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FEMALE EDUCATION AND FERTILITY IN RURAL SIERRA LEONE: A TEST OF THE THRESHOLD HYPOTHESIS

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Résumé — Cette étude met à l'essai l'hypothèse seuil de l'éducation des femmes qui énonce qu'il y a un niveau critique d'acquisition éducationnelle audessus laquelle la fécondité commence à baisser des hauts niveaux traditionnels. En utilisant des données provenant d'un énchantillon de femmes actuellement mariées à l'âge gestatif de 15 à 49 ans dans la région rurale de Sierra Leone, des analyses de regression non linéaires révèlent une valeur de seuil de six ans de scolarité des femmes rurales. Des femmes en dessous et audessus de la valeur de seuil révèlent les coefficients positifs et negatifs escomptés sur la fécondité respectivement. Bien que les coefficients ne soient pas statistiquement importants au niveau cinq pour cent, ils sont compatibles avec les grands groupes d'âge 15 à 24, 25 à 34, 35 à 49, ce qui montre que les résultats observés ne sont pas une fabrication de différences inter-cohortes.

Abstract—This study tests the female education threshold hypothesis, which posits that there is a critical level of educational attainment beyond which fertility begins to decline from traditional high levels. Using data from a sample of currently married women of childbearing ages 15-49 in rural Sierra Leone, non linear regression analyses reveal a threshold value of six years of schooling for rural women. Women below and above the threshold value exhibit the expected positive and negative coefficients on fertility respectively. Although the coefficients are not statistically significant at the five per cent level, they are consistent for broad age groups 15-24, 25-34, and 35-49, which shows that the observed results are not an artifact of inter-cohort differences.

Key Words — **female, education, fertility, hypothesis**

Introduction

At a general level some relationship between a woman's education and her fertility is found for most countries. For many developed countries, this relationship has been observed to be monotonically inverse. Evidence from developing nations, however, shows that this relationship is either positive, negative or irregular (Cochrane, 1979, 1983).

A comprehensive review of literature on the effects of education on fertility using cross-national and cross-regional studies by Cochrane (1979) revealed that uniformly inverse relationships were found in only 49 per cent of the cross tabular studies, significant negative coefficients were found in only 31 per cent of the regression studies, and in cases where the relationship was not monotonically inverse, fertility first rose with education and then fell. In these cases, peak fertility was generally found with lower primary education.

In Egypt, El-Badry and Rizk (1967) found a curvilinear relationship between standardized parities of currently married women and their education in the non-urban Governorates but an inverse relationship in the urban Governorates. Analysing the 1971 Indonesian census data, Hull and Hull (1977) also revealed a curvilinear relationship between women's level of schooling and mean number of children ever born in every age group, and in both urban and rural areas.

Rodriguez and Cleland (1980) examined the effects of education, residence and other explanatory variables on fertility for 22 countries in which World Fertility Surveys (WFS) were conducted. They reported a monotonically inverse relationship between education and fertility for married women in Latin America, Jordan, Korea, and Malaysia, but an irregular overall pattern for Sri Lanka and Pakistan. In a comparative study of socioeconomic differentials in achieved fertility for Europe and the U.S.A., Jones (1982) observed a negative association between level of education and fertility, and noted that this relationship was stronger at the lower than at the upper end of the education scale.

In a related study, Alam and Casterline (1984) examined socioeconomic differentials in recent fertility for 29 developing countries in Africa, Asia and the Americas using WFS data. Their analysis indicated an inverse relationship between total fertility rate and level of education. Although this relationship did not hold for the 1-3 years and 4-6 years of schooling subgroups, the 7+ years of schooling subgroup exhibited the smallest total fertility rate. Alam and Casterline's analysis revealed two important results. First, it demonstrated the powerful effect on reproductive behaviour of schooling beyond the primary level. Second, it pointed to a "threshold effect" of education in many countries, thus cautioning against specifying linear effects of education.

Caldwell (1980) advocates mass education as a vehicle for achieving fertility decline in developing nations. His argument focuses on the economic and social obligations children owe to their parents as the key to explaining high fertility in developing nations. Caldwell stresses that "Western education" can alter family structure by breaking up the extended family and depriving elders of the benefits they previously counted on from children, and by bringing about a decline in the willingness of children to turn over their earnings to their parents.

In nations where the relationship between female education and fertility is positive or irregular, an important issue of concern to policy planners is the level of educational attainment at which fertility begins to decline. This level is usually referred to as the female education threshold level. Thus, the female education threshold hypothesis states that there are threshold values of educational attainment which have to be crossed by a population before its fertility levels start their downward trend. Till these values are crossed, no decline in fertility can be expected.

A number of studies have attempted to identify female education threshold values for various populations. Utilizing the 1955 sample survey data from the Puerto Rican Bureau of Labour Statistics, Jaffe (1959) concluded that at least six and possibly nine years of schooling for women is required before any significant decline in fertility occurs. Stycos (1967) extended Jaffe's thesis by examining the 1960 Puerto Rican census data. Confining his analysis to married women of completed fertility, Stycos noted a marked differential fertility by education and that this differential accelerated with education; a major decline occurred only after the elementary school level of education was achieved. Using the 1968 Philippine data, Encarnacion (1974) observed a positive relationship between fertility and female education up to four years of primary school. Ketkar (1978) noted that fertility reaches a peak around five years of schooling for urban Sierra Leonean housewives. Ahmad's (1985) investigation of the effect of education on marital fertility in Muslim countries showed that six or more years of education of both husband and wife had some negative effect on fertility in Bangladesh, Jordan and Pakistan. Based on a large sample of married women aged 15-49 from the 1970 census of Mexico, Holian (1985) investigates the effect of literacy and education on the number of children ever born in different sized communities. His analysis indicates that fertility is slightly higher at 1-3 years of primary school than at no school, declines slightly at 4-5 years of primary school, and then declines substantially at completed primary, secondary and university levels.

Located on the western coast of Africa between Guinea and Liberia, Sierra Leone is a small country (3.6 million total population) with a crude birth rate of about 48 per 1,000 population and a total fertility rate of over six according to United Nations estimates (UNFPA, 1985). Over 70 per cent of its people live in rural areas, infant mortality rate is over 200 per 1,000 live births, and life expectancy at birth is around 33 years.

This study explores the relationship between female education (here measured by the number of years of schooling completed) and fertility (number of children ever born) in Sierra Leone, by utilizing data from a sample of currently married women of childbearing ages 15-49 in rural Sierra Leone. First, the female education threshold level, i.e., the critical education level at which fertility begins to decline, is derived using a nonlinear regression technique. Second, using the estimated threshold level, an alternative fertility model is specified and estimated, using OLS regression technique to obtain the expected positive and negative marginal effects of education on fertility for women below and above the threshold level respectively. Third, the policy implications of these findings are discussed.

Data Source

This study utilizes data from the fertility and family planning survey in rural Sierra Leone, sponsored by the International Development Research Centre in Canada. There are no census or other official criteria for defining urban or rural settlements in Sierra Leone. Researchers usually use a minimum population size of either 2,000 or 5,000 persons as the divide between rural and urban localities. According to the 1974 National Census (Thomas, 1983), there were 20 localities each with 5,000 or more persons and 75 localities each with 2,000 or more persons in the country. These figures show a relatively low level of urbanization. Over 70 per cent of all urban localities had fewer than 5,000 persons, while only five localities satisfied the United Nations-recommended minimum sized class of 20,000 persons for defining urban areas.

The study area comprises four chiefdoms (Dasse, Kamajei, Kori and Kowa) in the Moyamba District, Southern Province. Moyamba District has a total population of 188,745 persons, of which 44,862 reside in the study area. Each locality in the study area has a population fewer than 3,000 persons. Only two localities have population over 2,000 inhabitants. Thus, using a minimum population size of 5,000 persons as the divide between rural and urban localities, the study area is undoubtedly rural (3.4 per cent of the total population in the Moyamba District reside in localities of 5,000 or more persons).

A sample of 2,000 currently married women aged 15-49 in the study area was obtained between February and May, 1979, under the auspices of the Mathematics Department, Njala University College, University of Sierra Leone, using a three-stage probability sample of the target population. The primary sampling units were the enumeration areas, of which there are approximately 2,800 in the country, each containing roughly 500-1,500 persons. Since the target population is women, total female population was adopted as a measure of size for selection and, because of the variation in size, units were selected with probability proportional to measure of size. Twenty units were selected by systematic sampling from the list of enumeration areas covering the four chiefdoms in the Moyamba District.

The secondary stage units were villages and towns. Two were chosen from each selected enumeration area with probability proportional to female population. The design required a uniform overall sampling fraction, and as the preceding stages were drawn with probability proportional to size this required the selection of a constant number of names at the final stage.

The strategy adopted was to fix the number of interviews to be achieved in each of the 40 villages or towns selected; thus a target sample of 2,000 interviews meant 50 interviews with eligible females per unit. Names (sampling points) were selected from the taxpayers' list for each village or town by systematic sampling, treating the list as circular. The taxpayers' register lists those eligible to pay local tax every year, together with their address at the time the register is compiled. This list and the electoral register are in fact the only available lists of adults in the population, and, except where consideration is given to area sampling, they constitute the only available sampling frame. The selected names from the taxpayers' list served to identify particular households. If there was more than one eligible female in the household, a Kish selection procedure was adopted (Kish, 1965).

A wide variety of information was collected on personal characteristics of the respondent and her husband, fertility behaviour, socioeconomic and religious characteristics, family size intentions, contraceptive use, attitudes toward and knowledge of family planning, etc. Of the 2,000 women in the sample, 1,600 reside in places with fewer than 500 inhabitants, 200 reside in places with 500-1,999 inhabitants and 200 reside in places with 2,000-3,000 inhabitants.

Variables

Eleven variables were used in this analysis. The dependent variable is the total number of children ever born (CEB) to currently married women aged 15-49. The three background variables are wife's tribe (WTBE), her religious affiliation (WREL), and size of current place of residence (RSIZE). The three socioeconomic variables are the number of years of schooling completed by the respondent (WED) and her husband (HED), and wife's occupation (FWORK). The four demographic variables are wife's current age (AGE), age at first marriage (AGFM), desired family size (DESF) and infant-child mortality rate (SRATE).

Background Variables

Religion, current place of residence, and tribal affiliation may be associated with differences in fertility. For instance, various religious and tribal groups may have significant effects on fertility through their teachings on contraceptive practices and abortion, value of children, and differences in norms regarding age at marriage. Dow (1971) and Devis (1973) documented significant differences among the tribal groups in Sierra Leone. Snyder (1975), on the other hand, argues that other influences such as those considered here might overwhelm the importance of tribal affiliation as a determinant of fertility. A dummy variable, WTBE, which takes the value of one if the wife belongs to the Mende tribe, is introduced in the model.

Empirical studies in Tropical Africa have documented lower fertility among Muslims than among non-Muslims (Bailey, 1986; Caldwell, 1969; Clairin, 1969; Sembajwe, 1980). To test whether Muslim families differ significantly in fertility from non-Muslim families, a dummy variable, WREL, which takes the value of one if the wife is affiliated to the Muslim religion, is included in the model.

Current place of residence signifies potential exposure to different values, norms, and economic opportunities that may be related to fertility. Cochrane (1983) has pointed out that many of the factors affecting individual decision making regarding fertility are determined in part by the community of residence. These factors include presence in the community of contraceptive services, schooling opportunities and health facilities; economic opportunities and costs, such as the demand for labour of men, women and children; the costs of food and housing; and exposure to disease. All of these factors vary between smaller and larger rural places, and may directly or indirectly impinge on fertility.

Generally in Sierra Leone, places with population of 2,000 and over may have a primary school, a health centre, a postal service, and in some cases a secondary school. To test the effect of household location on fertility, a dummy variable, RSIZE, which is equal to one if household is located in an area with a population of at least 2,000 persons, is included in the model.

Socioeconomic Variables

Traditional economic theory would lead one to believe that the effect of increases in income should be to increase demand for all goods, including children, and thus to increase fertility. Taking husband's education as a proxy for household's permanent income (Ketkar, 1979; Snyder, 1974; Willis, 1973), we can argue that husband's education can increase fertility by minimizing the perceived cost of rearing children and by increasing the fecundity of the wife due to improved nutrition and better medical care. Thus, a positive relationship is expected between a husband's education and his wife's fertility.

Wife's education is assumed to reduce fertility by increasing contraceptive use, by delaying entry into marriage either directly or by changing the alternatives available to the woman (Kendall and O'Muircheartaigh, 1977), and by lowering the demand for children (Cochrane, 1979). On the other hand, one can argue in the case of Tropical Africa that an increase in education can raise fertility initially as it leads to the abandonment of traditional practices such as prolonged breastfeeding, abstinence, and polygamy, which have fertility-suppressing effects. For example, Bongaarts, *et al.* (1984) noted that fertility is increasing among young, educated, married urban women in Kenya. They also observed a similar phenomenon in several studies in Nigeria. In particular, the Nigeria Fertility Survey confirms that current fertility is higher among women with primary education compared to those with less or none.

The relationship between female occupation and fertility has been widely discussed in the literature (Standing, 1983; Weller, 1984). In some instances, women who are in the labour force have lower fertility than those who are not (Adewuyi, 1980; Elizaga, 1974; Feyisetan, 1985); in others the two groups of women have the same fertility (Chaudhury, 1978; Gurak and Kritz, 1982; Loza-Soliman, 1981) and in other instances those women in the labour force have higher fertility than those not in the labour force (De Graft-Johnson, 1978; Standing and Sheehan, 1978).

It is generally accepted that wage employment away from home is much more incompatible with fertility than nonwage activity whether on farms, in trading or in unpaid family work (Standing, 1983). In rural Sierra Leone, women frequently carry children on their backs while they are engaged in agricultural activities, and in this case jobs performed by women are not necessarily incompatible with bearing and caring for children. To test whether the fertility behaviour of women engaged in non-farming activities is significantly different from those engaged in farming activities, a dummy variable, FWORK, which takes the value of one if wife is engaged in non-farming activities, is included in the model.

Demographic Variables

Demographic variables such as age and age at marriage are related to fertility. Age differentials might be expected to play an important role in inter-area fertility differences. It is assumed that an increase in the age at marriage reduces the length of exposure to the risk of pregnancy and therefore reduces cummulative fertility. Hence we expect an inverse relationship between age at marriage and the total number of children ever born.

A family formation variable such as desired family size is closely related to the investment motives of parents (raising children in the expectation that they will provide their parents with economic support in old age). In Tropical Africa, children represent an investment for the future, even in situations where the rate of return is negative (Caldwell, 1983). For protection and financial support in old age, there is often no satisfactory form of investment except surviving children, particularly in rural areas where agriculture constitutes the major form of economic activity. Thus, desired family size is expected to have a positive effect on the number of children ever born.

Heer (1983) reviewed a large body of research on the relationship between infant-child mortality and the demand for children. The evidence indicates that the number of previous child deaths to married couples is positively associated with the couple's demand for subsequent births. This association may also depend on the sex composition of existing children. For instance, Heer and Wu (1978) noted that the effect of prior child loss in Taiwan depended largely on the sex of the child. In a related study conducted in Guatemala, Pebley, *et al.* (1979) noted a significantly positive association between the number of prior child deaths and the desire for additional births. In rural Egypt, Rizk, *et al.* (1982) found that after adjusting for other factors, women who had lost one or more children desired almost one-half a child more than women who had not experienced child loss.

The incidence of infant-child mortality is generally considered to be high in Sierra Leone. According to the Population Reference Bureau (1984) infant mortality is as high as 206 per 1,000 live births. This figure may even be higher for the rural areas where adequate medical facilities are lacking. Such high mortality rate undoubtedly introduces considerable uncertainty into the family formation process. One consequence of a high infant-child mortality rate is to increase the number of births needed to produce a survivor and this will increase the demand for the total number of births. Generally parents respond to this demand either in advance by attempting more live births than the number of surviving children desired, or by attempting to replace children who die. For instance, Snyder (1974) noted that households in urban Sierra Leone tend to replace a child who dies with an additional birth. To test whether similar results hold for rural households, the reciprocal of child survivor rate, SRATE, is included in the model. If rural parents replace all children who die, the coefficient of SRATE is expected to be equal to or greater than one.

Results

Summary statistics for the number of children ever born to rural women are presented in Tables 1 and 2. Table 1 gives the mean number of live births and desired family size for currently married women aged 15-49. The mean number of live births and the mean desired family size for the entire sample are 3.49 and 6.36 respectively. The data reveal substantial variation in these indices when controls are introduced. Age differentials indicate highest fertility (4.78) for the oldest age category (35-49) and lowest fertility (1.53) for the youngest age group (15-24), thus suggesting that fertility is positively correlated with age. Similarly, wife's age and her desired family size are positively related.

Fertility variations among the tribal groups are also reflected in the data. The Mendes exhibit lower fertility and smaller desired family size than non-Mendes. These findings are in agreement with earlier results on tribal differences in fertility (Devis, 1973; Dow, 1971). Religious differences in fertility indicate that the mean number of live births for Muslim women (3.42) is lower than that of the Catholics (3.51) and Protestants (3.59). Similarly, the mean desired family size of 6.37 for Muslim women is smaller than that of the Protestants (6.47) but higher than that of the Catholics (6.12). There are noticeable differences in fertility by size of place of residence. The mean number of live births decreases with increase in size of place of residence. Residents of the smallest rural places (0-499 persons) have, on average, 0.41 more live births and desire 0.63 more children than those in the largest rural places (2,000-3,000 persons).

The analyses also reveal that women in traditional sector jobs have lower fertility and desire fewer children than women employed in modern sector jobs.

These findings confirm what Ware (1977) noted for Nigerian women, namely, white collar women workers had more children on average than those with no occupation. These results raise an important question of whether expansion of the modern sector employment opportunities for women may delay fertility reduction in rural areas. It would seem that any inverse relationship between female employment and fertility is more likely to occur if jobs performed by women are made more compatible with childbearing and caring and if the extended family system which provides help around the house and care for the children is replaced with the nuclear family system.

TABLE 1. MEAN NUMBER OF CHILDREN EVER BORN (CEB) AND DESIRED FAMILY SIZE (DESF) FOR RURAL WOMEN AGED 15-49 WITH CONTROL VARIABLES

	N	CEB	DESF
Total	1997	3.49	6.36
Age			
15-24	498	1.53	5.83
25-34	763	3.52	6.49
35-49	736	4.78	6.57
Wife's Education			
None	1757	3.53	6.41
1-4	115	3.19	5.62
5-7	53	3.04	6.79
8+	75	3.29	6.01
Husband's Education			
None	1592	3.56	6.45
1-4	184	3.05	5.83
5-7	91	3.45	6.30
8+	133	3.25	6.00
Tribe			
Mende	1791	3.47	6.31
Non Mende	209	3.69	6.72
Religion			
Catholic	350	3.51	6.12
Protestant	572	3.59	6.47
Muslim	1070	3.42	6.37
Residence Population			
<500	1600	3.47	6.49
500-1999	200	3.10	5.82
2000-3000	200	3.06	5.86

TABLE 1. CONTINUED

	N	CEB	DESF
Wife's Occupation			
Traditional Sector	1780	3.46	6.35
Modern Sector	220	3.70	6.44
Age at Marriage			
<15 years	763	3.66	6.47
15-20 years	993	3.45	6.29
20+ years	244	3.10	6.28
Proportion of infant-child mortality (CEB 1)			
None	806	2.86	5.96
≤0.20	138	6.55	6.99
0.21-0.50	478	5.45	6.86
>0.50	268	4.35	6.55

Traditional sector jobs include farming, housekeepers, cooks, maids, etc.

Modern sector jobs include teaching and other professional occupations, civil service, sales and service sectors and clerical work.

Age at marriage is inversely related to the mean number of live births and desired family size. Women who marry at age 20 or higher have 0.56 live births fewer than those who marry at 15 or below. Infant and child mortality experiences show a strong positive effect on fertility. Women who had lost at least half of their live births have given births to 1.69 more children than those who had not experienced any previous child loss. The higher fertility among those who had experienced previous child loss probably compensates for those losses and also guarantees that some of the remaining children survive to adulthood to provide old age support for their parents. The effects of husband's and wife's education on fertility show clear differentiation between those with or without education. Couples with some education exhibit lower fertility than those without education. They also desire smaller family size than their counterparts with no education.

Controlling for age (Table 2), women in the youngest age group (15-24) with some primary education (1-7 years of schooling) show higher mean number of children ever born compared to those with no education and with some secondary education (8+ years of schooling); those in the middle age group (25-34) exhibit a fertility level that is higher than those with no education but lower than those with some secondary education. Women in the oldest age group (35-49) with some primary education, however, show lower fertility than those with no education or with some secondary education. In general, the lower fertility among women with some primary education compared to others is the reverse of what Ketkar (1978) noted for urban Sierra Leonean housewives, namely that urban Sierra Leonean housewives with some primary education have more children than those with none. These results indicate that the relationship between female education and fertility for rural married women in Sierra Leone is irregular and similar to that observed in Sri Lanka and Pakistan (Cochrane, 1983). Thus, the inverse relationship between a woman's education and her fertility often observed in many developed nations does not hold for rural Sierra Leone. The results are consistent with the work of Graff (1979) and others (Cochrane, 1979; Holian, 1985; Jain, 1981) that, in less developed countries, increasing amounts of education are not always associated with lower fertility.

TABLE 2. MEAN NUMBER OF LIVE BIRTHS PER WOMAN BY EDUCATIONAL ATTAINMENT FOR RURAL WOMEN AGED 15-49

Age group	No. of women	Total	No schooling	1-7 yrs schooling	8+ yrs schooling
15-24	498	1.53	1.41	2.04	2.00
25-34	763	3.52	3.49	3.64	4.03
35-49	736	4.78	4.78	4.64	5.17
15-49	1997	3.49	3.53	3.14	3.29

The bivariate analysis discussed in this section has clarified the relative importance of key variables as determinants of fertility in rural Sierra Leone. The extent to which these variables are significant independent predictors of fertility will be assessed in the section on multivariate analysis.

Female Education Threshold Level

To estimate the female education threshold level, that is the critical level of female educational attainment at which fertility begins to decline, a nonlinear regression model with the number of children ever born as the dependent variable is specified below.

$$EB = b_0 + b_1\,HED = b_2\,WED + b_3\,WED^2 + b_4\,FWORK + b_5\,SRATE + b_6\,RSIZE + b_7\,AGEM + b_8\,DESF + b(\,AGE + b_{10}\,WTBE + b_{11}\,WREL + \text{Error term}$$

where

- CEB = number of children ever born (exact number of live births)
- HED = husband's educational level in number of years of schooling completed
- WED = wife's educational level in number of years of schooling completed
- WED^2 = the square of WED
- FWORK= dummy for wife's occupation (1=non-farming, 0=farming)
- SRATE = the reciprocal of the child survival rate
- RSIZE = dummy for size of current place of residence (1=place of 2,000-3,000 persons; 0=others)
- AGFM = wife's age at first marriage in single years
- AGM = wife's current age in single years
- DESF = wife's desired family size (exact number)
- WTBE = wife's tribe (1=Mende, 0=others)
- WREL = wife's religion (1=Muslim, 0=others)

The estimated regression equation for the entire sample of rural women is reported below (t-values are shown in parentheses):

$$\underset{}{CEB} = -1.413 + \underset{(0.81)}{0.016\,HED} + \underset{(1.13)}{0.089\,WED} - \underset{(-1.26)}{0.008\,WED^2} - \underset{(-0.45)}{00.77\,FWORK} +$$

$$\underset{(23.9)}{1.394\,SRATE} + \underset{(3.89)}{0.723\,RSIZE} - \underset{(-7.36)}{0.086\,AGFM} + \underset{(11.5)}{0.217\,DESF} +$$

$$\underset{(19.1)}{0.113\,AGE} - \underset{(-1.66)}{0.287\,WTBE} - \underset{(-1.18)}{0.126\,WREL}$$

$R^2 = 0.451$ F = 139.3

At this stage the purpose of this regression is to determine the threshold level with respect to female educational attainment. Rudimentary calculus (Chiang, 1984) suggests that differentiating the estimated equation twice with respect to WED variable will permit us to estimate the threshold level of female education. The first derivative determines the threshold value and the second derivative indicates whether the estimated threshold value is a maximum or a minimum. If the second derivative is negative, the estimated threshold value is a maximum. Setting the first derivative to zero and solving for WED gives WED* = 5.7. The second derivative which is negative indicates that WED* = 5.7 is a maximum value. This implies that fertility reaches a peak around six years of schooling for married women in rural Sierra Leone. While the first six years of schooling have the effect of increasing fertility, only female educational attainment beyond six years of schooling has a negative effect on fertility.

Reasons for the existence of the threshold value have been attributed to social (Encarnacion, 1974) and economic (Ketkar, 1978) phenomena. Encarnacion argues that at levels of educational attainment below the threshold level, more education means better knowledge of hygiene, health and child care practices which enable a woman to bear more children. When educational levels surpass the threshold, however, the expected negative response of fertility to more education becomes effective. Ketkar's economic explanation surrounds the differences in jobs performed by women of varying levels of educational attainments. He argues that jobs performed by uneducated and marginally educated women are not necessarily incompatible with bearing and rearing of children, and for those women the income effect can be expected to be stronger than the substitution effect, leading to an increase in the demand for children. On the other hand, women with at least secondary school level attainment undertake occupations that are largely incompatible with having and caring for children, and thus the price effect can be expected to outweigh the substitution effect and subsequently lead to a reduced demand for children.

These arguments may also apply to the married female population in rural Sierra Leone, but in my opinion there is a third possible explanation, namely the existence of an extended family system in the culture. Extended family system prevails in the country. Many families, particularly those who are educated and live in larger rural places or urban centres, bring along a young relative from their village to help around the house and to care for the children, so their presence in the household reduces the wife's burden and the household cost for providing alternative child care, and may lead to a new demand for children.

Marginal Effects of Female Education on Fertility

We have identified the critical level of female education to be around six years of schooling for married rural women. The next logical step is therefore to estimate coefficients of WED variable for women below and above the threshold level. If the threshold hypothesis holds for this population, we would expect positive and negative coefficients of WED for women below and above the threshold level respectively. As in Encarnacion's (1974) procedure, the WED variable is decomposed into two variables, WEDMIN = min (0, WED - WED*) and WEDMAX = max (0, WED - WED*) where WED* is the estimated threshold level of female educational attainment. The revised model for the fertility equation now becomes:

$$\text{CEB} = c_0 + c_1\,\text{HED} + c_2\,\text{WEDMIN} + c_3\,\text{WEDMAX} + c_4\,\text{FWORK} + c_5\,\text{SRATE} + c_6\,\text{RSIZE} + c_7\,\text{AGFM} + c_8\,\text{DESF} + c_9\,\text{AGE} + c_{10}\,\text{WTBE} + c_{11}\,\text{WREL} + \text{Error term}$$

The revised model is estimated using OLS regression method for the entire sample and for broad age groups 15-24, 25-34, and 35-49. The results are presented in Table 3. Of the background variables, size of place of residence is statistically significant for the sample and for age groups 25-34 and 35-49, exerting a positive effect on fertility; religion and tribal affiliation have negative coefficients for the sample, although not significantly different from zero. The signs on these variables imply the following: a positive size on the size of place of residence dummy indicates relatively higher fertility in larger rural places (2,000-3,000 persons); a negative sign on the religion dummy variable implies that Muslim women have fewer children than their Christian counterparts; and finally a negative sign on the tribal dummy variable means that Mende women have lower fertility than non-Mendes.

In the case of the socioeconomic variables, wife's occupation exerts a negative influence on fertility (significant at the 0.01 level for age group 25-34). The negative sign on the occupation dummy variable implies that wives engaged in non-farming activities have fewer children than those women engaged in farming activities. Husband's education, on the other hand, exhibits a positive coefficient on fertility although it is not statistically significant. If husband's education can be assumed as a proxy for household permanent income, it can be seen that husband's education increases fertility by lowering the perceived financial cost of rearing children and by increasing the fecundity of the wife due to improved nutrition, better health care provision, and early weaning of the child.

All four of the demographic variables exert strong effects on fertility and operate in the direction expected. Higher age, higher infant-child mortality

TABLE 3. REGRESSION RESULTS (SHOWING t-VALUES) FOR RURAL WOMEN WITH CHILDREN EVER BORN AS THE DEPENDENT VARIABLE BY AGE GROUP

Variables	15-49	15-24	25-34	35-49
HED	0.017 (0.84)	0.019 (1.05)	0.010 (0.36)	0.042 (0.83)
WEDMIN	0.054 (0.87)	0.008 (0.15)	0.137 (1.54)	0.123 (0.70)
WEDMAX	-0.069 (-1.04)	-0.047 (-0.93)	-0.071 (-0.75)	-0.178 (-0.73)
FWORK	-0.076 (-0.44)	-0.188 (-1.12)	-0.750** (-2.77)	-0.563 (-1.63)
SRATE	1.390** (23.99)	1.142** (14.82)	1.121** (13.58)	1.627** (14.36)
RSIZE	0.724** (3.89)	-0.020 (-0.11)	0.617* (2.29)	0.931* (2.37)
AGFM	-0.085** (-7.34)	-0.107** (-5.12)	-0.132** (-6.72)	-0.063** (-3.41)
DESF	0.216** (11.45)	0.030 (1.21)	0.164** (6.08)	0.315** (8.90)
AGE	0.112** (19.01)	0.164** (6.05)	0.190** (6.49)	0.033 (1.37)
WTBE	-0.287 (-1.66)	-0.246 (-1.48)	0.012 (0.05)	-0.729 (-1.92)
WREL	-0.127 (-1.20)	0.004 (0.03)	0.105 (0.66)	-0.390 (-1.84)
CONSTANT	-1.100	-1.026	-1.882	1.815
R-SQUARE	0.451	0.498	0.369	0.348
F-RATIO	139.22	40.06	36.94	33.80
N	1875	457	707	708

* Significant at 0.05 level; ** Significant at 0.01 level

within the household and higher desired family size positively influence fertility while age at marriage exerts a comparatively weak, but significant negative influence. Within age-specific fertility equations, however, the statistical significance of these variables is substantially reduced. The variables WEDMIN and WEDMAX exhibit the predicted positive and negative coefficients on fertility respectively. The positive sign implies that for women below the threshold, increases in education lead to increases in fertility; a negative sign indicates that for women above the threshold, increases in education lead to a reduction in fertility. Although the variables WEDMIN and WEDMAX are not statistically significant at the 0.05 level, they are consistent for broad age groups 15-24, 25-34, and 35-49, which shows that the observed results are not an artifact of inter-cohort differences. Finally, in identifying variables which are more appropriate in explaining fertility differentials in rural households, a model which incorporates the demographic variables and the size of place of residence variable loses but little in the way of overall explanatory power.

Conclusions and Some Policy Implications

This paper has attempted to analyze the demographic and socioeconomic influences on fertility in rural Sierra Leone with particular emphasis on the role which female educational attainment plays in these relationships. The R-square for the entire sample is 0.45 which indicates that 45 per cent of the variation in fertility among rural households is explained by the variables in the model. The results suggest that similar to Snyder's (1974) and Ketkar's (1978) findings, wife's occupation (here measured by wife's non-farming employment) has, in general, a negative influence on fertility. The demographic variables behaved as generally expected; Snyder's results pertaining to a strong positive effect of previous infant mortality on fertility for urban Sierra Leone are found here for the rural portion as well. Age, age at marriage and desired family size also exhibited the expected signs. While background variables such as tribe and religion may be important, they do not affect in any direct way the fertility of rural women in Sierra Leone. Only larger rural places (2,000-3,000 people) have shown a significant, positive effect (perhaps surprisingly) on fertility.

As in Ketkar's (1978) analysis, when consideration is given to wife's educational attainment, no consistent relationship was found between wife's education and fertility. However, the critical level at which fertility begins to decline was identified to be six years of schooling, which is a year higher than what Ketkar calculated for the urban portion. Of particular importance of the education variable are the signs on the WEDMIN and WEDMAX variables. The positive coefficient of the WEDMIN variable implies that the initial effect of improvement in female education is likely to increase rather than reduce fertility. Only female educational attainment beyond the threshold level would have a depressing effect on fertility. This conclusion is supported by the negative coefficient of the WEDMAX variable.

The findings presented here raise a major policy issue concerning the type of policy that should be pursued by less developed nations where education is unlikely to reduce fertility immediately and may in fact increase fertility in the short run. The negative coefficient of the WEDMAX variable suggests among other things, that female education should receive priority. It then becomes a question of whether emphasis should be placed on a broad-based program of primary education or a more restricted program of secondary education. Also there are questions of whether formal schooling or non-formal or informal education are more important. Studies on the relationship between female education and fertility from the least literate countries (Cochrane, 1979) indicate that secondary education has more immediate negative effects on fertility but at a fairly high cost and has the implication of a more limited distribution of educational facilities. On the other hand, policies that forge universal education (formal or informal) will result in initially higher individual fertility (the positive coefficient of the WEDMIN variable attests to this fact) but will also raise aggregate literacy which is likely to depress fertility in the long run.

In the context of the Sierra Leone situation where over 70 per cent of the population live in rural areas, women generally do not have equitable access to education and virtually everywhere (as in other parts of Tropical Africa) males are given priority for education. For instance, Thomas (1983) noted that school enrollment for girls (14 per cent) is far below that for boys (25 per cent). The rates for the districts (which are predominantly rural) are as low as seven per cent (both sexes) for some districts. The observed low rates are undoubtedly a consequence of the combined effects of economic, social and cultural factors.

Government expenditure on education has become increasingly inadequate to provide the schools, physical infrastructure and manpower needed for a rapidly growing school age population. This has severely hampered the proportion of the population which can be actually enrolled, especially in the primary and secondary levels. Moreover, in the predominantly rural/agricultural areas where over 70 per cent of the population live, children are expected to contribute significantly to total household production (Cain, 1977; Caldwell, 1977; Vlassoff, 1982), a factor which tends to mitigate against school attendance.

Cultural factors are equally important. The low levels of school attendance in the rural areas may be partly the result of a stronger preference for non-formal Arabic education in areas where Islam is the dominant religion. The perception of many traditional societies that young girls should marry and bear children, rather than go to school, provides partial explanation for the lower enrollment rates for females in rural areas. Besides, many of the available schools and other educational facilities are located mainly in towns, which means that rural children would have to leave home and stay either with relatives or in boarding schools. This creates additional expenses, apart from school fees, uniforms and stationery, which many cannot afford (Caldwell, 1980).

The low enrollment rates point to the fact that there is an urgent need for education in the country with particular focus on female education. Any educational policy geared toward improving both boys' and girls' educational opportunities through the initial provision of free univeral education can have an immediate payoff in terms of lower fertility of their parents. Evidence from household surveys in India, Egypt and Nigeria shows that parents have fewer children when education is readily available (Clausen, 1984). The long-term payoff is the shift from high to reduced fertility through the effects of education on several intermediate variables such as better knowledge of health care, increased age at marriage and reduced infant and child mortality.

Formal education and mass media will improve health standards and conditions by diffusing improved knowledge with regard to personal hygiene, food care, etc. They may also break down traditional beliefs and customs such as intercourse taboos and replace them with family planning programs which stress awareness of contraceptive methods and their proper use. Formal education can also operate through higher age at marriage to reduce fertility by shortening the lifetime exposure to the risk of pregnancy. Moreover, it can lead to lowered fertility by reducing infant and child mortality. In this respect, Caldwell (1979) has made a powerful case for the importance of maternal education as a determinant of child mortality. Analyzing the Nigerian survey data, Caldwell concluded that maternal education was the most important single determinant of mortality in childhood. This conclusion is buttressed by the fact that the author controlled for many other variables which might influence mortality such as paternal education and occupation, maternal age and occupation, place of residence, and access to modern medical facilities.

In examining the relationship between female education and fertility, this study has dealt with the educational attainment variable in the "formal schooling" sense only. It is likely, however, that a great deal of the effect of educational attainment on fertility levels is accounted for by a nonformal or informal aspect that this study cannot isolate. A lot of schooling is socialization and indoctrination of social values, which are not necessarily accounted for by educational attainment. Nam (1982) argues that both the nonformal and informal aspects of education through which population learning takes place are equally important.

In this regard, Nam posits that nonformal education in the form of adult or continuing education may provide the student with a structured learning environment in which population-relevant knowledge is transmitted, and that informal education in the form of population socialization may enable the individual to receive and internalize values, attitudes, and norms of behaviour that may have implications for later population-related actions. Nam's argument may have a particular relevance to policy makers in rural areas where formal schooling facilities are grossly inadequate and may not be easily accessible to most rural families.

Like the education attainment factor, the policy implications of the effects of nonformal and informal education on fertility levels could be as important as those of the formal schooling. For example, the Information, Education and Communication (IEC) programmes on maternal and child health, family planning, and nutrition are increasingly providing the awareness and motivation required to space births and reduce levels of fertility and infant-child mortality amongst women who have had no formal schooling. In this regard, nonformal or informal education could be a real policy alternative. Thus, the possible use of both formal and nonformal or informal education to bring about fertility decline in rural areas will be far more effective than the use of the formal approach alone.

Wife's age at marriage is significant and inversely related to fertility. Like education, wife's age at marriage has important implications regarding policy. In rural Sierra Leone, where marriage is almost universal, and fertility by custom is largely limited to married women, age at marriage is fairly low and contraception is not widely practiced. Therefore, raising age at marriage for women by some social legislation or extended schooling can lower fertility substantially. The coefficient of wife's non-farming occupation is negative and significant. This suggests that expansion of the modern sector employment opportunities for women can lead to a reduction in fertility. The coefficient of infant-child mortality is positive and significant. This implies that rural households tend to replace a child who dies with an additional birth. Thus, a reduction in infant-child mortality brought about by rural development, improved medical facilities and increased female education (Caldwell, 1979) would also lead to a decline in fertility.

The results presented here derive from rural areas of Sierra Leone where the illiteracy level is high, so the general problems associated with data from less-developed countries — response errors, age misreporting and age heaping — may have affected the quality of the data and hence the estimates produced. In spite of these limitations, this study has demonstrated three things. First, no consistent relationship exists between a wife's education and her fertility in rural

Sierra Leone. Second, the threshold level of educational attainment for rural women is around six years of schooling, which is a year higher than that identified for urban housewives. Third, the female education threshold hypothesis appears to hold for rural women, that is, women below and above the critical level exhibited the predicted positive and negative coefficients on fertility respectively.

Finally, as noted in the literature, reasons for the existence of the female education threshold level has been attributed to a social or economic phenomenon. What is lacking in these explanations is the linkage between the existence of the threshold levels and the proximate variables (Bongaarts, 1978; Davis and Blake, 1956) through which any social factors influencing the level of fertility must operate. In particular, in addition to identifyng the threshold levels, one would like to know which combinations of the proximate variables produce the positive and negative effects on fertility for women below and above the threshold level respectively. Future research in this area might profitably focus on the linkages between threshold levels and proximate variables, to throw more light on the understanding of the relationship between fertility and the female education threshold concept.

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