Fertility and Child Mortality in Côte d'Ivoire and Ghana

Kofi Benefo and T. Paul Schultz

This article examines individual, household, and community characteristics that may affect fertility in contemporary Côte d'Ivoire and Ghana and the relationship between child mortality and fertility. It was not possible to reject the null hypothesis that child mortality is exogenous. Treating child mortality as exogenous, fertility responds directly to child mortality, but by a smaller proportion than estimated in studies of East Asia and Latin America. Increases in female education and urbanization are likely to contribute to declines in fertility in both countries, but economic growth without these structural changes is not yet strongly related to lower fertility.

This article examines individual, household, and community characteristics that affect fertility in two neighboring West African countries: Côte d'Ivoire and Ghana. It analyzes the relationship between child mortality and fertility and examines the idea that high levels of child mortality encourage parents to have large numbers of births (Notestein 1945; Smith 1961; Freedman 1975; Schultz 1969, 1976). The reduction in child mortality is an obvious objective of parents and society. Public programs that promote child health might, nonetheless, receive still more support if reduced levels of child mortality were shown to contribute to reducing fertility and thereby to slowing population growth.

There are conceptual and statistical problems with measuring the causal relationship between child mortality and fertility. Both variables may affect each other, both may be modified by other factors, and both may be measured with error, generating a difficult-to-interpret association between fertility and child mortality. For social scientists to measure without bias the effect of child mortality on fertility, they must observe features of the woman's environment that affect only the mortality of her own child. One such environmental factor might be a local public health program that increases child survival, but does not otherwise directly affect fertility.

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Most previous studies of fertility in Africa have relied on surveys such as the World Fertility Survey or the subsequent Demographic Health Surveys, neither of which collected much information on the household's economic characteristics, community environmental setting, or local health programs (Barbieri 1989). This article analyzes data from the Living Standards Measurement Surveys (LSMS) in Côte d'Ivoire and Ghana, which were collected in the late 1980s, and include information on household consumption and economic behavior, as well as on prices and conditions in each sample cluster (or community). These data have greater potential for clarifying the economic and educational determinants of fertility in combination with child mortality than do those from previous African surveys (Ainsworth 1989).

Section I discusses the determinants of child mortality and fertility and explores the statistical problems that arise in estimating interrelationships between the two. Section II presents the methodological issues, including data sources, sample selection, variable definitions, and descriptive statistics. Section III reports estimates of the determinants of child mortality and fertility. Section IV presents conclusions. An expanded version of this article appears in Benefo and Schultz (1994), and a contemporary overview of demographic conditions in Sub-Saharan Africa is provided by van de Walle and Foster (1990).

I. Determinants of Fertility and Child Mortality

This section develops the conceptual framework for the choice and treatment of determinants of fertility and child mortality. Exogenous determinants of fertility are characteristics of the woman, her household, and community over which she exerts no control, but which are likely to affect her fertility. By contrast, endogenous variables that may determine a woman's fertility reflect in part decisions and choices that either she or the members of her household have made and that are constrained by her economic endowments and luck. This distinction between exogenous and endogenous variables is important, because the use of endogenous choice variables to explain fertility and child mortality can lead to biased and misleading results if this endogeneity is not recognized and properly treated econometrically.

This conceptual framework could lead to two alternative but potentially complementary approaches in an empirical analysis of fertility. The first approach estimates *reduced-form relationships*, including among the explanatory variables all exogenous variables that potentially affect fertility, directly or indirectly. This approach thereby excludes family outcome variables that are endogenous because they may be affected by the woman's behavior or choices. In other words, because the errors embodied in such endogenous variables are likely to be correlated with those in the fertility equation, they must be excluded from reduced-form relationships to avoid bias by single-stage estimation methods, such as ordinary least squares (OLS). The correlation of errors could be caused by preferences, unobserved heterogeneity of couples, or other omitted factors and measurement errors. Parallel reduced-form analyses of child mortality determinants can be undertaken.

The second estimation strategy is pursued here and introduces further *structural assumptions* about how some endogenous family outcome variables, such as the child death rate, are themselves determined by additional variables that do not directly impact fertility. These structural assumptions are used to identify statistically and to estimate consistently the effect of an endogenous explanatory variable on fertility, conditional on the hypothesized structure.

Fertility, Income, and Child Mortality

Economic theories of fertility assume that parents have the number of children they want, given the costs and benefits associated with having a specific number of births, including the costs of avoiding unwanted births. The lifetime demand for births (F) is a function of many socioeconomic factors, and we stress a few of the lifetime economic constraints as they affect a representative woman: the woman's productive opportunities, W ; her household's nonhuman capital assets, V ; the mortality rate her children experience, D ; local market prices, P ; and local public services and environment, S (Willis 1974; Ben Porath 1978; Schultz 1981);

$$F = F\,[W(E, T),\ V,\ D;\ P,\ S] \qquad (1)$$

where E denotes the woman's education and T her height.

The productivity of a woman's time is expected to decrease her demand for births, because the increase in the opportunity cost of her time in childcare outweighs, on balance, the increase in her income opportunities (Schultz 1981). The woman's schooling may have many effects on her opportunities and behavior, one of which is to increase her wage. Education may also affect women's demand for children in other unspecified ways and shift their biological supply of births, positively through improvements in their health and nutrition, and perhaps also through reducing their risk of contracting sexually transmitted diseases, which are implicated in premature sterility and a shortfall in reproductive supply. The educational control variables are thus proxies for the productive value of a woman's time, her ability to practice effective birth control, and all other mechanisms by which education influences reproductive capacity, goals, and behavior (Kritz and Gurak 1989). In both Côte d'Ivoire and Ghana, the education of women is strongly associated with their wages. The proportionate gain in wages is larger at the secondary school level than at the primary level per year completed, and wage returns to schooling are generally larger in Côte d'Ivoire than in Ghana (Schultz and Tansel 1992). Consequently, education is specified as a spline in years completed at three levels of schooling.

Taller individuals are widely observed to be more productive and to have fewer health problems. The nutritional status that is achieved through improved diet and reduced exposure to disease during early childhood increases the height that an adult can reach (Fogel 1991; Schultz 1995). Migration from a rural region to an urban area is another important investment that increases the productivity of women (by 21 to 64 percent in Ghana and Côte d'Ivoire, respectively) (Schultz 1995: table 2). However, adult migration is more likely to be determined simultaneously with fertility. Consequently, migration is endogenous in a lifetime fertility model, and it is omitted from this analysis. Results in which migration is treated as exogenous are reported elsewhere (Benefo and Schultz 1994).

Market income per adult in the household is endogenous to lifetime cumulative fertility because it embodies the effect of labor supply and family composition decisions, and it is also intertemporally redistributed by savings and investments, such as the choice as an adult to migrate from a rural to an urban area. Most clearly, the woman's market labor supply and her fertility over the life cycle are jointly determined, to the extent that children and market labor place competing demands on her budget of time. What initial economic conditions are expected to affect a woman's lifetime demand for children? The framework calls for information on her inherited nonhuman capital assets or exogenous cumulative transfers, just as we have included indicators of her initial human capital stocks as an adult, in the form of education, and early nutrition, proxied by height.

Without information in our data on inherited nonhuman capital assets or exogenous transfers, we can either omit altogether income from the model or use current assets of the household per adult as an instrument to predict household income (proxied commonly by more accurate measures of consumption per adult). This latter estimation approach could be misleading if current assets are themselves endogenous to the life-cycle accumulation process, in which case assets would be an invalid instrument. Elsewhere we have reported these instrumental variable (*IV*) estimates that treat household income or consumption as endogenous (Benefo and Schultz 1994). In this article, at the urging of a referee, we have eliminated income or consumption entirely from the model, and implicitly income is solved out of the partially reduced-form equation estimated. The household assets per adult and the prevalence of tree crops in the community are retained from the previous study as exogenous conditioning variables. The notable finding of that previous study was that income was positively associated with fertility in Côte d'Ivoire and negatively in Ghana, and positively in rural areas of both countries and negatively in urban areas.

The relative prices of market goods and public services in the community may have diverse effects on the costs and benefits of fertility, and are included as control variables. If parents want to have fewer children than they would otherwise have, the price of contraception should affect fertility. Unfortunately, insufficient information on the local availability and cost of birth control methods is available to include them in this study (Benefo and Schultz 1994). Family planning services are not provided by the public health system in Côte d'Ivoire, and the LSMS data for that country do not include individual- or community-level information on birth control practices or availability of family planning methods. A health facility questionnaire collected information in Ghana about the provision of family planning services and availability of supplies, but these facility data could be matched with only 60 percent of the LSMS households. About 2 percent of women report using modern methods of contraception in Côte d'Ivoire and 5.6 percent in Ghana (Oliver 1995). The variation in fertility analyzed in this study appears to be largely associated with differentials in the timing and incidence of marriage and traditional birth-spacing practices.

The first model specification assumes that all of the explanatory variables in the fertility equation are exogenous. OLS estimates of model I are a reasonable first step in the empirical analysis of the survey data on these variables.[1]

The decision of a woman to marry—and consequently the characteristics of her husband—or to head her own household can be viewed as decisions made jointly with fertility over the life cycle. If these household composition variables are themselves adapting to changes in the constraints on individual choice during the development process, it is not clear how they would be structurally identified in a fertility model (Schultz 1994). A common practice of stratifying the population and explaining the reproductive behavior of only married women merely transforms the problem into one of correcting for sample selection bias, which also depends on some form of identification. One solution to this conundrum is to omit the household composition and husband characteristics from the model entirely and implicitly solve them out of partially reduced-form equations as with income. This approach would seek to understand the woman's behavior on the basis of her own initial endowments and locally evolving opportunities. This specification is estimated as model II.

The specification for model III makes the less satisfactory assumption that household composition and husband characteristics are exogenous to fertility and are likely to affect child mortality and fertility.

Most economic studies of fertility are based on a static formulation of a lifetime demand for births, which abstracts from considerations of dynamic optimization. Without a panel survey of long duration that measures time-varying constraints on fertility, our model can only attempt to account for lifetime fertility, conditional on nonlinear age effects.

Child Mortality

Child mortality can affect a woman's demand for births in two ways. First, it can induce her to *replace ex post* her children who die. This response could occur by means of a biological feedback or through adaptations of behavior. This mechanism would be more effective if childbearing is initiated at an early age and premature sterility is infrequent, allowing most couples to have the biological capacity to bear more births than they want. Even if parents do not use modern birth control practices, shorter periods of postpartum abstinence and shorter

1. Tobit and ordered probit models can also be estimated to deal with the censored and discrete form of the fertility variable. Reestimation of our final models did not noticeably change the conclusions reviewed here.

durations of breastfeeding could allow the fertility of individuals to compensate substantially for their experience of child mortality.

Second, in a society where child mortality has been stable or slowly declining for some decades, parents can adapt their fertility behavior *in anticipation of* the levels of child mortality they will experience on average. One form of anticipatory behavior would be the case in which parents help their children marry earlier in higher child mortality regions, as observed in Taiwan (China), for example (Schultz 1980). Early marriage might be preferred to shortened birth intervals in environments where early weaning of infants would expose them to further health risks.

An objective of this article is to assess the sum of the replacement and anticipatory responses of fertility to child mortality. As indicated in the introduction, estimating this effect from the observed association may be misleading. First, the causal effects can flow in both directions, overstating the one-way effect we want to estimate. High levels of fertility may increase child mortality by stretching family resources and the biological capacity of the woman to bear healthy children. Second, unobserved features of the woman, her household, and her community may contribute to her experiencing higher child mortality and fertility, introducing a spurious correlation between the two outcomes. Third, errors in measuring the appropriate (realized and anticipated) child mortality would probably bias downward the estimated effect of child mortality on fertility. Fourth, the possible values of the child mortality rate depend on the number of children born, a factor that introduces additional forms of interdependence (Olsen 1980).

Child mortality may be affected by all the exogenous variables in the fertility equation (equation 1) and by certain additional exogenous factors that change the relative cost or availability of child health inputs for the parents. We assume that a set of community variables (C), associated with water and sanitation infrastructure, distance to the nearest health clinic, and community disease problems (Patterson 1981; Morrow, Smith, and Nimo 1982) affect the proportion of children dying before their fifth birthday, D, but do not otherwise impact a woman's fertility:

$$D = D[W(E, T), V; P, S, C]. \tag{2}$$

Household assets are expected to reduce child mortality. Most recent studies of child mortality find a woman's education to be related negatively to her experience of child mortality, although this effect of female education could be due partly to the child health inputs she is able to purchase or produce with her education-enhanced wages and improved marriage prospects (Pitt 1995). The mother's height is a proxy for her own health investments as well as her genetic health endowments, which are likely to improve the chances for her children to survive.

With child mortality, errors in measurement may be substantial. By treating child mortality in the fertility equation as endogenous and estimating it by instrumental variables (*IV*), we should eliminate both simultaneous equations bias and classical random measurement error bias. Hausman (1978) specification tests can also be implemented to test whether child mortality is empirically endogenous, as we hypothesize in models II and III. The *IV* estimates of fertility (equation 1) and the Hausman specification tests will be treated with greater confidence if the identifying instruments in the child mortality equation (equation 2) are jointly significant in explaining child mortality, after controlling for the other exogenous variables.

Additional Issues of Empirical Specification

The unusually high level of child mortality between the ages of one and five in West Africa is an argument for basing our analysis on a five-year cohort measure of child mortality rather than a conventional infant mortality rate. Because weaning is often delayed until after the first year, it seemed important to understand how household resources and environment affect child survival prospects beyond the critical weaning-feeding transition, when children must develop their own immunities to local pathogens and local water and sanitation facilities may affect child mortality. In order to measure this dimension of child mortality, our working sample must be limited to women who have had a child five years before the survey.

The choice of five-year child survival rates (*q* in lifetable terms) is perhaps more suitable than infant mortality if the goal is to estimate replacement responses to child mortality. The analysis was repeated using only infant (first year) mortality as our measure of child deaths for the same sample examined here, and again for the larger sample that included fertility and infant mortality for all births up to one year before the survey. No substantial changes in the conclusions were noted, although food prices tended to be more significant in explaining child mortality through age five than they were in explaining infant mortality.

The opportunity cost of a woman's time is expected to be an important determinant of the price of having children. Although women in West Africa are the main providers of childcare and are often responsible for producing or purchasing the food and medical care children receive, women infrequently work as wage laborers. In the late 1980s, in Côte d'Ivoire only 4 percent of women worked for wages, and in Ghana the proportion was 7 percent (Schultz and Tansel 1992). Consequently, any prediction we might devise for the market wage that a particular woman could expect to receive might not be a reliable indicator of the opportunity cost of her time if she worked outside of the wage labor force. In both countries, however, the education of women is strongly associated with their market wage rates and self-employment earnings. Thus, it seems reasonable to use years of educational attainment to proxy the value of women's time in both wage and nonwage work (van der Gaag and Vijverberg 1987).

Because the community price series are highly intercorrelated, any one price should not be treated as varying independently of the other prices for the purposes of policy simulations. Rather the entire set of prices summarizes the factors responsible for the relative scarcity of basic foods and household staples, such as local climate and geography, transportation infrastructure, and market integration. Finally, characteristics of the local economy and health and sanitation system are included to assess the impact of these policies.

II. METHODOLOGICAL ISSUES IN THE EMPIRICAL SPECIFICATION

The data for this study are primarily from the LSMS conducted by national statistical agencies in collaboration with the World Bank. We use the first three rounds of the Côte d'Ivoire Living Standards Survey (CILSS) conducted in 1985, 1986, and 1987, and two rounds of the Ghana Living Standards Survey (GLSS) in 1987–88 and 1988–89 (Ainsworth and Munoz 1986; Glewwe 1987). The CILSS interviewed 1,600 households per year for a total of 4,800, and the GLSS interviewed 3,200 households per year for a total of 6,400. The surveys used two-stage, self-weighted stratified (by three agroecological zones and size of localities) sample designs.

The surveys collected reproductive histories of one randomly selected woman of childbearing age in each household. The working sample is restricted to women who had at least one birth five or more years before the date of the survey. A small number of women (or their husbands) who did not report information are also excluded. Our working samples include 1,943 women in Côte d'Ivoire and 2,237 in Ghana. Each sampling cluster (or enumeration area) contains 16 households. Each year 100 clusters were sampled in Côte d'Ivoire and 200 in Ghana. The samples are a rotating panel, with half of the clusters randomly replaced each year. A subset of the sample households is reinterviewed in adjacent years, but these households have not been matched for this study. The household and individual identification codes from the first year were not preserved in the second-year data in Ghana; thus matching would be difficult. About 600 households were reinterviewed in Côte d'Ivoire in each following year and can be matched. This information is not used to adjust the standard errors in this study because, although the households can be matched, the woman interviewed in each household was not necessarily the same (Schultz 1995). The coefficient estimates obtained here are probably not biased by our failure to incorporate this sampling design in our estimates, but the true standard errors may be somewhat larger than those reported.

Definitions of Variables

The woman is the unit of analysis. The human capital endowment of the woman is summarized by her age, education (years by three levels), and height. If she is married, similar information is available for her spouse. Household-level information includes the sum of the value of business assets, land, and nonearned income.[2] Appendix table A-1 reports the means and standard deviations of all of the variables for the working samples of women.

2. Nonearned income is capitalized with other assets at a 10 percent rate of return.

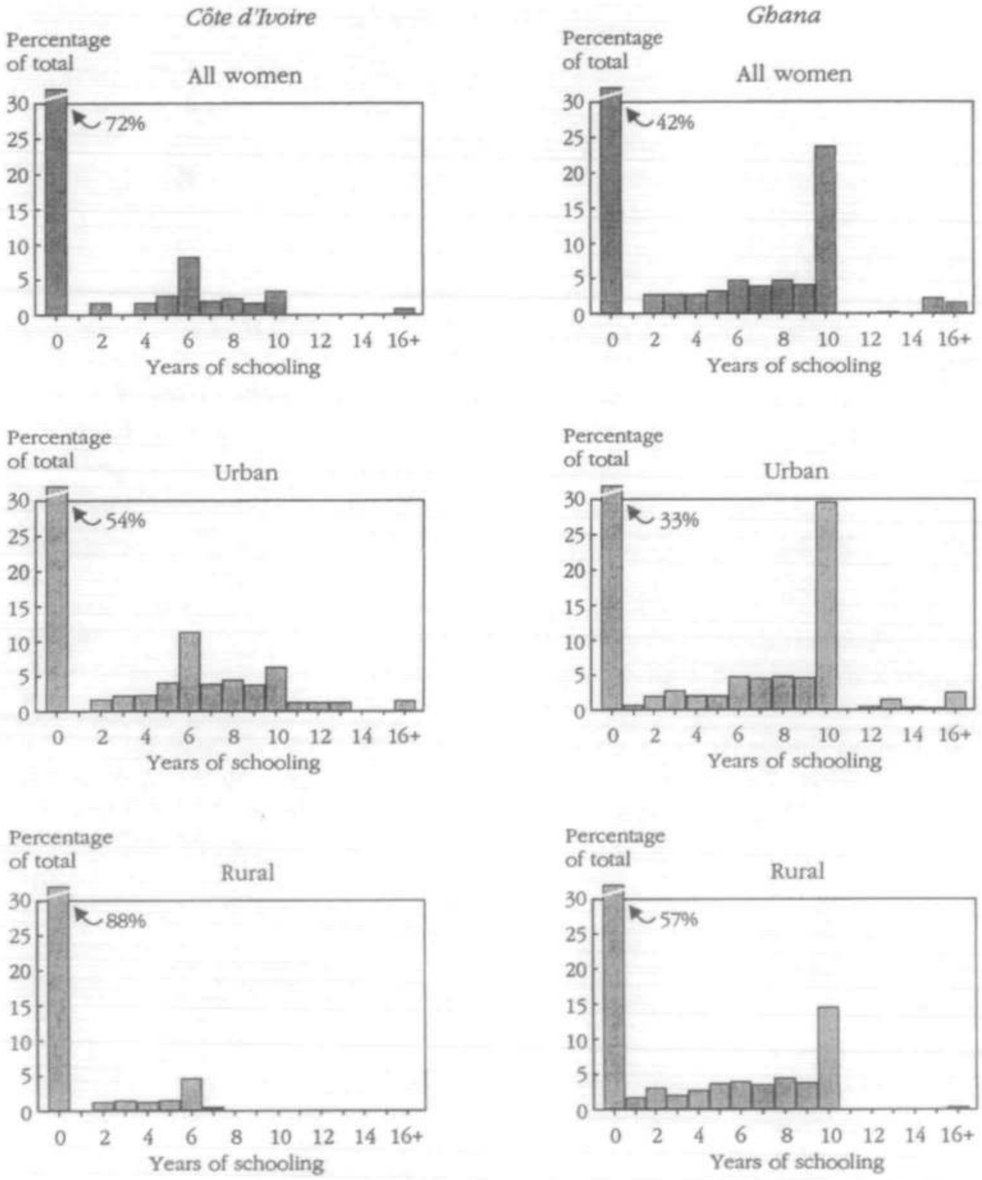
Major differences in the timing and extent of social development of the two countries are reflected in their educational systems. In Côte d'Ivoire, the colonial and postcolonial governments kept close control over schools. This resulted in a schooling system modeled quite closely after that in metropolitan France, with access restricted by competitive exams to only a small fraction of the population. The colonial government in Ghana adopted a largely laissez-faire attitude to education, allowing private school systems to respond to local demands not satisfied by public schools. Private and missionary organizations developed a quite differentiated and geographically dispersed system of schools.

Currently, levels of schooling are higher and gender inequalities in education are smaller in Ghana than in Côte d'Ivoire. Thirty-four percent of primary school enrollment in Côte d'Ivoire in 1965 was female, compared with 41 percent in Ghana (World Bank 1986). The differences in enrollments by gender widen at the secondary level. Figure 1 presents the distribution of schooling for women fifteen years and older for both countries from our surveys. In Côte d'Ivoire, 72 percent of women have no schooling—54 percent of those in urban areas and 88 percent of rural women. In Ghana, 42 percent of women have no schooling—33 percent of the women in urban areas and 57 percent of rural women. In Ghana, 25 percent of all women—33 percent of those in urban areas and about 15 percent of those in rural areas—have ten or more years of schooling. In contrast, in Côte d'Ivoire less than 5 percent of all women have ten or more years of schooling.

Community-level (or sample cluster) information is available for rural areas, but often in the case of urban areas the conditions may be inferred from other data sources. Information about prices of six food staples in the local market, the distance to weekly markets, and the proportion of the cultivated land planted in tree crops is averaged for each cluster from the sample respondents. Annual average rainfall for the sample clusters is obtained from the closest weather station.[3] Rainfall is associated both with more favorable agricultural production opportunities and also with the presence of certain parasitic and infectious diseases, such as malaria, that are responsible for a substantial share of the deaths of children under age five in West Africa (Feachem and Jamison 1991). Other specific community-level variables that are assumed to directly affect child health include the distance to a health clinic; the percentage of households with running or protected water supplies and sanitation facilities (toilets or latrines); and malaria, diarrhea, or measles being one of the two most serious health problems in the community, according to the community respondent. Additional information is also obtained from the GLSS on whether there had been a child immunization campaign in the locality in the five years before the survey. The government budget for Ghana in 1988 was used to estimate public expenditures per capita on health programs (exclusive of doctor training) in each of the ten

3. Provided by a research assistant of Angus Deaton for Côte d'Ivoire and derived from weather maps for Ghana.

Figure 1. *Distribution of Women 15 Years and Older by Schooling, Côte d'Ivoire, 1985–87, and Ghana, 1987–89*



Source: Authors' tabulations of survey data.

regions of Ghana. These public health expenditure levels are attributed to all clusters in each region in 1987–88 or 1988–89.

The woman's regional residence and ethnicity or language and, in the case of Ghana, religion are considered in the analysis as potential determinants of fertility, child mortality, and income. Controlling for these regional characteristics, as well as for climate, agricultural cropping patterns, and endemic disease problems is expected to diminish the estimated effects of individual education and health and community program variables on mortality and fertility.

Assets are first deflated to adjust for regional differences in price levels in both countries, and in particular for the higher cost of living in Abidjan and a slightly higher price level in Accra. Then, because the surveys were collected over two to three years, the expenditures reported by the respondent are further adjusted for the national price level during the month of the survey. This real value of the asset is based on the prices prevailing in the first month of the Ghana survey, that is, September 1987, and on the average prices for all of 1985 in Côte d'Ivoire. A monthly price index was not available for Côte d'Ivoire, but since the rate of inflation was less than 10 percent per year from 1984 to 1988, it was simply assumed that the annual rate of inflation was uniformly distributed over the twelve months from July of one year to June of the next. Prices are expressed relative to those in the base year.

Community Variable Correlations

The community data have three problems. First, there are at most only 200 observations on the several dozen community variables. Second, these community variables are highly intercorrelated. For example, the correlation between the distance to doctors and distance to clinics in the working sample of Ghana and Côte d'Ivoire is 0.70, and only the latter is included in the model to obtain more stable and precise estimates. The researcher must distill the community variables down into only a few reasonably distinct features of the communities. Consequently, what appears to be a rich array of community characteristics is realistically a much more sparse set of community information. This problem of intercorrelation among community variables limits the capacity of the researcher to assess the effects of individual program interventions.

Third, interregional variation in programs and policies may not be independent of household resources or individual preferences. Health programs may be offered in a region that has a particular health problem. Malaria eradication or child immunization campaigns tend to be fielded in poorer, more remote regions of Ghana, where women are relatively less educated. It should not be surprising, therefore, that some of these types of compensatory public health measures are associated with higher regional levels of child mortality (Rosenzweig and Schultz 1982; Rosenzweig and Wolpin 1986; Schultz and Tansel 1992).

In addition to this difficulty of program evaluation when programs are targeted to communities with special health problems, migrants within a population may move on their own accord toward healthier environments and toward regions served by better public health programs. If such migrants also are inclined to invest more in their own health and that of their children, for reasons that researchers cannot observe, this form of selective migration may also bias conventional regional-based policy evaluation studies using cross-sectional data. To deal with both of these evaluation problems, development agencies might phase their health and welfare pilot programs and policy interventions independently of other confounding background factors. Then the correlations between the implementation of a new program and household behavior and outcomes can be interpreted more confidently as evidence on the payoff to public policies and expenditures.

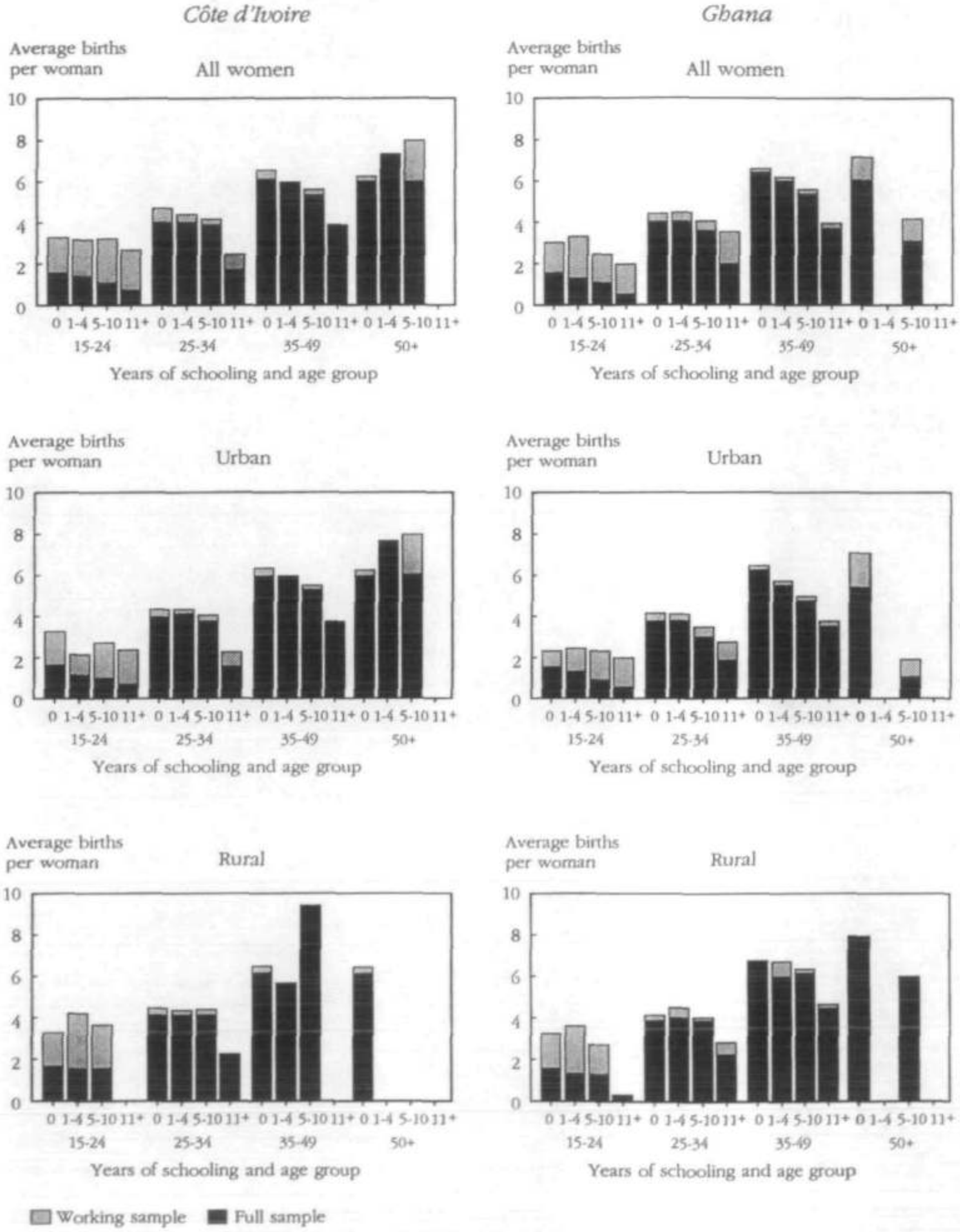
Descriptive Statistics

Our working sample is not representative of the entire population, because women who had not yet had a birth five years before the survey are excluded. Mean fertility in the sample exceeds that in the population, particularly among younger women. Appendix tables A-1 and A-2 in Benefo and Schultz (1994) report the number of children born for all women by age and education for the entire sample to facilitate comparisons with other survey estimates. Figure 2 shows the average number of births per woman for both the working and the entire samples by maternal age and education. The figure shows how the differences between the samples decline as the age of the woman increases. The child mortality rate is a cohort five-year rate; there is little reason to think this rate differs substantially between the restricted and unrestricted samples.

Table 1 reports the number of children born and the child mortality rate for the entire working sample of women by schooling and region, and for women age thirty-five to forty-nine. Our discussion covers only the older age group, whose representativeness should not be affected by the restriction that the woman had a birth five years before the survey. Child mortality is about equal in the two countries—16 percent in Ghana and 17 percent in Côte d'Ivoire—but fertility is slightly lower in Ghana, 6.13, compared with 6.53 for Côte d'Ivoire. In this age group, the effect of one to four years of schooling is associated with an 8 percent decline in fertility in Ghana, compared with women with no education, and a one-sixth decline in child mortality. In Côte d'Ivoire, one to four years of schooling is associated with fertility being 13 percent lower and child mortality being a third lower. Further education tends to be associated with additional declines in both fertility and child mortality, although the limited number of better-educated women, particularly in Côte d'Ivoire and in the rural areas, makes the estimates imprecise.

Education is a major correlate of lower fertility and child mortality in both countries. One difference between the countries is the age differentials in child mortality, summarized more fully elsewhere (Benefo and Schultz 1994). In Côte d'Ivoire, young women with no education appear to have experienced lower child mortality than older women, in both urban and rural areas. In Ghana young women's experience of child mortality is not appreciably different from

Figure 2. *Average Number of Births per Woman, by Maternal Education and Age, Côte d'Ivoire, 1985–87, and Ghana, 1987–89*



Source: Authors' calculations.

Table 1. *Fertility and Child Mortality, by Women's Schooling and Region, Côte d'Ivoire, 1985–87, and Ghana, 1987–89*

	Women's schooling (years)				
Country and indicator	*None*	*1–4*	*5–10*	*11 or more*	*All women*
Ghana					
Fertility rate[a]					
All women					
Total	5.43	4.79	3.97	3.27	4.73
Urban	5.49	4.71	3.86	3.19	4.54
Rural	5.37	4.93	4.25	4.00	5.01
Women age 35–49					
Total	6.67	6.11	5.38	3.70	6.13
Urban	6.59	5.77	5.09	3.58	5.80
Rural	6.75	6.81	6.41	4.60	6.67
Child mortality rate[b]					
All women					
Total	0.19	0.15	0.12	0.12	0.16
Urban	0.16	0.17	0.12	0.12	0.14
Rural	0.22	0.13	0.12	0.09	0.18
Women age 35–49					
Total	0.18	0.15	0.12	0.07	0.16
Urban	0.16	0.16	0.12	0.07	0.14
Rural	0.21	0.12	0.13	0.05	0.19
Côte d'Ivoire					
Fertility rate[a]					
All women					
Total	5.82	4.43	4.13	2.67	5.49
Urban	5.33	4.19	4.03	2.68	4.83
Rural	6.05	4.72	4.55	2.50	5.94
Women age 35–49					
Total	6.64	5.79	5.52	3.57	6.53
Urban	6.31	6.20	5.22	3.57	6.05
Rural	6.79	5.56	9.33	—	6.79
Child mortality rate[b]					
All women					
Total	0.18	0.08	0.09	0.00	0.16
Urban	0.13	0.04	0.08	0.00	0.11
Rural	0.20	0.14	0.12	0.00	0.20
Women age 35–49					
Total	0.18	0.12	0.05	0.00	0.17
Urban	0.13	0.16	0.05	0.00	0.11
Rural	0.20	0.09	0.00	—	0.19

— Not available.
Note: Working samples are 1,943 women for Côte d'Ivoire and 2,237 for Ghana.
a. Number of children born alive.
b. Number of deaths of children under age five per live birth.
Source: Benefo and Schultz (1994, tables 3 and 4).

older women's. The marked divergence in age patterns suggests that health conditions may have worsened in Ghana or at least not improved in the 1970s and early 1980s. Similar levels of child mortality are currently reported for the rural populations of both countries, although by the 1980s the urban population of Côte d'Ivoire appeared to have achieved a lower level of child mortality than that of Ghana.

III. Estimates of Alternative Specifications

Models of fertility determinants are estimated on the basis of three specifications. For model I, child mortality is assumed to be exogenous and the fertility equation can then be estimated by OLS. For model II, child mortality is endogenous, and is identified by instruments measuring community health services and environment. Because household composition, husband characteristics, and household income are likely to be endogenous and cannot be readily identified, these intervening variables are implicitly solved out of the model and thus omitted from the estimated model (Schultz 1994). For model III, household composition and husband characteristics are assumed to be exogenous and potentially affect child mortality and fertility. Child mortality is otherwise determined and estimated as in model II.

On conceptual grounds, model II is preferred, but empirically the identification of child mortality may not be satisfactory. Model I, which is an unstructured description of the data, may then provide more reliable estimates, although potentially they are biased due to simultaneity and measurement error. Model III is reported to assess the robustness of the structural model II estimates by conditioning both equations on household composition and husband characteristics despite their potential endogeneity.

Child Mortality Determinants

Multivariate results are presented in table 2, where the mortality rate of children through the first five years of life is estimated using OLS in regression 1, based on model I (or II). That is, the effects of household income, husband characteristics, and family headship are assumed endogenous and implicitly solved out of these reduced-form estimates. In regression 2, based on model III, husband characteristics and family headship are assumed exogenous and are included.

Mother's education, as shown in table 1, is associated with lower child mortality when the population is cross-tabulated by age and rural or urban residence, a pattern observed in many studies of African demographic surveys (for example, Cochrane, O'Hara, and Leslie 1970; Frank and Dakuyo 1985; Aly and Grabowski 1990; Okojie 1991; Maglad 1994). The results show that when controls are included for the community health infrastructure, health problems, food prices, household assets, ethnicity, and region, the mother's education is more weakly—although still negatively—related to child mortality (table 2).

The effects of education by level of schooling are not individually statistically significant. Each year of secondary schooling completed by the mother in Côte d'Ivoire and each year of middle school completed by the mother in Ghana is associated with a reduction in her child mortality rate of about 0.01.

The mother's height, an indicator of her health human capital, is statistically significant and negatively associated with child mortality in Ghana. Household assets per adult are associated with lower child mortality in Ghana, but not in Côte d'Ivoire. We interpret these patterns as suggesting that access to economic resources in Ghana has a larger effect on child mortality than it does in Côte d'Ivoire (Benefo and Schultz 1994).

The west forest region of Côte d'Ivoire has notably higher levels of child mortality than Abidjan, the excluded region. All regions in Ghana except urban forest and rural savannah have higher child mortality rates than Accra. Ethnic differences in child mortality are statistically significant as a group in both countries, with the Krou in Côte d'Ivoire reporting lower mortality compared with the Akan (omitted), and the Ewe and Ga-Adangbe with lower mortality in Ghana. Christian women also report lower mortality in Ghana.

As a set, the community variables do not explain a great deal of variation in child mortality and consequently provide a weak basis for identifying the exogenous effects of child mortality in the subsequent fertility equation. Nonetheless, these instruments are statistically significant as a group, a common criterion for reliable *IV* estimates (Bound, Jaeger, and Baker 1995).[4] Living farther from a market is associated with higher child mortality in Ghana, and distance to a clinic is not statistically significant. Conversely, in Côte d'Ivoire, women who reside closer to a clinic experience lower child mortality, but the effect of distance to a market has an unexpected sign. Greater rainfall reduces child mortality in both Ghana and Côte d'Ivoire, but the negative effect is not statistically significant in either country. Communities reporting a serious health problem with malaria and measles in Côte d'Ivoire show higher child mortality, but a local problem with diarrhea is related to the poorer survival prospect of children in Ghana. Water and sanitation do not exhibit any noted relationship with child mortality at the community level, although later analysis of these variables suggests benefits may differ across groups of mothers. The food prices are jointly significant, but they are difficult to evaluate on an individual basis for reasons noted earlier. Adding control variables for household composition and husband characteristics in regression 2 does not improve the estimates significantly or alter substantially the other relationships discussed.

4. The joint F test on the exclusion of the set of community health and price variables from the child mortality equation including the predicted income variable based on model II is $F = 2.61$ (15,1904) in Côte d'Ivoire, and $F = 3.06$ (17,2191) in Ghana. Both are statistically significant at $p < 0.002$. Including household composition and husband characteristics increases slightly these F tests. There is always the possibility that the community variables also affect fertility, and they would then be invalid instruments for identifying child mortality in the fertility equation.

Table 2. *Regressions on the Child Mortality Rate for Côte d'Ivoire, 1985–87, and Ghana, 1987–89*

Variable	*Côte d'Ivoire* Regression 1	*Côte d'Ivoire* Regression 2	*Ghana* Regression 1	*Ghana* Regression 2
Individual variables				
Woman's schooling (years)				
Primary (1–6)	–0.0035	–0.0022	–0.0015	–0.0014
	(1.01)	(0.62)	(0.47)	(0.42)
Middle (1–4)	–0.0006	–0.0000	–0.0092	–0.0089
	(0.07)	(0.00)	(1.80)	(1.73)
Secondary and higher education (1–3 or more)	–0.0109	–0.0115	–0.0053	0.0058
	(1.18)	(1.21)	(1.24)	(1.34)
Woman's height (ln meters)	–0.111	–0.101	–0.330	–0.352
	(0.78)	(0.70)	(2.43)	(2.58)
Household assets (local currency)[a]	0.0182	0.0190	–0.0227	–0.0239
	(0.62)	(0.64)	(1.46)	(1.54)
Woman's age[b]				
25–29	0.0001	0.0008	0.0038	0.0088
	(0.01)	(0.04)	(0.18)	(0.40)
30–34	0.0108	0.0109	0.0080	0.0143
	(0.51)	(0.49)	(0.38)	(0.62)
35–39	0.0192	0.0183	–0.0103	–0.0021
	(0.86)	(0.75)	(0.46)	(0.08)
40–49	0.0280	0.0273	–0.0166	–0.0119
	(1.36)	(1.17)	(0.76)	(0.48)
50 or more	0.0671	0.0656	–0.0258	–0.0243
	(3.24)	(2.73)	(0.69)	(0.62)
Household composition and husband characteristics[c]				
No husband present (dummy)		0.0114		0.154
		(0.10)		(1.17)
Woman head of household (dummy)		0.0013		–0.0233
		(0.06)		(1.07)
Husband's schooling (years)				
Primary (1–6)		0.000		–0.0013
		(0.02)		(0.26)
Middle (1–4)		–0.0095		–0.0021
		(1.30)		(0.29)
Secondary and higher education (1–3 or more)		0.0029		–0.0025
		(0.41)		(0.75)
Husband's height (ln meters)		0.0937		0.418
		(0.62)		(2.47)
Husband's age (years)		–0.0014		0.0037
		(0.40)		(0.95)
Husband's age squared ($\times 10^{-2}$)		0.0014		0.0043
		(0.45)		(1.05)
Woman's current residence (dummy variables)[d,e]				
Other urban/urban coast	0.024	0.024	0.064	0.061
	(1.00)	(1.01)	(2.51)	(2.39)
East forest/rural coast	0.043	0.043	0.058	0.052
	(1.47)	(1.42)	(1.66)	(1.50)

(Table continues on the following page.)

Table 2. *(continued)*

	Côte d'Ivoire		*Ghana*	
Variable	*Regression 1*	*Regression 2*	*Regression 1*	*Regression 2*
West forest/urban forest	0.092	0.091	0.030	0.026
	(2.60)	(2.53)	(0.90)	(0.77)
Savannah/rural forest	0.027	0.026	0.073	0.070
	(0.79)	(0.77)	(2.00)	(1.92)
n.a./urban savannah			0.059	0.070
			(1.62)	(1.92)
n.a./rural savannah			0.062	0.052
			(1.58)	(1.41)
Woman's ethnicity or language (dummy variables)[d,f]				
Other/Ewe	0.018	0.0116	−0.070	−0.072
	(0.97)	(0.61)	(4.24)	(4.33)
Krou/Ga-Adangbe	−0.049	−0.050	−0.079	−0.084
	(2.23)	(2.22)	(3.45)	(3.61)
Mande-North/Dagbani	−0.013	−0.017	0.022	0.015
	(0.60)	(0.78)	(0.63)	(0.43)
Mande-South/Hausa	0.017	0.016	−0.032	−0.038
	(0.84)	(0.79)	(0.82)	(0.97)
Voltaic/Nzema	−0.024	−0.028	−0.000	0.002
	(0.99)	(1.16)	(0.01)	(0.03)
Other language			−0.022	−0.027
			(1.21)	(1.45)
Woman's religion (dummy variables)[g]				
Muslim			−0.0033	−0.0048
			(0.11)	(0.16)
Christian			−0.0596	−0.0567
			(2.45)	(2.32)
Traditional and other			0.0032	0.0003
			(0.12)	(0.01)
Community variables				
Proportion of cluster sample households with toilet or latrine	−0.019 (0.83)	−0.019 (0.78)	−0.0044 (0.23)	−0.0009 (0.05)
Proportion of cluster sample households with protected water source, including piped water and wells with pumps	0.0088 (0.52)	0.0102 (0.60)	−0.0022 (0.13)	−0.0011 (0.06)
One of the two most serious community health problems (dummy variables)				
Malaria	0.042	0.042	−0.0083	−0.0079
	(2.20)	(2.17)	(0.46)	(0.44)
Diarrhea	0.021	0.021	0.0336	0.0333
	(1.26)	(1.27)	(2.00)	(1.98)
Measles, chicken pox, or other infectious illnesses	0.036 (2.11)	0.036 (2.12)	−0.0097 (0.63)	−0.0079 (0.51)
Distance to nearest health clinic (kilometers for Côte d'Ivoire, miles for Ghana)	0.0011 (2.97)	0.0011 (2.91)	0.0007 (0.64)	−0.0006 (0.57)
Distance to nearest marketplace (kilometers for Côte d'Ivoire, miles for Ghana)	−0.0024 (1.59)	−0.0025 (1.66)	0.0025 (2.69)	0.0026 (2.70)

Table 2. *(continued)*

	Côte d'Ivoire		Ghana	
Variable	*Regression 1*	*Regression 2*	*Regression 1*	*Regression 2*
Child immunization campaign in last five years (dummy)			−0.0084	−0.0077
			(0.45)	(0.40)
Public health expenditures per person in the province ($x10^3$, 1988 cedis)			−0.361	−0.303
			(0.48)	(0.40)
Rainfall (centimeters per year)[h]	−0.0006	−0.0005	−0.0011	−0.0010
	(1.27)	(1.18)	(1.40)	(1.29)
Share of tree crops[i]	−0.0208	−0.0232	−0.0623	−0.0635
	(0.84)	(0.93)	(2.04)	(2.08)
Prices in the community[d,j]				
Manioc/cassava	0.0224	0.0240	0.0030	0.0029
	(0.15)	(0.16)	(2.29)	(2.20)
Bananas/maize	−0.0599	−0.0641	0.0023	0.0023
	(0.41)	(0.43)	(2.98)	(2.97)
Fish/fish	−0.0756	−0.0744	−0.0000	−0.0000
	(2.11)	(2.07)	(0.54)	(0.64)
Beef/eggs	−0.118	−0.120	−0.0074	−0.0075
	(1.85)	(1.87)	(3.52)	(3.56)
Palm oil/antibiotics	−0.0330	−0.0321	0.0214	0.0218
	(1.82)	(1.77)	(1.88)	(1.92)
Peanut butter/sugar	−0.0723	−0.0706	0.0012	0.0011
	(1:82)	(1.77)	(3.52)	(3.46)
Round 2 (dummy)	0.004	0.0004	−0.001	−0.001
	(0.21)	(0.02)	(0.11)	(0.08)
Round 3 (dummy)	−0.017	−0.021		
	(0.78)	(0.96)		
Intercept	0.396	0.379	0.135	0.0119
	(3.64)	(2.56)	(0.94)	(0.06)
R^2	0.087	0.088	0.098	0.102

n.a. Not applicable.

Note: The dependent variable is the child mortality rate. The coefficients were estimated using ordinary least squares. The absolute values of the *t*-statistics are in parentheses. The sample size is 1,943 in Côte d'Ivoire and 2, 237 in Ghana.

a. The value of the household's assets includes the value of owned land, business assets, and ten times other property income per year per adult in thousands of CFA francs for Côte d'Ivoire and thousands of cedis for Ghana.

b. The excluded category is women age fifteen to twenty-four.

c. The sample average is based on a variable that is set to zero for women who have no reported husband. For example, the average number of years of husband's primary education for women with husbands in Côte d'Ivoire is (1.31)/(1−0.240) = 1.72 years.

d. The term before the slash (/) applies to Côte d'Ivoire, the term after applies to Ghana.

e. The excluded category is Abidjan or Accra.

f. The excluded category is Akan.

g. The excluded category is no response.

h. Rainfall in the area, or at the nearest weather station, in annual average centimeters per year in Ghana and in centimeters for the previous year in Côte d'Ivoire.

i. Proportion of cluster sample household land area that is farmed in tree crops such as cocoa, coffee, bananas, or coconuts.

j. Local prices are averaged and adjusted for inflation to the initial survey date in CFA francs for Côte d'Ivoire and in cedis for Ghana.

Source: Authors' calculations.

As noted in the cross-tabulations, older mothers experience higher child mortality rates even when they have the same education and reside in similar communities in Côte d'Ivoire, suggesting a secular monotonic improvement in child mortality in that country. The same pattern of age coefficients is not observed in Ghana, and although the age coefficients are not statistically significant, child mortality among mothers age twenty-five to thirty-four may be somewhat higher than that among older mothers.

Fertility Determinants

Women's education is associated with lower fertility in table 3, as seen in virtually all studies of fertility (Schultz 1981). As others have noted in some regions of Africa, however, the effects become statistically significant only after the completion of the first few years of primary schooling (Ainsworth, Beegle, and Nyamete in this issue). This could be partially explained by the low wage returns on primary education, particularly in Ghana, or the low content and quality of early schooling. A major dissimilarity between the two countries emerges in the effect of other economic endowment variables on fertility. Household assets per adult are positively related to fertility in Côte d'Ivoire and negatively related in Ghana. The magnitude and statistical significance of the asset effect on fertility depends on whether it is estimated in regression 2 or in regression 3, where husband characteristics are controlled. The mother's height is interpreted here as a measure of her health status and productivity. It is positively related to her fertility in Côte d'Ivoire and has no relation in Ghana. As in a previous study (Benefo and Schultz 1994) that estimated household income and instrumented for it in the fertility equation, we interpret these results as suggesting that income from male workers and nonhuman capital appear to be associated with greater fertility in Côte d'Ivoire but not in Ghana.

The effect of child mortality on fertility is statistically significant only if child mortality is assumed exogenous, as in model I. When child mortality is treated as endogenous and identified by community variables representing health services, conditions, and food prices, the fertility response to the predicted mortality variable is not statistically significant in either country, and even changes sign in Ghana.[5] This finding is in contrast with many other studies using a variety of methodologies (Taylor, Newman, and Kelly 1976; Cantrelle, Ferry, and Mondot 1978; Olsen 1980; Lee and Schultz 1982; Rosenzweig and Schultz 1982; Cochrane and Zachariah 1983; Okojie 1991; Maglad 1994).

The distance to the market is again an important factor in Ghana, where it predicts higher levels of fertility, as it did of child mortality. Religion is not significantly related to fertility in Ghana, given the other variables in the regression. Regions are important in both countries, although ethnic categories are more significant as a group in Ghana than in Côte d'Ivoire. Husband characteristics

5. Child mortality is accepted as exogenous according to the Hausman test in both Ghana and Côte d'Ivoire at the 10 percent confidence level.

Table 3. *Regressions on the Number of Children Born to Women, Côte d'Ivoire, 1985–87, and Ghana, 1987–89*

Variable	*Côte d'Ivoire* *Regression 1*	*Côte d'Ivoire* *Regression 2*	*Côte d'Ivoire* *Regression 3*	*Ghana* *Regression 1*	*Ghana* *Regression 2*	*Ghana* *Regression 3*
Individual variables						
Woman's schooling (years)						
Primary (1–6)	0.0133	0.0131	0.0364	–0.021	–0.024	–0.011
	(0.35)	(0.34)	(0.91)	(0.85)	(0.95)	(0.45)
Middle (1–4)	–0.164	–0.164	–0.125	–0.169	–0.185	–0.169
	(1.84)	(1.83)	(1.35)	(4.31)	(4.51)	(4.13)
Secondary and higher education (1–3 or more)	–0.231	–0.232	–0.218	–0.133	–0.122	–0.106
	(2.30)	(2.25)	(2.09)	(4.06)	(3.66)	(3.16)
Woman's height (ln meters)	3.40	3.39	2.66	–0.064	–0.532	–0.552
	(2.20)	(2.16)	(1.72)	(0.06)	(0.48)	(0.51)
Child mortality rate[a]	1.07	1.01	1.31	0.480	–1.10	–1.14
	(4.30)	(0.51)	(0.68)	(2.95)	(0.93)	(0.98)
Household assets (local currency)[b]	0.538	0.539	0.393	–0.0473	–0.0797	–0.106
	(1.68)	(1.67)	(1.24)	(0.40)	(0.65)	(0.88)
Woman's age[c]						
25–29	0.902	0.903	0.692	0.878	0.886	0.749
	(4.03)	(4.01)	(3.11)	(5.32)	(5.36)	(4.51)
30–34	1.91	1.92	1.51	1.97	1.99	1.71
	(8.30)	(8.21)	(6.36)	(12.0)	(12.0)	(9.84)
35–39	3.21	3.21	2.75	2.85	2.83	2.47
	(13.2)	(12.9)	(10.5)	(16.3)	(16.1)	(13.0)
40–49	3.59	3.59	3.06	4.33	4.31	3.99
	(16.0)	(15.3)	(11.9)	(26.0)	(25.6)	(21.2)
50 or more	3.41	3.41	3.27	4.32	4.28	4.08
	(15.1)	(13.0)	(11.3)	(15.1)	(14.8)	(13.7)
Household composition and husband characteristics[d]						
No husband present (dummy)			1.16			2.15
			(0.95)			(2.18)
Woman head of household (dummy)			–0.066			0.050
			(0.27)			(0.30)
Husband's schooling (years)						
Primary (1–6)			0.082			0.017
			(2.28)			(0.45)
Middle (1–4)			–0.030			–0.071
			(0.39)			(1.31)
Secondary and higher education (1–3 or more)			–0.036			–0.001
			(0.49)			(0.02)
Husband's height (ln meters)			–4.49			–1.16
			(2.80)			(0.91)
Husband's age (years)			0.174			0.146
			(4.84)			(4.88)
Husband's age squared ($\times 10^{-2}$)			–0.158			–0.138
			(4.68)			(4.46)

(Table continues on the following page.)

Table 3. *(continued)*

	Côte d'Ivoire			*Ghana*		
Variable	*Regression 1*	*Regression 2*	*Regression 3*	*Regression 1*	*Regression 2*	*Regression 3*
Woman's current residence (dummy variables)[e,f]						
Other urban/urban coast	0.272	0.273	0.424	0.422	0.532	0.587
	(1.17)	(1.16)	(1.84)	(2.25)	(2.60)	(2.91)
East forest/rural coast	0.751	0.754	0.800	0.834	0.880	0.932
	(3.05)	(2.70)	(2.92)	(3.58)	(3.73)	(4.01)
West forest/urban forest	0.501	0.506	0.627	0.268	0.311	0.395
	(1.96)	(1.54)	(1.94)	(1.18)	(1.35)	(1.74)
Savannah/rural forest	0.381	0.385	0.337	0.578	0.679	0.675
	(1.37)	(1.17)	(1.04)	(2.33)	(2.62)	(2.63)
n.a./urban savannah				0.666	0.746	0.789
				(2.65)	(2.86)	(3.07)
n.a./rural savannah				0.249	0.349	0.344
				(1.09)	(1.45)	(1.45)
Woman's ethnicity or language (dummy variables)[e,g]						
Other/Ewe	–0.215	–0.214	–0.301	–0.346	–0.456	–0.476
	(1.09)	(1.06)	(1.47)	(2.86)	(3.11)	(3.30)
Krou/Ga-Adangbe	–0.250	–0.252	–0.419	–0.553	–0.688	–0.707
	(1.09)	(1.03)	(1.73)	(3.18)	(3.42)	(3.57)
Mande-North/Dagbani	–0.196	–0.196	–0.274	–0.622	–0.576	–0.872
	(0.87)	(0.87)	(1.22)	(2.33)	(2.14)	(3.19)
Mande-South/Hausa	–0.261	–0.260	–0.500	0.202	0.176	0.009
	(1.26)	(1.22)	(2.38)	(0.68)	(0.59)	(0.03)
Voltaic/Nzema	–0.605	–0.604	–0.575	–0.640	–0.637	–0.442
	(2.69)	(2.66)	(2.54)	(1.50)	(1.50)	(1.03)
Other language				–0.080	–0.102	–0.274
				(0.59)	(0.75)	(1.96)
Woman's religion (dummy variables)[h]						
Muslim				0.204	0.231	0.252
				(0.91)	(1.02)	(1.13)
Christian				–0.005	–0.076	0.011
				(0.03)	(0.39)	(0.06)
Traditional and other				0.145	0.185	0.212
				(0.70)	(0.88)	(1.03)
Community variables						
Distance to nearest marketplace (kilometers for Côte d'Ivoire, miles for Ghana)	–0.0027	–0.0028	0.0046	0.0140	0.0170	0.0188
	(0.17)	(0.18)	(0.30)	(2.10)	(2.41)	(2.71)
Rainfall (centimeters per year)[i]	–0.0054	–0.0054	–0.0028	0.0064	0.0041	0.0038
	(1.23)	(1.19)	(0.63)	(1.14)	(0.69)	(0.65)
Share of tree crops[j]	0.216	0.215	0.087	0.0077	–0.079	–0.105
	(0.85)	(0.51)	(0.33)	(0.33)	(0.34)	(0.46)
Round 2 (dummy)	0.141	0.142	0.107	–0.085	–0.088	–0.089
	(0.64)	(0.63)	(0.48)	(1.05)	(1.08)	(1.12)

Table 3. *(continued)*

Variable	Côte d'Ivoire *Regression 1*	Côte d'Ivoire *Regression 2*	Côte d'Ivoire *Regression 3*	Ghana *Regression 1*	Ghana *Regression 2*	Ghana *Regression 3*
Round 3 (dummy)	–.049	–0.049	–0.085			
	(0.21)	(0.21)	(0.38)			
Intercept	1.64	1.65	0.0060	2.04	2.66	0.220
	(1.74)	(1.61)	(0.00)	(3.61)	(3.63)	(0.19)
R^2	0.268	0.261	0.299	0.431	0.429	0.451
Hausman tests of child mortality being "exogenous"		0.027	–0.145		1.34	1.43

n.a. Not applicable.

Note: The dependent variable is number of children born alive to women over age fifteen. For regression 1, child mortality is assumed to be exogenous, and the fertility equation is estimated using ordinary least squares. Regression 2 is estimated using instrumental variables (*IV*); child mortality is endogenous and identified by instruments measuring community health services and environment. Regression 3 is estimated using *IV*; household composition and husband characteristics are assumed to be exogenous; child mortality is endogenous and identified as in regression 2. The absolute value of the asymptotic *t*-statistic is reported in parentheses. The sample size is 1,943 in Côte d'Ivoire and 2,237 in Ghana.

a. Number of deaths of children under age five per live birth.

b. The value of the household's assets includes the value of owned land, business assets, and ten times other property income per year per adult in thousands of CFA francs for Côte d'Ivoire and thousands of cedis for Ghana.

c. The excluded category is women age fifteen to twenty-four.

d. The sample average is based on a variable that is set to zero for women who have no reported husband. For example, the average number of years of husband's primary education for women with husbands in Côte d'Ivoire is (1.31)/(1–0.240) = 1.72 years.

e. The term before the slash (/) applies to Côte d'Ivoire; the term after applies to Ghana.

f. The excluded category is Abidjan or Accra.

g. The excluded category is Akan.

h. The excluded category is no response.

i. Rainfall in the area, or at the nearest weather station, in annual average centimeters per year in Ghana and in centimeters for the previous year in Côte d'Ivoire.

j. Proportion of cluster sample household land area that is farmed in tree crops such as cocoa, coffee, bananas, or coconuts.

Source: Authors' calculations.

and family composition variables are not jointly significant as a set of variables in regression 3 for understanding the cumulative patterns of fertility. The differential effect of male and female education on fertility has been observed widely (Ainsworth, Beegle, and Nyamete in this issue). Increases in middle and secondary education for women in either country are associated with substantial decreases in fertility, but advances in male education are not associated with significant declines in fertility in either country. These results do not, however, give support to Caldwell and Caldwell's (1987) argument that fertility is determined in a different cultural context in Africa. The different effect of male and female education on fertility is a common conclusion drawn from many economic models and from empirical studies in Africa and elsewhere (Willis 1974; Schultz 1981).

In sum, we find different patterns of fertility for the two countries. In Côte d'Ivoire, assets are weakly associated with higher levels of fertility. Economic growth associated with the formation of nonhuman capital may be associated with small declines in fertility in Ghana, but may not have this immediate consequence in Côte d'Ivoire. Child mortality reductions in both countries are associated with fertility declines, but the individual association in model I suggests that only about one-sixth of any decline in child mortality will be translated into an offsetting fertility decline in Côte d'Ivoire (the comparative figure for Ghana is one-twelfth). These are smaller responses of fertility to child mortality than others have found from individual data, where child mortality is assumed exogenous (Cochrane, O'Hara, and Leslie 1970; Rosenzweig and Schultz 1983). This result may be caused by the increased number of control variables included in this study or by a reduced responsiveness in fertility when the overall level of child mortality is as high as in these West African countries.

Women's education in both countries, particularly schooling beyond the primary level, is linked in this and other studies to fertility declines of a substantial magnitude—each additional year of education for women is associated with their having 0.1 to 0.2 fewer births. By contrast, advances in the educational attainment of men will yield few such dividends in terms of slowing population growth. Social investment in women's education is economically productive both in the labor force, and as a source of demographic externalities that contribute to slowing the rate of population growth.

Fertility Estimates by Age and Rural-Urban Residence

The fertility equation is reestimated in table 4, for women age twenty-five to thirty-four and thirty-five to forty-nine living in rural and urban areas, treating child mortality as exogenous. These subsamples are about one-fifth the size of those in the overall regressions, and consequently the estimated coefficients are subject to much more sampling variability. However, number of children born at these later ages is a better proxy for lifetime fertility, and the importance of the different variables for fertility may differ between rural and urban areas. Education of women, when it is statistically significant, always has a negative effect on fertility. The coefficient on the levels of education vacillates considerably in the small subsamples, to the point where it is undefined at two levels for rural Ivorian women because in the sample there are no rural women thirty-five to forty-nine with schooling beyond the primary level. Urban women age twenty-five to thirty-four exhibit the clearest evidence that an additional year of postprimary schooling is associated with a reduction in fertility of 0.2 children in Côte d'Ivoire and about 0.1 children in Ghana. The estimates for these education coefficients do not change greatly for older women, but the precision of the estimates decreases.

The positive effect of household assets on fertility is evident only among younger rural women in Côte d'Ivoire. The negative effect of assets on fertility may be evident among older groups of Ghanaian women in both rural and urban

Table 4. *Regressions on the Number of Children Born to Women Age 25–34 and 35–49, by Rural and Urban Residence, Côte d'Ivoire, 1985–87, and Ghana, 1987–89*

	Côte d'Ivoire				*Ghana*			
	Rural		*Urban*		*Rural*		*Urban*	
Individual or household variable	*25–34*	*35–49*	*25–34*	*35–49*	*25–34*	*35–49*	*25–34*	*35–39*
Woman's schooling (years)								
Primary (1–6)	0.0656	0.0226	0.0363	–0.129	–0.0331	0.0704	–0.0143	–0.0460
	(0.97)	(0.11)	(0.82)	(1.00)	(0.76)	(0.71)	(0.41)	(0.72)
Middle (1–4)	–1.02	n.a.	–0.203	–0.069	–0.185	–0.104	–0.175	–0.204
	(0.91)		(2.38)	(0.26)	(2.60)	(0.58)	(3.60)	(1.98)
Secondary and higher education	0.243	n.a.	–0.235	–0.163	–0.155	–0.145	–0.0892	–0.136
(1–3 or more)	(0.53)		(2.30)	(0.96)	(1.18)	(0.96)	(2.16)	(2.40)
Woman's height (ln meters)	0.0475	5.76	1.50	3.77	–1.39	1.65	–0.862	2.92
	(0.02)	(1.63)	(0.55)	(0.62)	(0.70)	(0.49)	(0.60)	(1.10)
Household assets (local currency)[a]	0.75	–0.52	1.60	–10.7	–0.146	–1.30	0.086	–0.303
	(2.03)	(0.12)	(1.00)	(1.25)	(0.42)	(1.12)	(0.77)	(0.98)
Child mortality rate (exogenous)[b]	0.487	0.986	0.826	0.562	0.175	0.952	0.534	0.722
	(1.18)	(1.66)	(1.69)	(0.55)	(0.70)	(1.48)	(2.41)	(1.36)
Woman's age (years)	0.211	0.0107	0.232	0.099	0.239	0.204	0.203	0.148
	(5.27)	(0.33)	(6.58)	(2.16)	(9.10)	(6.71)	(9.52)	(6.41)
Distance to nearest marketplace	0.0159	–0.0289	0.0236	–1.07	0.0122	0.0275	0.0073	0.0151
(kilometers for Côte d'Ivoire,	(0.69)	(0.89)	(0.04)	(2.00)	(1.34)	(1.44)	(0.59)	(0.78)
miles for Ghana)								
Rainfall (centimeters per year)[c]	–0.0056	–0.0154	–0.0007	–0.0172	0.0147	–0.0131	0.0011	0.0265
	(0.78)	(1.69)	(0.09)	(0.93)	(1.59)	(0.71)	(0.14)	(1.85)
R^2	0.143	0.079	0.218	0.139	0.252	0.199	0.227	0.263
Sample size	299	428	343	224	436	344	663	560

n.a. Not applicable. No women fit this category.

Note: The dependent variable is the number of children born alive to women in the age categories. Regressions are estimated using ordinary least squares. Child mortality rate is treated as exogenous. Absolute value of the *t*-statistic is reported in parentheses. Controls are also included for ethnic or religion groups and survey round.

a. The value of the household's assets includes the value of owned land, business assets, and ten times other property income per year per adult in thousands of CFA francs for Côte d'Ivoire and thousands of cedis for Ghana.

b. Number of deaths of children under age five per live birth.

c. Rainfall in the area, or at the nearest weather station, in annual average centimeters per year in Ghana and in centimeters for the previous year in Côte d'Ivoire.

Source: Authors' calculations.

areas. Expanding female education is associated with decreases in fertility in both countries, but the scarcity of educated women resident in rural Côte d'Ivoire makes it difficult to forecast whether this process lowers fertility among those staying in rural areas or only contributes to the decline in national fertility because it contributes to rural-urban migration.

In the rural and urban subsamples, child mortality is again positively associated with fertility at all age subsamples. Child mortality is statistically significant in the older rural and younger urban samples in Côte d'Ivoire and in the older rural and both urban samples in Ghana. The implied replacement rate for births to a child death by the time a woman has completed her childbearing at age thirty-five to forty-nine is 0.20 to 0.25, somewhat higher than previously estimated across all ages for Ghana in table 3. Overall, the disaggregation of the sample by age and rural or urban areas gives us more confidence in the findings based on the age-aggregated fertility functions, although the much smaller samples prevent us from obtaining precise estimates.

Who Benefits Most from Local Programs?

Some studies of fertility and child mortality have found evidence that the benefits which a population receives from community health and sanitation services depend on the level of women's education. Education allows women to reduce their children's mortality and reduce unwanted childbearing (Schultz 1981, 1988a, 1988b, 1992; Rosenzweig and Schultz 1982; Rosenzweig and Wolpin 1986; Barrera 1990, 1991). The empirical pattern observed most often in this literature suggests that higher levels of these community health services are associated with greater benefits for less-educated women and their families. Female education and these community health and sanitation services are "substitutes" in the production of child health, and these programs reduce educational differences in health outcomes. The opposite pattern is also noted, but less often, where a particular social service, such as piped water, is found to be more effective in the hands of the better educated, in which case these services "complement" the mother's educational attainment.

To test the hypothesis that community programs in Ghana and Côte d'Ivoire differentially benefit women who have different levels of education, explanatory variables are defined as the product of the mother's years of completed education and the four community characteristics. These interaction variables are included in the regressions reported in table 5, explaining child mortality and fertility that also control for (overall) years of education, age, and community variables.

In the Ghana child mortality regression, the negative coefficient on the interaction between schooling and protected water indicates that the availability of protected water sources in the community lowers child mortality by a greater amount among more-educated mothers. Maternal education also has a stronger effect in reducing child mortality among Ghanaian mothers in rural areas than among those in urban areas. These estimates imply

Table 5. *Child Mortality and Fertility Regressions with Interactions between Mother's Education and Community Characteristics, Côte d'Ivoire, 1985–87, and Ghana, 1987–89*

	Côte d'Ivoire		*Ghana*	
Selected explanatory variable	*Child mortality (age 0–4)*	*Fertility*	*Child mortality (age 0–4)*	*Fertility*
Woman's schooling (years)	–0.034	0.0096	–0.0031	0.0534
	(2.84)	(0.07)	(1.16)	(2.60)
Woman's height (ln meters)	–0.0873	2.94	–0.258	–0.208
	(0.63)	(1.92)	(1.89)	(0.20)
Rural residence (dummy)	0.027	0.861	0.063	–0.042
	(1.44)	(4.14)	(3.91)	(0.34)
Distance to nearest health clinic	0.0011	0.0087	–0.00038	0.0162
(kilometers for Côte d'Ivoire, miles for Ghana)	(3.25)	(2.30)	(0.34)	(1.87)
Proportion of cluster sample	–0.013	0.017	0.0682	0.0073
households with protected water source, including piped water and wells with pumps	(0.76)	(0.10)	(3.47)	(0.05)
Proportion of cluster sample	–0.041	0.375	–0.0649	0.115
households with toilet or latrine	(1.91)	(1.60)	(3.31)	(0.77)
Schooling interacted with				
Rural residence	0.0089	0.0464	–0.013	0.017
	(0.82)	(0.39)	(4.33)	(0.75)
Distance to nearest health clinic	0.0001	–0.0011	0.00043	0.00069
	(0.24)	(0.21)	(1.79)	(0.38)
Proportion of cluster sample	–0.0032	–0.0592	–0.0109	–0.0632
households with protected water source, including piped water and wells with pumps	(0.61)	(1.03)	(3.74)	(2.85)
Proportion of cluster sample	0.0336	–0.0394	0.0057	–0.035
households with toilet or latrine	(2.88)	(0.31)	(1.70)	(1.39)
R^2	0.071	0.251	0.048	0.419

Note: Regression estimates are based on a reduced-form specification. Controls also included for age dummies, survey round, rainfall, and distance to market. *t*-statistics are in parentheses. The sample size is 1,943 in Côte d'Ivoire and 2,237 in Ghana.

Source: Authors' calculations.

that public sector subsidies to increase female education in Ghana would have a greater effect in reducing child mortality if they were allocated to rural rather than to urban areas. Improvements in water supplies are more effective in reducing child mortality if they are provided to communities where more women are better educated, possibly because education teaches mothers how to use water for hygienic purposes. The remoteness of a clinic in Ghana raises child mortality by a greater amount for more-educated women than for less-educated. Thus, the proximity to a clinic appears to "complement" women's education.

The prevalence of modern sanitation facilities in the form of toilets and latrines in the community is the only community variable that appears to interact with maternal education in determining child mortality in Côte d'Ivoire, where it complements a mother's education. Thus the availability of toilets in the local community appears to increase educational differentials in child mortality in both countries.

The sparseness of measured educational interactions in Côte d'Ivoire compared with Ghana may be partly due to the lower levels of education among older Ivorian women. When the maternal education interactions are disaggregated by primary, middle, and secondary and higher education, as in the earlier regressions, several additional regularities are evident. The interaction between maternal education and the frequency of toilet or latrine availability in the cluster is stronger for primary schooling, the only interaction variable with the level of women's education that is separately an important correlate with child mortality in Côte d'Ivoire. In Ghana these child health benefits from the community sanitation practices improve for mothers with primary, middle, or secondary education. In Ghana, primary and secondary education of mothers appear to protect their children from the health disadvantages of rural residence and to strengthen the benefits they realize from community protected water supplies.

IV. Conclusions and Research Priorities

To assess how development and social welfare programs affect such outcomes as child mortality and fertility, the researcher must measure the critical dimensions of these policies and programs. Moreover, the variation observed across a surveyed population in these policies and programs must also be independent of the host of confounding factors that might otherwise explain these outcomes. More research is needed to quantify independent variation in the character and quality of local health care that is produced by specific government policies, programs, and the pricing of services. In the collection of policy-oriented household surveys, such as the LSMS program, the information gathered at the community level is critical for linking policy interventions to socioeconomic outcomes. Relatively little is known about the accuracy or relevance of current responses to community questionnaires regarding the availability of health, education, or family planning services, or how the measured availability of services actually affects the welfare of the neighboring population. The design, validation, and refinement of community policy questionnaires that parallel household sample surveys are neglected topics for research. Community policy questionnaires could be important for improving development welfare policies.

Are community health programs allocated in response to prior health conditions across communities, or do these program allocations affect the migration of people with special health needs or preferences? If either of these processes occurs, cross-sectional relations between programs and outcomes, even when programs are suitably measured, can yield biased estimates of program effects.

The only way to be confident that cross-sectional variation in community programs is independent of unobserved community conditions is to design the programs to achieve a phased sequence of program interventions that are orthogonal to such unobserved factors. Unless the variation across women in their child mortality rates is then explainable by community health programs and environments, we should be agnostic about the capacity of the public health sector, as it is currently measured, to improve substantially child survival. By the same token, if education and family planning programs cannot be shown to enhance significantly school enrollments and achievements and to reduce unwanted fertility, there should be skepticism regarding the effectiveness of expanding these existing social welfare systems.

We found indications in Ghana that economic resources of households, maternal education, access to markets, and food prices are all associated with child mortality. Residence closer to a health clinic (public or private) is not a good predictor of child mortality in Ghana, perhaps because local proximity to a clinic does not capture the effect of the prices for, or quality of, clinic-provided health care. In both countries, sanitation infrastructure, in the form of community toilets and latrines, may slightly increase child survival prospects, but only for children of less-educated mothers. The higher levels of child mortality in rural areas of Ghana are less severe for better-educated mothers. Conversely, the health advantages of urban residence are particularly beneficial for the children of the uneducated mothers (table 5). In contrast, communities in Ghana in which a larger fraction of the sampled cluster can rely on protected water supplies do not report decreased child mortality, except perhaps for women with more than six years of education (table 5). Education may teach women how to use improved water supplies effectively for reducing health risks for their children.

In Côte d'Ivoire, where the public health clinics are nominally free (at least until the time of the survey), there is evidence that households living a greater distance from a clinic experience higher mortality among their children. Perhaps because of the more uniform distribution of child health benefits from the public health system in Côte d'Ivoire than in Ghana, household assets are not a significant predictor of child mortality in Côte d'Ivoire. Advancements in women's education at the most basic levels in both countries are likely to foster further reductions in child mortality. To assess how maternal education at the three schooling levels is related to child mortality in the absence of other control variables, a set of regressions was calculated with only the age of the mother controlled by the dummy variables (not reported here). Child mortality is significantly lower for each year of completed primary education of mothers, –0.011 in Côte d'Ivoire and –0.008 in Ghana. These child survival benefits of maternal education continued and increased in magnitude in middle school in Ghana, –0.014, but lost their significance and size in Côte d'Ivoire. No significant child health differences were associated with secondary or higher education in either country.

One objective of this study was to consider the policy connections between child mortality and fertility. The available information on the local health programs and environment could explain relatively little of the variation in child mortality across mothers in Côte d'Ivoire and Ghana, although these instruments are statistically significant as a group. The Hausman (1978) test could not reject the hypothesis that child mortality is exogenous. When child mortality is treated as an exogenous variable in fertility model I in the aggregate or disaggregated regressions, we estimate that four to fifteen fewer child deaths are associated with a reduction of only one birth. We have no good explanation for the small size of this estimate of the fertility response to child mortality.

The study also sought to evaluate the other determinants of fertility in these two countries, which have very high fertility rates and high child mortality. Women's education, particularly beyond the primary school level, is strongly related to declines in fertility in both countries, but the education of husbands is not associated with similar declines. However, other measures of wealth and socioeconomic status appear to have opposite effects on fertility in the two countries. In Côte d'Ivoire, assets and maternal health are positively related to fertility, but in Ghana these variables are negatively related to fertility. An implication of our model is that household income should be treated as an endogenous variable. This led us to omit income from this study. In another investigation of these data, *IV* estimates of income effects, identified by household assets, are substantial in both countries, but positive in Côte d'Ivoire and negative in Ghana (Benefo and Schultz 1994). Age disaggregation of rural and urban subsamples suggests that the negative effect of household assets on fertility is only evident in the urban subsamples of both countries among older women.

The variables examined here are undoubtedly measured with error, and the relationships estimated omit many relevant factors. It is also risky to infer how time trends will evolve in a society even from well-measured cross-sectional patterns. Nonetheless, there are several similarities and differences between these countries that may help forecast future trends. In Côte d'Ivoire, increments to household nonhuman wealth are associated with higher fertility, while in Ghana the tendency to invest family wealth in having more children has been altered, at least in urban areas. Although per capita incomes and male earnings were higher in Côte d'Ivoire than in Ghana, the earlier investment of Ghana in an egalitarian educational system has provided women with greater productive opportunities relative to men than those of women in Côte d'Ivoire. Given the relationship observed between female education, wages, and productivity and reduced fertility, we expect that the changing composition of income sources in Ghana will be more favorable for women and hence contribute to an earlier national decline in fertility than in Côte d'Ivoire. Urbanization in both countries is likely to lower national fertility levels, but with the greater integration of the regional labor markets in Ghana, the potential for urbanization to foster a fertility decline is probably greater in Côte d'Ivoire.

A more equal distribution of social services would appear likely to hasten the decline in child mortality and fertility, particularly if women's education increases more rapidly in rural areas and rural sanitation and health problems are effectively addressed. Only in the case of community access to protected water supplies did we find evidence that, without a prior investment in female education, improvements in water supplies are not associated with increased child survival among the rural poor. A resumption of growth in personal incomes in Côte d'Ivoire may offset, rather than reinforce, the fertility-reducing effect of the slow expansion in women's education. Conversely, sustained income growth in Ghana may benefit women's productivity as much as it does men's, and both income growth and increased education of women will work together to reduce childbearing and to shift social resources toward greater investments in child quality in the form of schooling, health, and migration.

Table A-1. *Means and Standard Deviations of Variables, Côte d'Ivoire and Ghana*

	Côte d'Ivoire		*Ghana*	
Variable	*Mean*	*Standard deviation*	*Mean*	*Standard deviation*
Dependent variables				
Number of children born alive	5.48	2.85	4.72	2.47
Number of children born in last five years	0.920	1.00	1.11	0.934
Proportion of children born at least five years before the survey who died before their fifth birthday (child mortality rate)	0.161	0.233	0.157	0.254
Infant death rate (before first birthday)	0.118	0.209	0.114	0.220
Explanatory variables at individual household level				
Woman's schooling (years)				
Primary (1–6)	1.00	2.15	2.76	2.86
Middle (1–4)	0.232	0.870	1.25	1.76
Secondary and higher education (1–3 or more)	0.0602	0.619	0.233	1.29
Woman's age (years)	39.6	13.5	34.0	7.74
Woman's height (ln meters)	0.457	0.0390	0.455	0.0393
Household assets (local currency)[a]	16.5	176	70.6	339
Share of tree crops[b]	0.346	0.298	0.295	0.259
Woman migrant (dummy)[c]	0.357		0.441	
No husband present (dummy)	0.240		0.354	
Woman head of household (dummy)	0.080		0.290	
Household composition and husband characteristics[d]				
Husband's schooling (years)				
Primary (1–6)	1.31	2.40	2.30	2.87
Middle (1–4)	0.406	1.16	1.29	1.83
Secondary and higher education (1–3 or more)	0.199	1.04	0.424	1.71
Husband's height (ln meters)	0.393	0.224	0.338	0.253
Husband's age (years)	36.9	23.6	27.1	21.9

(Table continues on the following page.)

Table A-1. *(continued)*

Variable	*Côte d'Ivoire* *Mean*	*Côte d'Ivoire* *Standard deviation*	*Ghana* *Mean*	*Ghana* *Standard deviation*
Other variables averaged for sample cluster				
Rainfall (centimeters per year)[e]	107.0	18.4	50.7	14.3
Distance to nearest marketplace (kilometers for Côte d'Ivoire, miles for Ghana)	2.37	4.64	3.15	6.66
Proportion of cluster sample households with toilet or latrine	0.580	0.400	0.569	0.358
Proportion of cluster sample households with protected water source including piped water and wells with pumps	0.491	0.352	0.337	0.395
One of the two most serious community health problems (dummy variables)				
Malaria	0.103		0.443	
Diarrhea	0.198		0.168	
Measles, chickenpox, or other infectious illnesses	0.176		0.270	
Distance to nearest health clinic (kilometers for Côte d'Ivoire, miles for Ghana)	11.9	18.2	4.22	6.82
Child immunization campaign in last five years (dummy)	—		0.502	
Public health expenditures per person in the province ($x10^3$, 1988 cedis)	—		309.0	95.0
Prices in the community[f,g]				
Manioc/cassava	0.0736	0.0458	26.6	4.94
Maize	—		61.8	8.68
Fish/fish	0.437	0.169	526.0	118.0
Beef/eggs	0.810	0.146	24.5	3.43
Palm oil	0.682	0.319	—	
Peanut butter	0.396	0.156	—	
Sugar	—		152.0	19.1
Bananas	0.0820	0.0410	—	
Antibiotics	—		4.17	0.548
Woman's religion (dummy variables)				
Muslim	—		0.135	
Christian	—		0.633	
Traditional religions	—		0.179	
Woman's ethnicity or language (dummy variables)				
Akan	0.291		0.464	
Ewe	n.a.		0.173	
Ga-Adangbe	n.a.		0.080	
Dagbani	n.a.		0.037	
Hausa	n.a.		0.024	
Nzema	n.a.		0.009	
Other languages	n.a.		0.213	
Krou	0.089		n.a.	

Table A-1. *(continued)*

Variable	Côte d'Ivoire *Mean*	Côte d'Ivoire *Standard deviation*	Ghana *Mean*	Ghana *Standard deviation*
Mande-North	0.090		n.a.	
Mande-South	0.137		n.a.	
Voltaic	0.097		n.a.	
Alien	0.135		n.a.	
Woman's current residence (dummy variables)[g,h]				
Current rural resident	0.560		0.398	
Abidjan/Accra	0.187		0.129	
Other urban/urban coast	0.214		0.146	
Urban forest	n.a.		0.257	
Urban savannah	n.a.		0.070	
East forest/rural coast	0.244		0.081	
West forest/rural forest	0.142		0.173	
Rural savannah	0.213		0.144	

— Not available.

n.a. Not applicable.

Note: Samples are reduced by about 5 percent to have complete reporting of height, and by 30 percent to include only women with at least one birth five or more years ago. The reproductive module was administered to one woman in each household who was between age fifteen and fifty in Ghana and fifteen or older in Côte d'Ivoire. Thus, the sample from Côte d'Ivoire is older than that in Ghana by almost five years. Standard deviations are not reported for dummy variables because they are equal to $[m(m-1)^{1/2}]$, where m is the mean. The sample sizes are 1,943 for Côte d'Ivoire and 2,237 for Ghana.

a. The value of the household's assets includes the value of owned land, business assets, and ten times other property income per year per adult, in thousands of CFA francs for Côte d'Ivoire and in thousands of cedis for Ghana.

b. Proportion of cluster sample household land area that is farmed in tree crops such as cocoa, coffee, bananas, and coconuts.

c. A woman migrant is a rural-born, currently urban resident who has lived in an urban area for more than five years.

d. The sample average is based on a variable that is set to zero for women who have no reporting husband. For example, the average number of years of husband's primary education for women with husbands in Côte d'Ivoire is (1.31)/(1–0.240) = 1.72 years.

e. Rainfall in the area, or at the nearest weather station, in annual average centimeters per year in Ghana and in centimeters for the previous year in Côte d'Ivoire.

f. Local prices averaged and adjusted for inflation to the same date in local currency.

g. The term before the slash (/) applies to Côte d'Ivoire; the term after applies to Ghana.

h. The excluded term is Abidjan or Accra.

Source: Authors' calculations.

References

The word "processed" describes informally reproduced works that may not be commonly available through library systems.

Ainsworth, Martha. 1989. *Socioeconomic Determinants of Fertility in Côte d'Ivoire.* LSMS Working Paper 53. Washington, D.C.: World Bank.

Ainsworth, Martha, and Juan Munoz. 1986. *The Côte d'Ivoire Living Standards Survey.* LSMS Working Paper 26. Washington, D.C.: World Bank.

Ainsworth, Martha, Kathleen Beegle, and Andrew Nyamete. 1996. "The Impact of Women's Schooling on Fertility and Contraceptive Use: A Study of Fourteen Sub-Saharan African Countries." *The World Bank Economic Review* 10(1):85–122.

Aly, Hassan Y., and Richard Grabowski. 1990. "Education and Child Mortality in Egypt." *World Development* 18(5):733–42.

Barbieri, Magali. 1989. "The Determinants of Infant and Child Mortality in Senegal: An Analysis of DHS Data." Ph.D. diss., University of California at Berkeley, Department of Demography, Berkeley.

Barrera, Albino. 1990. "The Role of Maternal Schooling and Its Interaction with Public Health Programs in Child Health Production." *Journal of Development Economics* 32:69–91.

———. 1991. "The Interactive Effects of Mother's Schooling and Unsupplemented Breastfeeding on Child Health." *Journal of Development Economics* 34:81–98.

Benefo, K. D., and T. P. Schultz. 1994. *Determinants of Fertility and Child Mortality in Côte d'Ivoire.* LSMS Working Paper 103. Washington, D.C.: World Bank.

Ben Porath, Yorum. 1978. "Fertility Response to Child Mortality: Microdata from Israel." In S. H. Preston, ed., *The Effects of Infant and Child Mortality on Fertility.* New York: Academic Press.

Bound, John, D. A. Jaeger, and R. M. Baker. 1995. "Problems with Instrumental Variables Estimation When the Correlation between the Instruments and Endogenous Explanatory Variables Is Weak." *Journal of the American Statistical Association* 90(430):443–50.

Caldwell, J. C., and Pat Caldwell. 1987. "The Cultural Context of High Fertility in Sub-Saharan Africa." *Population and Development Review* 13(3):409–37.

Cantrelle, P., B. Ferry, and J. Mondot. 1978. "Relationship between Fertility and Mortality in Tropical Africa." In S. H. Preston, ed., *The Effects of Infant and Child Mortality on Fertility.* New York: Academic Press.

Cochrane, S. H., and K. C. Zachariah. 1983. *Infant and Child Mortality as a Determinant of Fertility.* World Bank Staff Working Paper 556. Washington, D.C.: World Bank.

Cochrane, S. H., D. J. O'Hara, and Joanne Leslie. 1970. *The Effects of Education on Health.* World Bank Staff Working Paper 405. Washington, D.C.: World Bank.

Feachem, R. G., and D. T. Jamison. 1991. *Disease and Mortality in Sub-Saharan Africa.* New York: Oxford University Press.

Fogel, R. W. 1991. "New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health Mortality, and the Process of Aging." NBER Working Paper 26. National Bureau of Economic Research, Cambridge, Mass. Processed.

Frank, Odile, and M. Dakuyo. 1985. "Child Survival in Sub-Saharan Africa: Structural Means and Individual Capacity." Center for Policy Studies Working Paper 122. The Population Council, Center for Policy Studies, New York. Processed.

Freedman, Ronald. 1975. *The Sociology of Human Fertility*. New York: John Wiley and Sons.

Glewwe, Paul. 1987. *The Distribution of Welfare in the Republic of Côte d'Ivoire*. LSMS Working Paper 29. Washington, D.C.: World Bank.

Hausman, Jerry. 1978. "Specification Tests in Econometrics." *Econometrica* 47(1):153–62.

Kritz, M. M., and D. T. Gurak, 1989. "Women's Status, Education and Family Formation in Sub-Saharan Africa." *International Family Planning Perspectives* 15(3):100–05.

Lee, B. S., and T. P. Schultz. 1982. "Implications of Child Mortality Reductions for Fertility and Population Growth in Korea." *Journal of Economic Development* 7(1):21–44.

Maglad, N. E. 1994. "Fertility in Rural Sudan: The Effect of Landholding and Child Mortality." *Economic Development and Cultural Change* 42(4):761–72.

Morrow, R. H., P. G. Smith, and K. P. Nimo. 1982. "Assessing the Impact of Disease." *World Health Forum* 3(3):331–35.

Notestein, Frank. 1945. "Population—The Long View." In T. W. Schultz, ed., *Food for the World*. Chicago: University of Chicago Press.

Okojie, C. E. E. 1991. "Fertility Response to Child Survival in Nigeria: An Analysis of Microdata from Bendel State." In T. P. Schultz, ed., *Research in Population Economics*. Vol. 7. Greenwich, Conn.: JAI Press.

Oliver, Raylynn. 1995. *Contraceptive Use in Ghana: The Role of Service Availability, Quality, and Price*. LSMS Working Paper 111. Washington, D.C.: World Bank.

Olsen, R. J. 1980. "Estimating the Effects of Child Mortality on the Number of Births." *Demography* 17(4):429–44.

Patterson, K. D. 1981. *Health in Colonial Ghana: Disease, Medicine, and Socio-Economic Change, 1900–1955*. Waltham, Mass.: Cross-Roads Press.

Pitt, Mark. 1995. *Women's Schooling, Selective Fertility and Child Mortality in Sub-Saharan Africa*. LSMS Working Paper 119. Washington, D.C.: World Bank.

Rosenzweig, M. R., and T. P. Schultz. 1982. "Determinants of Fertility and Child Mortality in Colombia." Report to USAID on grant DSPE-G-0013. Yale University, Economic Growth Center, New Haven, Conn. Processed.

———. 1983. "Consumer Demand and Household Production: The Relationship between Fertility and Child Mortality." *American Economic Review* 73(2):38–42.

Rosenzweig, M. R., and Kenneth Wolpin. 1986. "Evaluating the Effects of Optimally Distributed Programs." *American Economic Review* 76(3):470–82.

Schultz, T. P. 1969. "An Economic Model of Family Planning and Fertility." *Journal of Political Economy* 77(2):153–80.

———. 1976. "Interrelationships between Mortality and Fertility." In R. G. Ridker, ed., *Population and Development: The Search for Selective Interventions*. Baltimore: Johns Hopkins University Press.

———. 1980. "An Economic Interpretation of the Decline in Fertility in a Rapidly Developing Country." In R. A. Easterlin, ed., *Population and Economic Change in Developing Countries*. Chicago: University of Chicago Press.

———. 1981. *Economics of Population*. Reading, Mass.: Addison-Wesley.

———. 1988a. "Economic Demography and Development: New Directions in an Old Field." In Gustav Ranis and T. P. Schultz, eds., *The State of Development Economics: Progress and Perspectives*. London: Basil Blackwell.

———. 1988b. "Population Programs: Measuring Their Impact on Fertility." *Journal of Policy Modeling* 10(1):113–49.

———. 1992. "Assessing Family Planning Cost-Effectiveness: Applicability of Individual Demand-Program Supply Framework." In J. R. Phillips and J. A. Ross, eds., *Family Planning Programmes and Fertility*. Oxford, U.K.: Oxford University Press.

———. 1994. "Marital Status and Fertility in the United States." *Journal of Human Resources* 29(2):637–69.

———. 1995. *Returns to Reproducible Human Capital and Development*. New Haven, Conn.: Yale University, Economic Growth Center.

Schultz, T. P., and Aysit Tansel. 1992. "Measurement of Returns to Adult Health: Morbidity Effects on Wage Rates in Côte d'Ivoire and Ghana." Economic Growth Center Discussion Paper 663. Yale University, New Haven, Conn. Processed.

Smith, Adam. 1961. *The Wealth of Nations*. Edward Cannon, ed. London: University Paperbacks, Methuen.

Taylor, C. E., J. S. Newman, and N. U. Kelly. 1976. "The Child Survival Hypothesis." *Population Studies* 30(2):263–78.

van de Walle, Etienne, and Andrew Foster. 1990. *Fertility Decline in Africa: Assessment and Prospects*. World Bank Technical Paper 125. Washington, D.C.

van der Gaag, Jacques, and Wim Vijverberg. 1987. *Wage Determinants in Côte d'Ivoire*. LSMS Working Paper 33. Washington, D.C.: World Bank.

Willis, R. J. 1974. "Economic Theory of Fertility Behavior." In T. W. Schultz, ed., *Economics of the Family*. Chicago: University of Chicago Press.

World Bank. 1986. *World Development Report 1986*. New York: Oxford University Press.