S}\right|_{P_n,\ P_q \text{ fixed}} = \left.\frac{d \ln N}{d \ln S}\right|_{P_n,\ P_q \text{ fixed}}$$

η_q (true or pure quality income elasticity) =

$$\left.\frac{dQ}{Q} \Big/ \frac{dS}{S}\right|_{P_q,\ P_n \text{ fixed}} = \left.\frac{d \ln Q}{d \ln S}\right|_{P_q,\ P_n \text{ fixed}}$$

Using U = U (N, Q, C) as the household utility function, where

N = Number of children
Q = Quality of children
C = Standard of living of parents

and $S = P_c C + \pi QN$

where

S = full income
P_c = price of C
π = price of one unit of Q

It can be shown that:

$$\frac{\partial U}{\partial C} = Uc = \lambda Pc; \quad \frac{\partial U}{\partial Q} = UQ = \lambda \pi N; \quad \frac{\partial U}{\partial N} = Un = \lambda \pi Q$$

hence $Pq = \pi N$ and $Pn = \pi Q$

Similarly,

Observed quantity (quality) income elasticity is the percentage change in quantity (quality) consumption per 1 percentage change in own income, I, with market prices, π, held constant

$\bar{\eta}_n$ (observed quantity income elasticity) =

$$\left. \frac{dN}{N} \Big/ \frac{dI}{I} \right|_{\pi \text{ fixed}} = \left. \frac{d \ln N}{d \ln I} \right|_{\pi \text{ fixed}}$$

$\bar{\eta}_q$ (observed quality income elasticity) =

$$\left. \frac{dQ}{Q} \Big/ \frac{dI}{I} \right|_{\pi \text{ fixed}} = \left. \frac{d \ln Q}{d \ln I} \right|_{\pi \text{ fixed}}$$

It can be shown that for developed economies, "$\bar{\eta}_q$ is relatively high while $\bar{\eta}_n$ is relatively low and sometimes negative even if η_n and η_q are equal and of average value."[1]

In developing economies, η_n may well be greater than η_q, in which case $\bar{\eta}_q$ may be small. Nevertheless we expect $\bar{\eta}_n > o$.

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[1]See Gary S. Becker, and Nigel Tomes, "Child Endowments and the Quarterly and Quantity of Children." Journal of Political Economy, 84, part 3 (August 1976).

Appendix IV

FERTILITY AND CHILD MORTALITY: PRICE EFFECTS[1]

Let $1-p$ = child mortality rate
p = survival rate
$N = pB$ = number of surviving children
B = number of births
π = cost of birth (ignoring cost of rearing children)

Household maximize $U(N,X)$ - - - (1)

where X is consumption of parents
N is number of children assuming all children have identical quality

Let I = full family income

Maximizing household utility subject to income constraint;

$$L = U(N,X) + \lambda(I - p_X X - \pi B)$$

$$B = N/p \quad \text{Let } P_X = 1$$

$$L = U(N,X) + \quad (I - X - \frac{\pi}{p} N)$$

$$\frac{\partial L}{\partial X} = U_X - \lambda = 0; \quad \frac{\partial L}{\partial N} = U_N - \pi/p\lambda = 0$$

$$\therefore \frac{U_n}{U_X} = \frac{\pi}{p}$$

$\pi/p = \pi^*$ is relative price of N

Thus as $p\uparrow$, $\pi^*\downarrow$, $N\uparrow$ i.e. $\frac{\partial N}{\partial p} > 0$

Similarly $(1-p)\downarrow$, $\pi^*\downarrow$ $N\uparrow$ i.e. $\frac{\partial N}{\partial(1-p)} < 0$

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[1]This analysis is taken from classroom notes given by Michael Grossman, Graduate Center, City University of New York.

Thus reduction in mortality rate should increase quantity of surviving children.

Effect on birthrate

$B = N/P$

$\ln B = \ln N - \ln P$

$$\frac{\partial \ln B}{\partial \ln P} = \frac{\partial \ln N}{\partial \ln P} - 1$$

$$\frac{\partial \ln B}{\partial \ln P} = \frac{\partial \ln N}{\partial \ln \pi^*} \cdot \frac{\partial \ln \pi^*}{\partial \ln P} - 1$$

$$\frac{\partial \ln B}{\partial \ln P} = - \varepsilon \frac{\partial \ln \pi^*}{\partial \ln P} - 1$$

ε = gross own price elasticity of number of surviving children.

$\ln \pi^* = \ln \quad - \ln P$

$$\frac{\partial \ln \pi^*}{\partial \ln P} = - 1$$

$$\therefore \frac{\partial \ln B}{\partial \ln P} = \varepsilon - 1 \gtrless 0 \text{ as } \varepsilon \gtrless 1$$

Thus if $\varepsilon < 1$ i.e. elasticity of demand for surviving children is less than 1

$$\frac{\partial \ln B}{\partial \ln P} < 0$$

i.e. $\dfrac{\partial \ln B}{\partial \ln (1-P)} > 0$

Thus there is a positive relationship between fertility and child mortality if the demand for number of surviving children is price inelastic.

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