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FERTILITY RESPONSE TO CHILD SURVIVAL IN NIGERIA:

AN ANALYSIS OF MICRODATA FROM BENDEL STATE

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The views expressed and any errors are the responsibility of the author.

ABSTRACT

The paper analyzes the response of fertility to own child survival among respondents in Bendel State of Nigeria. The micro-economic theory of fertility behavior provides the theoretical framework for the analysis. Fertility is specified as a function of price and income variables and the survival ratio--two equations were estimated. Actual survival ratio is used as a regressor in the first equation. A preferred two-stage procedure is also used in which the survival ratio is estimated by the method of instrumental variables, because of its endogeneity. The survival ratio has a negative and statistically significant association with fertility for all sub-groups--all women, age groups and rural-urban women respectively. The response of fertility is inelastic for all subgroups with the response elasticity varying between 0.3 and 0.8. The response elasticity is highest among rural women who had experienced the highest incidence of child mortality in the sample. Results suggest the need to reduce mortality levels significantly and fertility will respond rapidly to changes in mortality levels.

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INTRODUCTION

The relationship between infant and child mortality and fertility has become a subject for population analysis in recent times. Such interest has been generated by the theory of the demographic transition, the child replacement hypothesis and the child survival hypothesis (Scrimshaw, 1978). The theory of the demographic transition suggests that mortality declines will eventually be followed by fertility declines because parents would need to bear fewer children to achieve desired surviving offspring. The child replacement hypothesis states that couples produce enough children to ensure the survival of some intended number of children to adulthood. It was therefore assumed that high fertility is a response to high mortality levels.

If couples aim at a given number of surviving children, then one would expect a couple to take action to replace a dead child, and couples who suffer lower mortality are therefore likely to have fewer births. Some authors have thus argued that a reduction of child mortality may be a precondition for successful population control efforts. In recent years however, despite reductions in mortality levels in many developing countries, fertility levels are yet to fall. Rather, population growth rates have remained high and have even risen in some countries. It is therefore important to understand the response of fertility to child mortality.

In Nigeria, the infant mortality rate declined from about 187 per 1000 live births in the sixties to 90 per 1000 live births at present. Crude death rates also declined from about 27 deaths per 1000 persons to about 13-16 deaths per 1000 persons in the same period. Despite these appreciable declines in mortality levels, the population growth rate has increased from about 2.5 percent per annum in the 1970s to about 3.3 percent currently (National Population Policy, 1988). Consequently, Nigeria's population has increased from 55.7 million persons in 1963 to about 98 million persons in 1985, and is expected to rise to 165 million persons by the year 2000 (National Population Policy, 1988). Thus, demographic evidence suggests that child replacement effect may be weak in Nigeria. It is therefore necessary to quantify the strengths of the relationship between fertility and own child mortality in an attempt to identify the reasons for the slow adjustment of fertility to aggregate mortality declines in Nigeria.

This paper attempts to estimate the response of fertility to own child survival using micro-data from Bendel State of Nigeria. A standard demand model of fertility is estimated using own survival ratio as a regressor. Focus is on the effect of survival of a mother's own children on her own fertility because the causal relation is direct and obvious. While current changes in child mortality outside the family and in adult mortality reinforce the incentive to modify reproductive behavior, they are not always easily observed by the individual family.

The paper is organized as follows. Section II discusses theoretical considerations underlying the analysis. Section III discusses data sources for the study. Section IV presents empirical results including computations of fertility response elasticities with respect to own child survival ratios for different subgroups. Section V concludes the paper.

II. THEORETICAL CONSIDERATIONS

Fertility Response to Child Mortality

The response of fertility to child mortality takes any or both of two forms--an *ex post* replacement response and an *ex ante* expectations response (Ben Porath, 1978; Preston, 1978; Lee and Schultz, 1982). According to the child survival hypothesis, parents aim at a given number of surviving children (Taylor, Newman and Kelly, 1976). Thus if a couple intends to have X surviving children, they attempt to bear X children, and if any die, they practice replacement. A replacement strategy is one which attempts to secure the same number of surviving children at the end of reproductive life regardless of the incidence of child death. Replacement is said to be complete when one additional child death induces one additional birth (Preston, 1978).

One can further distinguish between behaviorally induced (volitional) and biologically induced (non-volitional) replacement behavior. The biological effect operates through the termination of breast-feeding at the death of an infant and the consequent shortening of the post-partum infecundable period. Infant deaths potentially shorten birth intervals and increase the potential number of birth over a woman's reproductive life.

The expectations effect is sometimes called a hoarding or insurance response to child mortality (Ben Porath, 1978; Lee and Schultz, 1982). A couple may intend to have X surviving children. They know or believe that some will die later or at a point beyond their childbearing period when they are biologically unable to replace them. Therefore they attempt to bear more than X children even if they experience no child mortality as a form of insurance against possible future deaths.

It is usually difficult to separate replacement and expectations effects on child mortality. The replacement effect can be evaluated by examining cross-section data showing individual maternity histories of children ever born and the survival status of those births. Understanding the hoarding response requires knowledge of parents' attitudes towards childbearing and risk and their perceptions of prevailing child mortality levels in the community. Where parents target child survival to older ages, the insurance effect may dominate replacement effects. In countries where parents expect children to care for them in old age, perpetuate their family line, perform burial ceremonies, etc. (as in Nigeria), one would except the insurance or expectations effects to be stronger (Preston, 1978). Cross-section data at higher levels of aggregation such as for local communities or socio-economic groups and time series may provide a better basis for estimating the combined magnitudes of the expectations and replacement effects on reproduction due to actual and expected mortality across a population (Lee and Schultz, 1982).

Empirical Specification of Explanatory Variables

The standard formulation of the microeconomic theory of fertility emphasizes the demand for children as the key to fertility behavior. The household is presented as making a choice about the number of children it wants within an economic framework of constrained choice. Thus the fertility equation to be estimated is interpreted as an unconditional household demand function which includes all appropriate income and price variables. It excludes all other simultaneously determined household demand variables which interact with or are jointly determined with fertility such as age at marriage, duration of marriage, and mother's labor force participation. A reduced form demand equation which expresses number of children born as a function of explanatory variables assumed to be outside the potential control of the household (that is, purely exogenous variables) is estimated.

To capture non-linearity of cumulative fertility with age, age is introduced as a quadratic variable. The fertility equation is also estimated for age groups to minimize problems due to interaction between age and other explanatory variables.

Respondent's (female) and husband's (male) education are introduced as measures of the value of time and family income emphasized by the economic demand model of fertility. In the case of the wife, it is generally assumed that the substitution effect of the wage rate outweighs the income effect leading to a negative net effect of the wife's eduction on fertility. The net effect of husband's education is indeterminate; it has been found to be positive or U-shaped in some studies (Schultz, 1973; Cochrane, 1979). The hypothesis is that male education or male income is directly related to fertility. Education is allowed to affect fertility non-linearly by introducing four dummy categories of educational attainment--none, primary, secondary and tertiary levels.[1] Husband's education and occupation are used as proxies for income in this study. *A priori* expectations are indeterminate in the case of husband's education while a negative relationship between fertility and female education is hypothesized.

A number of variables representing household's community of residence are also introduced into the fertility equation. They are exogenous to the family's reproductive behavior as they cannot be affected appreciably by the individual's behavior. They are accessibility to the community (i.e. transportation system), occupation-mix or main occupation in the community, and availability of health services.[2] All three variables reflect the degree of urbanization or socio-economic development of the community of residence. It is expected that the more accessible the community is to external influence, the more modern the occupational options, and the greater the availability of modern health facilities (hospitals), the lower fertility is likely to be.

Under some simplifying static assumptions about parental goals for surviving children and the relative costs of survivors, it can be shown that if parents' demand for survivors is price-inelastic, their demand for births with increase when they lose a child (Schultz, 1973). The prediction of this demand framework is that parents are likely to desire an additional birth if one of their children dies, but this replacement response is incomplete (Lee and Schultz, 1982). That is, the response elasticity of children ever born with respect to child death is positive but less than one.

<u>Treatment of Mortality in the Micro-Fertility Equation</u>

The relationship between fertility and mortality is not unidirectional, the association could be in either direction. Thus mortality can be a stimulus to fertility as postulated by the child survival and child replacement hypotheses. Fertility can also lead to higher mortality. Given prevailing high mortality levels in many developing countries, women who have more births are likely to experience higher child mortality. It is also argued that child mortality is a deliberate strategy for controlling family size in some societies (Scrimshaw, 1978). However, the relationship of interest in this study is that from mortality to fertility.

Given the obvious correlation between children born and children dead, direct estimates of the relationship between own child mortality and a woman's cumulative fertility presents estimation problems (Olsen, 1980; Brass and Barrett, 1978). Various approaches to overcoming these problems have been suggested in the literature. In some estimates, the actual realized child mortality ratio $r = D/C$ (where D = child deaths and C = number of births) has been substituted as an instrument for the absolute number of children dead (Olsen, 1980; Lee and Schultz, 1982) to avoid the bias implicit in using the absolute number of child deaths as a regressor. The chain rule is then used to derive the replacement effect. The replacement coefficient can be approximated by dividing the regression coefficient (of D/C) by the sum of the sample mean fertility $(\bar{C})$ plus the coefficient times the mean child mortality ratio. The mortality ratio serves as an instrumental variable for actual number of deaths. One of the problems of using the mortality ratio as a regressor is that the last child has to be born before the final response to mortality can be estimated, while using actual deaths captures the sequential nature of the adjustment to child mortality. The major virtue of the mortality rate specification is that it can be used as an instrumental variable because it is highly correlated with child deaths and at the same time uncorrelated with the error term (Olsen, 1980).

Olsen also suggested a two-stage approach to the estimation of the replacement effect (Olsen, 1980; Trussel and Olsen, 1983). The Olsen technique requires only data on children ever born and children surviving or dead for each woman. For each woman with at least one live birth, the proportion dead (D/C) or the mortality ratio can be calculated. An instrumental variable (for D/C) can also be obtained in a two-stage procedure, in which the mortality rate is estimated at the first stage and used as a regressor in the fertility equation at the second stage. Since mortality and fertility are jointly determined by various socio-economic variables, identification requires that information be available on an identifying variable which affects mortality but does not affect fertility directly. Various correction factors for a variety of circumstances were developed by Olsen (1980). The replacement effect can also be estimated for different age groups to assess whether replacement behavior changes among women of different age groups. This captures the major advantage of using actual mortality as a regressor.

In this paper, the measure of mortality used is the survival ratio, that is, the proportion of surviving children at the time of interview (S = S/C , where S = number of survivors and C = children ever born), which is equivalent to one minus the child mortality ratio. The actual survival ratio is first used as a regressor in the fertility equation. Second, two-stage estimates of the fertility equation are presented.[3] These estimates employ an instrumental variable, the availability of potable water in the community, to predict the child survival ratio, because child mortality itself may be endogenous. This estimation approach provides a basis for estimating consistently only the one-way effect of child mortality on fertility, and separating it from the reverse effect or that due to spurious correlations between fertility and child mortality attributable to unobserved variables. The identification of the structural model by proposed instrumental variable is based on the argument that potable water affects child mortality but does not directly affect fertility. Under these assumptions the two-stage estimates reported here are consistent and can then be used to implement the Wu (1973) Hausman (1978) specification test that assesses whether the child survival ratio is actually an endogenous or exogenous variable in this setting.

III. DATA SOURCES

This paper relies on data collected in a 1985 survey of ever-married women in Bendel State of Nigeria. The major objective of the survey was to examine the relationship between women's status and their fertility behavior. Five major ethnic groups in Bendel State--the Binis, Ishans, Western Ibos, Itsekiris and Urhobos--were included in the study. Five urban and ten rural communities were selected as sample areas. A multi-stage sampling approach was adopted. Altogether, 2,145 ever-married women aged 15-50 years old were successfully interviewed.

The maternity history section of the female questionnaire collected all the information required for the analysis--number of children ever born, their survival status at the date of interview, etc. Information was also collected on postpartum practices after the last two births and on contraceptive knowledge and use by respondents.

As with other studies where retrospective data is collected, there were problems of recall of child deaths, especially of age of child at death or date of birth. Some women were unwilling to talk about child deaths. They were however persuaded to report how many of their live births had subsequently died. Many respondents in some communities in particular, were unable to provide information on year of birth of death and age at death of dead children. However, there is sufficient information to calculate survival rates of children ever born to women in the sample.

IV. EMPIRICAL FINDINGS

Results are presented for a specification of the fertility equation which includes actual survival rate as an explanatory variable in addition to other socio-economic variables. The equation was estimated for three age groups 15-24 years, 25-34 years, 35-50 years and for urban and rural women respectively. Tables 1 and 4 present means and standard deviation of variables used in regression for various sub-groups. Tables 2 and 5 present regression results using actual survival ratio as regressor, while Tables 3 and 6 present results of the two-stage estimations. Emphasis of the discussion is on the relationship between survival rate and children ever born. Results for fertility equations have been presented elsewhere (Okojie, 1989).

Altogether, 1,895 women had completed information on all the variables used in the estimated equations. Mean age of all respondents was 33.8 years. As expected, illiteracy rates are higher among older women and their husbands. Agriculture is the main occupation for respondents and their husbands. Similar distributions for rural and urban women are shown in Table 4.

Regression Results

There is an inverse association after age 35 between children ever born and female education; fertility declined monotonically with higher levels of education even after controlling for the age-education interaction. This negative and highly significant association is evident among the oldest women (35-50 years) most of whom have completed child-bearing. Education has no significant effect among younger age groups. The positive and significant effect of husband's education suggests a positive income effect on fertility eviident after age 25. Other occasionally significant variables were respondent's age and major occupation of community of residence.

The survival ratio is negatively related to fertility as expected for all women and for all three age groups. It is also statistically significant for all subgroups. It is, however, more significant for age group 25-34 years, women who are in their prime child-bearing period, and most of whom are still engaged in childbearing. The coefficient is smaller and less significant among the youngest age group (15-24 years) consisting of women who have just started child-bearing.

Table 3 is based on the instrumental variable estimates and shows many similar results to those in Table 2. The survival ratio is negatively associated with fertility among women over age 35. The instrument variable estimate of the survival ratio effect is less statistically significant than the OLS estimate based on the actual survival ratio.[5] The results still suggest that respondents adjust to own child mortality experience by the end of their childbearing years and that an increase in child survival rates (or a decrease in child mortality rates) will eventually lead to lower fertility as more women perceive that fewer children are required to achieve a target number of surviving children. The residuals from the instrumental variable equations predicting the child survival rate are included in the two-stage estimates reported in Table 3 to test whether the child survival rate is endogenous. The significant t statistic associated with the child survival residual for the older women and all women combined confirms that this variable is endogenous, according to the model specification test proposed by Wu (1973) and Hausman (1978). Because the survival ratio is not exogenous to the fertility relationship, the ordinary least squares estimates of this relationship reported in Table 2 are statistically biased and inconsistent.

Urban-Rural Women

Table 4 shows that urban women and their husbands have attained higher education than their rural counterparts. Urban women are also slightly younger than rural women. Table 5 presents ordinary least squares estimates of the fertility equation using the actual survival ratio, while Table 6 presents two-stage instrumental variable estimates as described earlier.

TABLE 1

Means and Standard Deviations of Variables
Used in Regressions, All Women, by Age Groups

Variables	All Women	15-24 Years	25-34 Years	35-50 Years
Children Ever Born	4.747 (2.465)	2.237 1.159)	4.271 (1.907)	5.819 (2.547)
Age of Woman	33.84 (8.205)	21.579 (1.948)	29.035 (2.683)	41.294 (4.719)
Age Squared	1212.696 (573.421)	469.429 (82.492)	850.261 (156.671)	1727.409 (196.550)
Female Education:				
Primary	0.478	0.548	0.571	0.377
Secondary	0.116	0.259	0.127	0.069
Tertiary	0.070	0.070	0.098	0.055
Age times Education (10^{-2})	1.84 (1.624)	1.740 (.922)	1.989 (1.316)	1.743 (1.969)
Husband Education:				
Primary	0.392	0.421	0.431	0.349
Secondary	0.205	0.267	0.239	0.159
Tertiary	0.141	0.197	0.153	0.116
Husband's Occupation				
Professional–Technical	0.226	0.281	0.261	0.180
Sales	0.125	0.145	0.129	0.116
Agriculture	0.419	0.197	0.364	0.116
Services	0.208	0.346	0.228	0.155
Community Variables:				
Highly Accessible	0.72	0.912	0.782	0.727
Occupation–Mixes:				
Mainly Farming	0.577	0.478	0.515	0.656
Farming/Fishing	0.189	0.171	0.213	0.172
Health Services	0.603	0.741	0.646	0.529
Community Potable Water	0.808	0.890	0.828	0.770
Piped Personal Well Water	0.181	0.167	0.192	0.174
Piped Other Source of Water	0.368	0.509	0.363	0.336
Survival Ratio	0.926	0.938	0.938	0.914
Education in Years	5.863 (23.752)	8.065 (4.136)	6.909 (4.557)	4.361 (4.866)
Sample Size	1895	228	785	882

Standard deviations are in parentheses.
For dummy variables standard deviations can be calculated as $SD = \sqrt{P(1-p)}$, where P is the mean of the variable.
For omitted categories, see footnote 4.

TABLE 2

Regressions of Children Ever Born for All Women and Age Groups
Ordinary Least Squares

Variables	All Women	15-24 Years	25-34 Years	35-50 Years
Intercept	-4.607	-1.179	-1.255	7.598
	(-4.362)	(-0.149)	(-0.173)	(0.991)
Age of Woman	0.561	0.254	0.250	0.001
	(10.829)	(0.343)	(0.507)	(0.003)
Age Squared	-0.006	0.0002	0.0008	-0.0001
	(-9.149)	(0.014)	(0.097)	(-0.018)
Female Education:				
Primary	-1.186	0.997	0.447	-2.822
	(-3.323)	(0.650)	(0.460)	(-2.520)
Secondary	-2.186	1.233	0.362	-4.748
	(-3.907)	(0.482)	(0.223)	(-2.546)
Tertiary	-3.277	0.057	0.548	-7.105
	(-4.907)	(0.242)	(0.269)	(-2.799)
Age times Education	0.005	-0.005	-0.003	-0.010
	(3.688)	(-0.548)	(-0.594)	(2.666)
Husband Education:				
Primary	0.499	-0.628	0.628	0.569
	(3.667)	(-2.314)	(3.104)	(2.557)
Secondary	0.439	-0.574	0.627	0.377
	(2.368)	(-1.407)	(1.564)	(1.209)
Tertiary	0.382	-0.517	0.468	0.523
	(1.612)	(-1.407)	(1.564)	(1.209)
Husband's Occupation:				
Professional–Technical	0.305	-0.177	-0.097	0.856
	(0.924)	(-0.409)	(-0.214)	(1.463)
Sales	0.520	-0.077	0.045	1.151
	(1.498)	(-0.167)	(0.093)	(1.899)
Agriculture	0.269	-0.491	0.311	0.577
	(0.787)	(-1.041)	(0.093)	(0.983)
Services	0.402	-0.521	0.244	0.961
	(1.190)	(-1.179)	(0.522)	(1.899)
Community Variables:				
Highly Accessible	0.088	-0.080	0.193	0.039
	(0.566)	(-0.252)	(0.903)	(0.154)
Mainly Farming	0.099	-0.277	0.156	0.145
	(0.764)	(-1.565)	(0.990)	(0.564)
Farming/Fishing	-0.798	-0.0441	-0.914	-0.831
	(-4.893)	(-1.751)	(-0.454)	(-2.689)
Health Services	0.022	-0.298	0.086	0.101
	(0.156)	(-1.346)	(0.455)	(0.421)
Survival Ratio (Actual)	-2.655	-0.865	-3.146	-3.017
	(-8.629)	(-2.199)	(-7.190)	(-5.639)

TABLE 2, continued

Variables	All Women	15-24 Years	25-34 Years	35-50 Years
F Ratio	52.76	3.64	17.44	5.000
Prob > F	0.0001	0.0001	0.0001	0.0001
R^2	0.3361	0.2383	0.2907	0.0945
Joint F Tests of All Coefficients Being Zero:				
Age – Age^2	117.70	0.123	0.268	0.000
Female Education	16.456	0.164	0.086	7.173
Husband's Education	7.797	4.218	7.167	3.249
Husband's Occupation	1.345	0.559	0.078	2.539
Occupation–Mix	6.936	3.674	5.520	1.745

Absolute values of t-ratios are in parentheses beneath regression coefficients.

TABLE 3

Regressions of Children Ever Born for All Women and Age Groups:
Two Stage Instrumental Variable Estimates

Variables	All Women	15-24 Years	25-34 Years	35-50 Years
Intercept	6.16	-4.36	11.3	14.1
	(1.97)	(-.49)	(.80)	(1.71)
Age of Woman	.538	.284	.199	-.0448
	(10.2)	(.38)	(.40)	(-.12)
Age Squared ($\times 10^{-2}$)	-.634	-.0043	.0964	.0273
	(-8.95)	(.00)	(.11)	(.06)
Female Education:				
Primary	-1.03	.971	.521	-2.67
	(-2.87)	(.63)	(.54)	(-2.38)
Secondary	-1.94	1.21	.417	-4.42
	(-3.46)	(.47)	(.26)	(-2.37)
Tertiary	-2.79	.890	1.21	-6.78
	(-3.64)	(.25)	(.54)	(-2.67)
Age times Education ($\times 10^{-2}$)	.474	-.537	-.281	.993
	(3.61)	(-.55)	(-.61)	(2.63)
Husband Education:				
Primary	.497	-.627	.558	.577
	(3.66)	(-2.31)	(3.06)	(2.60)
Secondary	.446	-.565	.610	.426
	(2.41)	(-1.84)	(2.57)	(1.26)
Tertiary	.387	-.511	.457	.540
	(1.64)	(-1.39)	(1.53)	(1.25)
Husband's Occupation				
Professional–Technical	.249	-.213	-.105	.748
	(.76)	(-.50)	(-.23)	(1.28)
Sales	.480	-.094	.035	1.07
	(1.39)	(-.201)	(.07)	(1.76)
Agriculture	.194	-.513	.268	.476
	(.57)	(-1.08)	(.56)	(.81)
Services	.374	-.538	.245	.889
	(1.11)	(-.44)	(.52)	(1.50)
Community Variables:				
Highly Accessible	-.0171	-.0059	.556	-.134
	(-.11)	(-.02)	(1.36)	(-.49)
Mainly Farming	.287	-.223	.332	.383
	(2.06)	(-1.17)	(1.44)	(1.36)
Mainly Fishing	-.341	-.449	-.403	-.457
	(-1.66)	(-1.78)	(-.76)	(-1.28)
Health Services	.166	-.377	.0658	.206
	(1.13)	(-1.55)	(.34)	(.84)
Survival Ratio (Actual)	-13.7	1.98	-15.7	-8.87
	(-4.52)	(.54)	(-1.30)	(-3.12)
Residual (actual-predicted)	11.2	-2.88	12.5	6.08
	(3.66)	(-.79)	(1.04)	(2.10)

TABLE 3, continued

Variables	All Women	15-24 Years	25-34 Years	35-50 Years
F Ratio	51.02	3.47	16.58	4.99
Prob > F	.0001	.0001	.0001	.0001
R^2	.3408	.2405	.2917	.0991
Joint F Tests of All Coefficients Being Zero:				
Age – Age^2	104.3	.15	.169	.015
Female Education	12.15	.16	.201	6.40
Husband's Education	7.96	4.13	6.84	3.59
Husband's Occupation	1.02	.64	.061	2.04
Occupation–Mix	.039	3.14	.009	.016

See note to Table 2.

Generally, the OLS equation performs better for urban women than for rural women. Among rural women, only age, husband's education and survival rate are statistically significant. Survival rate is significant suggesting that own child survival has a strong influence on fertility behavior of rural women. Female education is statistically insignificant for rural women, but there are only eight percent of the rural women with more than a primary education (Table 4), and they tend to be young.

Among urban women, the price and income variables have the expected signs and are statistically significant. Female education is negatively related to fertility and is statistically significant. Husband's education also has a positive and statistically significant income effect on wife's fertility. Survival rate also has the expected negative association with fertility and is statistically significant though to a lesser extent than for rural women.

The results using the two-stage estimation procedure are also similar to those in Table 5 where the actual survival ratio is used as the regressor. The survival ratio remains negatively correlated with fertility. However, the survival ratio is less statistically significant when the instrumentally predicted value is used in the estimation for urban women, perhaps because the access to water variable used as the instrument does not vary sufficiently in the urban sample or account for child mortality.

The two-stage procedure using predicted survival rates often resulted in a reduction in the statistical significance of the survival effect. However, the survival ratio remains an important determinant of fertility levels in the rural areas and among older women who have more or less completed their fertility. This may be due to the fact that urban women have generally experienced lower own-child mortality than rural women. While 23.7 percent of urban women had experienced own-child mortality, 36.7 percent of rural women had experienced a child death.

Thus fertility response is stronger and more statistically significant in the OLS regressions among older women, especially over age 25, and among rural women. Results suggest that replacement behavior is very strong among women aged 25-34 years who are likely to consider more seriously recent deaths of offspring in their decision to have more children. They would like to replace dead children if they have not reached their target number of surviving children before they are biologically unable to do so. The same reasoning may be true of rural women who experience high child mortality and would therefore want to replace dead children to meet their target number of surviving children.

The more pronounced reproductive response among older women and among rural women suggests that reproductive response may be due mainly to behavioral (demand) factors and less to biological factors. Among respondents in this sample, observed durations of postpartum birth regulating behavior were short. Mean

TABLE 4

Means and Standard Deviations of Variables Used in Regression:
Urban and Rural Women

Variables	Rural Women	Urban Women
Children Ever Born	4.722 (2.397)	4.769 (2.524)
Age of Woman	35.279 (8.006)	32.553 (8.172)
Age Squared ($\times 10^{-2}$)	13.08 (.578)	11.26 (.561)
Female Education:		
Primary	0.503	0.456
Secondary	0.057	0.169
Tertiary	0.022	0.113
Age times Education (10^{-2})	1.493 (1.460)	2.160 (1.698)
Husband Education:		
Primary	0.455	0.335
Secondary	0.095	0.305
Tertiary	0.062	0.212
Husband's Occupation		
Professional–Technical	0.088	0.349
Sales	0.109	0.138
Agriculture	0.704	0.162
Services	0.091	0.314
Community Potable Water	.595	1.00
Piped Personal Well Water	0.108	0.601
Piped Other Source of Water	0.266	0.104
Survival Ratio	0.928	0.926
Education in Years	4.559 (4.216)	7.035 (26.245)
Sample Size	897	998

Standard deviations are in parentheses.
For dummy variables, standard deviations can be calculated as $SD = \sqrt{P(1-p)}$.

TABLE 5

Regressions of Children Ever Born, Urban and Rural Women
Ordinary Least Squares

Variables	Rural Women	Urban Women
Intercept	-0.143	-6.971
	(0.079)	(5.302)
Age of Woman	0.437	0.649
	(5.290)	(9.601)
	0.649	9.601
Age Squared	-0.005	-0.008
	(4.083)	(8.151)
Female Education:		
Primary	-0.336	-1.428
	(0.556)	(3.141)
Secondary	-1.047	-2.474
	(1.057)	(3.556)
Tertiary	-1.134	-3.838
	(0.808)	(4.129)
Age times Education	0.001	0.006
	(0.496)	(3.556)
Husband Education:		
Primary	0.403	0.655
	(2.313)	(2.971)
Secondary	0.519	0.381
	(1.744)	(1.480)
Tertiary	0.915	0.269
	(2.179)	(0.874)
Husband's Occupation:		
Professional–Technical	-1.393	0.574
	(1.593)	(1.631)
Sales	-1.238	0.743
	(1.398)	(1.954)
Agriculture	-0.928	0.313
	(1.069)	(0.813)
Services	-1.027	0.505
	(1.149)	(1.395)
Survival Ratio (Actual)	-4.177	-1.599
	(8.735)	(3.992)
F Ratio	23.88	45.83
Prob > F	0.0001	0.0001
R^2	0.2749	0.3949
Joint F Tests of All Coefficients Being Zero:		
Age – Age^2	28.149	92.522
Female Education	0.748	14.352
Husband's Education	7.046	3.499
Husbarid's Occupation	1.784	2.426

See note to Table 2.

TABLE 6

Regressions of Children Ever Born, Rural-Urban Women,
Two-Stage Instrumental Variable Estimates

Variables	Rural Women	Urban Women
Intercept	20.67 (6.51)	-7.66 (-1.73)
Age of Woman	.387 (4.83)	.651 (9.50)
Age Squared ($\times 10^{-2}$)	-.411 (-3.86)	-.762 (-8.15)
Female Education:		
Primary	.194 (0.33)	-1.42 (3.12)
Secondary	-.650 (-0.69)	-2.48 (3.56)
Tertiary	-.0955 (-0.07)	-3.86 (4.11)
Age times Education ($\times 10^{-2}$)	0.0194 (.89)	.590 (3.56)
Husband Education:		
Primary	0.420 (2.49)	0.655 (2.97)
Secondary	0.547 (1.89)	0.379 (1.47)
Tertiary	0.756 (1.85)	0.268 (0.87)
Husband's Occupation:		
Professional–Technical	-1.35 (-1.59)	0.580 (1.64)
Sales	-0.759 (-0.89)	0.746 (1.96)
Agriculture	-0.706 (-0.84)	0.320 (0.83)
Services	-0.798 (-0.92)	0.508 (1.40)
Survival Ratio (Actual)	-25.98 (-9.24)	-0.920 (-0.22)
Residual (actual-predicted)	22.45 (7.86)	-0.686 (-0.16)
F Ratio	27.97	42.74
Prob > F	0.0001	0.0001
R^2	0.3224	0.3950
Joint F Tests of All Coefficients Being Zero:		
Age – Age^2	23.42	90.54
Female Education	0.038	14.36
Husband's Education	6.64	3.48
Husband's Occupation	1.182	2.45

See note to Table 2.

durations of breastfeeding and sexual abstinence after the second-to-the-last child were 11.1 and 8.0 months respectively. (Mean age at marriage was 18 years.) It appears that the fertility response is a behavioral preference to replace a dead child.

The observed higher population growth rates in Nigeria despite falling mortality levels may thus be partially explained as follows. First, fertility response to own child mortality is inelastic, and a higher survival rate has a negative effect on fertility. Second, own child mortality and community mortality experiences instrumented here may be more important considerations than national average mortality experience outside the community. Given the high illiteracy rate among women, they are unlikely to be aware of average mortality levels in the society outside their communities. There may be some lag in the response of fertility to lower mortality levels emerging among older women. There is a need to intensify maternal and child health care services to reach the rural areas which have thus far been relatively neglected. Findings imply that attempts to reduce child mortality in rural areas will have a significant effects on fertility levels since the response elasticity is highest among rural women. More conclusive statements on a national level would however require analysis of nation-wide data sets.

V. CONCLUSION

This paper has examined the relation between own child survival and cumulative fertility among respondents in Bendel State of Nigeria. Holding constant age, education, husband's education and occupation, and some community variables, statistically significant negative associations are reported between own child survival ratio and cumulative fertility. Individual reproductive responses to actual survival ratios are statistically significant among all groups for whom the fertility equation is estimated, particularly among older women and among rural women.

Thus fertility equations were estimated for each sub-group. The first equation was specified as a linear function of the actual survival ratio. A two-stage estimation procedure was reported where the survival ratio is treated as endogenous and instrumented by potable water. In both specifications, the fertility response to child deaths is evident. The results show that even with unavoidably weak identifying instrumental variables, one can still obtain an unbiased fertility response with some degree of confidence, even though the two-stage estimates of the effect of child survival on fertility appear to be less statistically precise. The specification test confirms that child survival is endogenous to the fertility determination process.

The paper suggests that there is a need for more studies of aggregate mortality trends and individual child survival experience and their relationship to individual reproductive behavior in Nigeria. Mortality levels need to be brought to much lower levels, especially in rural areas, and fertility should respond. For significant reductions in fertility levels to follow child mortality reductions, however, contraceptive use has to become more wide-spread in Nigeria.

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FOOTNOTES

1. A specification using years of education (of wife) instead of dummy categories was also estimated for urban-rural women for all women and age groups. The results remained unchanged; higher years of education were associated with lower fertility for older and urban women. Educational levels were converted into approximate years of schooling as follows:

   None – 0 years
   Primary – 7 years
   Secondary – 5 years
   Tertiary – 4 years

   Thus a woman with tertiary education would have spent approximately 16 years at school.

2. A community was highly accessible if it had good access roads, it was inaccessible (omitted category) if it had poor untarred access roads. With respect to occupation-mix, a community is categorized as mainly farming if farming is the major occupation. The excluded category consisted of highly urbanized areas with mainly non-agricultural occupations. Accessibility of health facilities was measured by the presence of modern hospital(s) in the community.

3. In the two-stage estimation of the fertility equation the availability of potable water in the community of residence was used as the identifying variable in the survival equation for the entire sample and in the age disaggregated and rural subsamples. For the urban subsample all communities have potable water, and the identifying variable is whether the household has piped water from a personal well or other source. The omitted category is no nearby source of household water.

4. The omitted categories are as follows:

   Education (male and female) – None
   Husband's occupation – Not in the labor force
   Accessibility – Not accessible
   Occupation-mix – Modern occupations
   Lack of health services – No hospitals

5. The fertility equation estimated at the second stage is of the form:

$$F = B_0 + \sum_{i=1}^{n-1} B_i X_i + B_n \left(\frac{S}{C}\right) + \gamma \left[\frac{S}{C} - \left(\frac{\hat{S}}{C}\right)\right] + e$$

where

F = children ever born

X_i = all other explanatory variables

$\frac{S}{C}$ = survival ratio

$\left(\frac{\hat{S}}{C}\right)$ = predicted survival ratio and

e = error term

$\frac{S}{C} - \left(\frac{\hat{S}}{C}\right)$ = residual

Thus, the response of a woman's fertility to a change in her predicted child survival ratio, that represents her likely response to an exogenous change occurring outside of the household such as from the community provision of potable water, is simply $-\gamma$.

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