

THE WORLD BANK

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How Important to India's Poor Is the Sectoral Composition of Economic Growth?

Martin Ravallion and Gaurav Datt

Using a new series of consistent, consumption-based poverty measures spanning forty years, we assess how much India's poor shared in the country's economic growth, taking into account its urban-rural and output composition. Rural consumption growth reduced poverty in both rural and urban areas. Urban growth brought some benefits to the urban poor, but had no impact on rural poverty. And rural-to-urban population shifts had no significant impact on poverty. Decomposing growth by output sectors, we found that output growth in the primary and tertiary sectors reduced poverty in both urban and rural areas but that secondary sector growth did not reduce poverty in either.

It is sometimes claimed that the sectoral composition of economic growth is an important determinant of the rate of poverty reduction in developing countries. But testing that claim is difficult. The main evidence cited by those who emphasize the importance of the pattern of growth is a static poverty profile from a single cross-sectional household survey, showing (among other things) where the poor live and the sectors in which they are employed. Poverty profiles for India (and most other developing countries) have indicated higher absolute poverty levels in the rural sector. But we cannot automatically assume that rural economic growth is the key to poverty reduction; the rural sector may just not have the potential for high growth. As in most developing countries the trend rate of growth in India has been higher in the modern industrial and service sectors—both of which are mostly urban based—than in the agricultural sector (Chenery and Syrquin 1986). Under certain conditions migration from rural to urban areas may be more important to poverty reduction than rural economic growth (Fields 1980; Anand and Kanbur 1985). The effects of growth in one sector can be crucial to growth in another (Thorbecke and Jung 1994). The fortunes of the poor in each sector are linked—through trade, migration, and transfers—to the living standards of both poor and nonpoor households in other sectors.

To avoid small-sample biases in testing the impact of growth on poverty, a reasonable number of time-series observations should be used. But although

Martin Ravallion and Gaurav Datt are with the Policy Research Department at the World Bank. The authors would like to thank Lyn Squire, T. N. Srinivasan, Dominique van de Walle, seminar participants at the World Bank, and three anonymous referees for their comments.

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national economic growth can be tracked annually for most countries, the household survey data needed to monitor living standards of the poor are collected much less frequently. Indeed most countries have, at best, a few nationally representative and comparable surveys spanning a period during which there have been shifts in the sectoral pattern of growth.

Among developing countries India has the longest series of national household surveys suitable for tracking living conditions of the poor. At the time of writing distributional data on household consumption in India from thirty-three surveys spanning from 1951 to 1991 could be assembled. The surveys are large enough to be representative at the urban and rural levels as well as nationally, and they are comparable over time because the basic survey method changed very little.

There has been much debate about how much India's poor have shared in the country's economic growth. Some critics have argued that the gains in farm output from the green revolution brought little or no gain to the rural poor, while others have pointed to the growth of farm output as the key to reducing rural poverty. (Lipton and Ravallion 1994 review this debate. On the effects of agricultural growth on rural poverty in India see Ahluwalia 1978, 1985; Bell and Rich 1994; Bhattacharya and others 1991; Gaiha 1989; Ravallion and Datt 1994; Saith 1981; and van de Walle 1985.) Views have also differed on how much urban growth has benefited the poor. The optimism of many of India's postindependence planners, who believed that the country's (largely urban-based) industrialization would bring lasting, longer-term gains to both the urban and rural poor, has not been shared by many critics (see, for example, Eswaran and Kotwal 1994). And the importance to the poor of the tertiary (mainly services) sector is unclear. Such intellectual debates about growth and the poor lie at the heart of ongoing discussions on development strategy and policy reform in India and elsewhere. (On the role of economic growth on a strategy for poverty reduction see World Bank 1990 and Lipton and Ravallion 1994. On the relevance of these issues to concerns about policy reform and the poor in India see Ravallion and Subbarao 1992.)

In this article we report new empirical evidence that sheds light on the effects of the sectoral pattern of economic growth on poverty in India over forty years. We measure the importance to India's poor of intrasectoral growth, rural-to-urban migration, and spillover effects between sectors. We also examine whether these effects differ according to how sensitive the poverty measure is to distribution among the poor.

The following section describes how cross-sectoral spillover effects might occur and sets up a framework to test for the effects of sectoral composition and population shifts on poverty during a period of growth. In section II we describe our data, including our estimates of a consistent time series of different poverty measures for urban and rural areas of India during 1951–91. Section III then presents our results and discusses their implications. Conclusions are summarized in section IV.

I. POVERTY AND THE SECTORAL COMPOSITION OF GROWTH

Why Would the Sectoral Composition of Growth Matter?

Theories of growth and distributional change have emphasized the role played by population shifts from the “traditional” rural sector to the “modern” urban sector. An influential model of this sort was sketched by Kuznets (1955) and later formalized by Robinson (1976), Fields (1980), and Anand and Kanbur (1985), among others. This model attributes growth and distributional shifts to urbanization, assuming that neither mean income nor its distribution changes within each sector. We call this the “Kuznets process” (following Anand and Kanbur).

Other strands of the literature have given more attention to intrasectoral changes. Growth of a given sector’s output will have a direct effect on incomes of those employed in that sector.

In most developing countries the rural sector accounts for a substantially higher share of absolute poverty than the urban sector; a rural resident is also more likely to be poor, by almost any standard (Lipton and Ravallion 1994 survey the evidence). These stylized facts suggest that the urban-rural composition of economic growth influences poverty reduction. Additionally, there may be indirect cross-sectoral effects arising from the sectoral interdependence of economic activity (Thorbecke and Jung 1994). In principle these may either enhance or retard the direct effect of growth.

For the class of additively decomposable poverty measures, national poverty is a population-weighted sum of rural and urban poverty. Thus these measures naturally decompose into population-shift and intrasectoral effects and can illuminate these issues (Ravallion and Huppi 1991). It is also of interest to look at the relationships among these components. The direct impact of a sector’s growth on national poverty is limited by its population share. However, in principle, growth or contraction of one sector can affect other sectors, with potentially wide-ranging implications for poverty reduction. For example, it is often said that an important cause of urban poverty in developing countries is rural poverty. According to this view, the vast urban slums of many cities in developing countries are simply the urban analogue of deprivation (often on a larger scale) in the rural hinterland. (For a survey of the literature on poverty in developing countries, including comparisons between urban and rural poverty, see Lipton and Ravallion 1994.) Because of cross-sectoral spillover effects, the significance of the urban-rural composition of growth for poverty extends beyond what is implicit in the sectoral population shares.

Spillover effects can occur in a number of ways. Labor mobility between urban and rural sectors can yield an equilibrium relationship between the real wages of similar workers, entailing some degree of horizontal integration in earnings and income distributions; the living standards of similarly endowed people in different sectors are causally related. Even without labor mobility such

integration can arise through trade in goods; the living standards of similar households in different sectors will move together to the extent that trade in goods eliminates differences in factor costs at the margin. But even without factor-price equalization, the fact that the rural sector produces food that is consumed in the urban sector means that agricultural growth raises urban welfare by lowering food prices. Transfers between related households living in different sectors can also produce horizontal integration.

If the degree of horizontal integration varies with the standard of living, we can also expect growth or contraction in one sector to induce distributional shifts in the other sector. There is no a priori reason to expect the integration to be uniform at all levels. And there is at least one good reason to expect that it will not be: the distributions of living standards in different sectors tend to overlap imperfectly, that is, they share a positive density over certain (compact) intervals of the range of living standards but not others. For example, the urban sector of a developing country will often include an elite class that simply has no counterpart in the rural sector. This imperfect overlapping can have strong implications for how an increase in incomes in one sector will affect both average levels of living and inequalities in other sectors.

Testing the Impact of the Sectoral Composition of Growth on Poverty

In this section we do not attempt to develop a comprehensive structural model of the potential channels described above. Rather, our aim is to test the importance of the sectoral composition of growth, allowing explicitly for population shifts and cross-sectoral effects.

We restrict attention to the broad class of additive poverty measures (Atkinson 1987) and consider two sectors, urban and rural. The average level of poverty is

$$(1) \quad P = n_u P_u + n_r P_r$$

where n_i and P_i are the population shares and poverty measures, respectively, for sectors $i = u, r$, representing urban and rural areas, respectively. Mean consumption can similarly be written

$$(2) \quad \mu = n_u \mu_u + n_r \mu_r$$

where μ_i is the mean for sector i . Let $s_i^P = n_i P_i / P$ and $s_i^\mu = n_i \mu_i / \mu$ be the sector shares of total poverty and total consumption income. The growth rate in the poverty measure can be decomposed by taking the total differential of equation 1:

$$(3) \quad d \ln P = s_u^P d \ln P_u + s_r^P d \ln P_r + (s_u^P - s_r^P n_u / n_r) d \ln n_u.$$

Equation 3 shows that the average rate of poverty reduction is made up of the intrasectoral gains to the poor, given by the share-weighted rates of poverty reduction within each sector ($s_i^P d \ln P_i$), and the independent contribution of the rate of urbanization. The second term can be interpreted as poverty reduction

attributable to the Kuznets process. Notice that the coefficient on $\text{dln}n_u$ can also be written as $(P_u - P_r)n_u/P$, indicating that urbanization under the Kuznets process will reduce average poverty only if poverty is greater in rural areas than in urban areas. Similarly,

$$(4) \quad \text{dln}\mu = s_u^\mu \text{dln}\mu_u + s_r^\mu \text{dln}\mu_r + (s_u^\mu - s_r^\mu n_u/n_r) \text{dln}n_u$$

gives the corresponding breakdown in the rate of growth in mean consumption.

We want to test whether the sectoral composition of growth matters. We have T discrete time-series observations on poverty and the composition of growth (the data are discussed later). Our proposed test entails estimating the following regression equation on the discrete data:

$$(5) \quad \begin{aligned} \Delta \ln P_t = & \pi_u s_{ut-1}^\mu \Delta \ln \mu_{ut} + \pi_r s_{rt-1}^\mu \Delta \ln \mu_{rt} \\ & + \pi_n (s_{rt-1}^\mu - s_{ut-1}^\mu n_{rt-1}/n_{ut-1}) \Delta \ln n_{rt} + \varepsilon_t \quad (t = 2, \dots, T) \end{aligned}$$

where the π 's are parameters to be estimated, Δ is the discrete time difference operator, and ε is an error term. The coefficients π_u and π_r can be interpreted as the impact of (share-weighted) growth in the urban and rural sectors, respectively, while π_n gives the effect of the population shift from rural to urban areas. Of course, other independent factors will influence measured poverty (including measurement errors); these have been allowed for in the above equation by adding the random error term ε . To motivate this test regression, notice that under the null hypothesis $\pi_u = \pi_r = \pi_n = \pi$, equation 5 collapses to:

$$(6) \quad \Delta \ln P_t = \pi \Delta \ln \mu_t + \varepsilon_t$$

using equation 4 and sweeping into the regression's residuals any errors due to replacing the unobserved continuous differential for each variable by its observed discrete time difference. Thus under the null hypothesis $\pi_u = \pi_r = \pi_n$ it is the overall rate of growth that matters, not its composition.

We also want to test whether economic growth in one sector affects distribution in other sectors. We can use equation 3 to decompose the rate of growth in average poverty, and thus estimate the following system of test equations (dropping time subscripts for brevity):

$$(7) \quad s_u^p \Delta \ln P_u = \pi_{u1} s_u^\mu \Delta \ln \mu_u + \pi_{u2} s_r^\mu \Delta \ln \mu_r + \pi_{u3} (s_r^\mu - s_u^\mu n_r/n_u) \Delta \ln n_r + \varepsilon_u$$

$$(8) \quad s_r^p \Delta \ln P_r = \pi_{r1} s_u^\mu \Delta \ln \mu_u + \pi_{r2} s_r^\mu \Delta \ln \mu_r + \pi_{r3} (s_r^\mu - s_u^\mu n_r/n_u) \Delta \ln n_r + \varepsilon_r$$

$$(9) \quad (s_r^p - s_u^p n_r/n_u) \Delta \ln n_r = \pi_{n1} s_u^\mu \Delta \ln \mu_u + \pi_{n2} s_r^\mu \Delta \ln \mu_r + \pi_{n3} (s_r^\mu - s_u^\mu n_r/n_u) \Delta \ln n_r + \varepsilon_n$$

where $\pi_i = \pi_{ui} + \pi_{ri} + \pi_{ni}$, $i = 1, 2, 3$. Summing equations 7, 8, and 9 yields equation 5. Equation 7 shows how the composition of growth and population shifts affect urban poverty, and equation 8 shows how they affect rural poverty. Equation 9 gives the effect on the population shift component of $\Delta \ln P$. We

estimate equations 7 and 8. Equation 9 need not be estimated separately because its parameters can be inferred from the estimates of equations 7 and 8 using the adding-up restriction that $\pi_{ni} = \pi_i - \pi_{ri} - \pi_{ui}$, $i = 1, 2, 3$.

The analysis of the impact of the output composition of growth on poverty is even simpler because there are no population-shift effects to consider. Splitting net domestic product per person into primary, secondary, and tertiary components so that $Y = Y_1 + Y_2 + Y_3$ and noting that the rate of growth in Y can be approximated by the sum of the share-weighted growth rates of the three sectors, we can write the test equation for the effect of output composition as:

$$(10) \quad \Delta \ln P = \pi_1 s_1 \Delta \ln Y_1 + \pi_2 s_2 \Delta \ln Y_2 + \pi_3 s_3 \Delta \ln Y_3 + \varepsilon_Y$$

where $s_i = Y_i/Y$. Equation 10 can also be broken down into its components:

$$(11) \quad s_u^P \Delta \ln P_u = \pi_{u1}^* s_1 \Delta \ln Y_1 + \pi_{u2}^* s_2 \Delta \ln Y_2 + \pi_{u3}^* s_3 \Delta \ln Y_3 + \varepsilon_u^*$$

$$(12) \quad s_r^P \Delta \ln P_r = \pi_{r1}^* s_1 \Delta \ln Y_1 + \pi_{r2}^* s_2 \Delta \ln Y_2 + \pi_{r3}^* s_3 \Delta \ln Y_3 + \varepsilon_r^*$$

$$(13) \quad (s_r^P - s_u^P n_r/n_u) \Delta \ln n_r = \pi_{n1}^* s_1 \Delta \ln Y_1 + \pi_{n2}^* s_2 \Delta \ln Y_2 + \pi_{n3}^* s_3 \Delta \ln Y_3 + \varepsilon_n^*$$

The breakdown enables us to test for the differential effects of growth in various sectors on urban and rural poverty as well as the effect of rural-to-urban migration. As before, we estimate equations 10–12 and use the condition $\pi_{ni}^* = \pi_i - \pi_{ri}^* - \pi_{ui}^*$, $i = 1, 2, 3$ to infer the parameters of equation 13.

The elasticities of the poverty measures to the sector means can be readily obtained. In the regressions of the national poverty measures (equations 5 and 10) the elasticities are obtained by multiplying the regression coefficients by the relevant consumption or income shares. For the decompositions of the rate of reduction in average poverty (such as equations 7 and 8), the elasticity of poverty in sector i ($= u, r$) to growth in sector j is obtained by multiplying the regression coefficient for j by that sector's consumption or income share relative to i 's share of total poverty.

II. DATA

The Consumption Distributions

For this investigation we derived a new and consistent time series of poverty measures for rural and urban India between 1951 and 1991. This time series is based on consumption distributions from thirty-three household surveys conducted by the National Sample Survey Organization (NSSO). We use distributions from the third survey round, for August to November 1951, up to the forty-seventh round, for July to December 1991.¹ This series substantially improves upon the most widely used time series on poverty measures in India to

1. The first two rounds of the National Sample Survey (NSS) covered rural areas only.

date. Past work has relied on poverty measures presented in Ahluwalia (1978), which gives estimates of the head count index, and Sen's (1976) poverty measure for rural areas, including only twelve rounds, spanning 1956–57 to 1973–74. One extra round (1977–78) was added in Ahluwalia (1985). Datt (1995) describes in detail how our new series was estimated, so we will be brief here. A set of data discs and a manual are available from the authors.

Several points should be made about the consumption distributions. Following the now well-established practice for India and elsewhere, a household's standard of living is measured by real consumption expenditure per person. The consumption measure is comprehensive, following sound and consistent survey and accounting practices. The underlying NSSO data do not include incomes—although it can be argued that current consumption is a better indicator of living standards than current income.² Nonetheless, this measure cannot capture various nonincome dimensions of well-being, and we say nothing here about how responsive these dimensions may be to growth (for further discussion and references see Anand and Ravallion 1993).

The average sample size of the thirty-three surveys is 10,988 urban households and 18,691 rural households. But there is considerable variation over time. The urban samples range from 514 to 58,162, while the rural samples range from 1,361 to 99,766. In both cases the smallest samples were in 1953 (although in different rounds), and the largest were in 1977–78. From 1955 onward all samples exceeded 1,000.

We use the urban-rural classification of the NSSO's tabulations.³ Over such a long period some rural areas naturally became urban areas. To the extent that rural (nonfarm) economic growth may foster such reclassifications, it may produce a downward bias in our estimates of the (absolute) elasticities of rural poverty to rural economic growth. The impact on urban elasticities could be positive or negative, depending on the circumstances of the new urban areas relative to the old ones. We have little choice but to use the NSSO's classification, given that unit record data are unavailable and given that we do not know what the best corrective action would be if we had access to those data.

Whenever the dependent and independent variables are estimated from the same survey data, a bias may arise because measurement errors in the survey can be passed on to both variables; if the mean is overestimated, poverty will tend to be underestimated. In all of our regressions we have also tried an instru-

2. Current consumption is a better indicator than current incomes particularly in this setting. For an overview of supporting arguments see Ravallion (1994). Using village panel data from India, Chaudhuri and Ravallion (1994) find that current consumption and income are better indicators of chronic poverty than other measures tested, although the choice between consumption and income is less clear. Even so, it can be argued that current consumption is the better indicator of current level of living.

3. The NSS has followed the census definition of urban areas, which is based on a number of criteria, including a population greater than 5,000, a density not less than 400 persons per square kilometer, and three-fourths of the male workers engaged in nonagricultural pursuits (Government of India 1992).

mental variables estimator, in which the instruments excluded variables derived from the same survey as the dependent variable.

The Poverty Line and Deflators

Consistent measurement of absolute poverty requires that the poverty line be the cost of a fixed standard of living over the period of analysis and across sectors (Ravallion 1994). The poverty line we use is the line originally defined by Government of India (1979) and recently endorsed by the Planning Commission (Government of India 1993). This poverty line is based on a nutritional norm of 2,400 calories per person per day in rural areas and 2,100 calories in urban areas. The poverty lines for rural and urban sectors were defined as the level of average per capita total expenditure at which the caloric norms were typically attained in each of the two sectors, following what has been termed the “food energy method” (Ravallion 1994). The rural poverty line was thus set at a per capita monthly expenditure of 49 rupees (rounded to the nearest rupee), and the urban at 57 rupees, measured at 1973–74 prices.

The food energy method may not yield consistent poverty lines (representing a uniform threshold in terms of the living standard indicator), especially if the average levels of living vary substantially across sectors (Ravallion 1994). Better-off regions or sectors will tend to have lower average food shares and hence reach caloric requirements at higher real expenditure levels. This tendency can severely distort the poverty profile. A case study for Indonesia found that this method produced poverty lines that vary so much in terms of their basic-needs purchasing power that the method produced considerable reranking of regions and sectors (Ravallion and Bidani 1994). However, one can readily test the method for India; independent estimates of the urban-rural cost of living differential can be used in conjunction with the rural poverty line to derive the equivalent urban line. For 1973–74 Bhattacharya, Choudhury, and Joshi (1980) estimated that the cost of living for the poor was 16 percent higher in urban areas—the same amount (to the nearest integer) implied by the food energy method (although this result may stem from the higher caloric requirement used for rural areas in the Planning Commission’s poverty lines).⁴ It can thus be argued that, for India, the food energy method has not vitiated the urban-rural poverty comparison.

After August 1968 the all-India consumer price index for industrial workers (CPIIW) is used as the deflator for the urban sector. A detailed discussion of the deflators used for comparisons over time can be found in Datt (1995). We will limit ourselves to only a brief description here. For the earlier period the Labour Bureau’s consumer price index for the working class is used, which is an earlier incarnation of the CPIIW, albeit with less coverage of urban centers (twenty-seven compared with fifty). The rural cost of living index series was constructed in three parts. For the period since September 1964 the rural cost of living index

4. This is the Fisher index, which gave a differential of 15.9 percent. The Laspeyres index gave 16.5 percent, while the Paasche index gave 15.2 percent.

is the all-India Consumer Price Index for Agricultural Laborers (CPIAL) published by the Labour Bureau. For September 1956 to August 1964 (for which an all-India CPIAL does not exist), a monthly series of the all-India CPIAL was constructed as a weighted average of the state-level CPIALS, using the same state-level weights as those used in the all-India CPIAL published since September 1964. For August 1951 to August 1956 forecasts were obtained from a dynamic model of the CPIAL as a function of the CPIIW and the wholesale price index (for details see Datt 1995).

Our CPIAL series also overcame the problem that arose because the Labour Bureau had used the same price for firewood in its published series since 1960–61. Firewood is typically a common property resource for agricultural laborers, but it is also a market good, and thus the Labour Bureau's practice is questionable. This practice is even more questionable because the NSS values nonpurchased firewood consumption at local market prices (see Minhas and others 1987 for further discussion). Our CPIAL series replaces the firewood subseries in the CPIAL with one based on mean rural firewood prices (only available from 1970) and a series derived by assuming that firewood prices increased at the same rate as all other items in the Fuel and Light category (prior to 1970).

The final CPIIW and CPIAL indexes are averages of monthly indexes corresponding to the survey period of each of the NSS's rounds. We differ in this respect from Ahluwalia (1978), who uses averages of the CPIAL over the agricultural year (July to June), even for NSS rounds in which the survey period was different. Given the seasonality of prices, matching the survey period is arguably a better procedure.

The National Accounts and Population Data

Our data on sectoral incomes are taken from various issues of the National Accounts Statistics (NAS) published by the Central Statistical Organization (CSO). In particular, we draw upon the NAS to create an annual series of the net domestic product (NDP) at factor cost at constant 1980–81 prices, and its sectoral components, that is, NDP in the primary, secondary, and tertiary sectors. The constant price conversions implicit in these series are based on the national accounts deflators. The primary sector includes agriculture, forestry, fishing, mining, and quarrying; the secondary sector includes manufacturing, construction, and electricity, gas, and water supply; the tertiary sector includes trade, hotels, restaurants, transport, storage, communication, finance, insurance, real estate, business services, and community, social, and personal services. We also draw upon the NAS to construct a series on private final consumption expenditure at constant prices as an alternative to the NSS-based series.

The NAS reports these series annually for the financial year April to March. To mesh these data with the poverty data from the NSSO, we linearly interpolated the annual national accounts data to the midpoint of the survey period for different rounds. But the first ten NSS rounds covered periods shorter than one year (from four to nine months), and thus the mapping into annual national

accounts data was far more problematic. We thus deleted the first ten surveys in any regressions using national accounts data.

The population estimates are based on the census population totals and assume a constant growth rate between censuses. They are also centered at the midpoints of NSS survey periods.

Poverty Measures

We use three poverty measures:

- The headcount index, given by the percentage of the population that lives in households with a per capita consumption below the poverty line.
- The poverty gap index, defined by the mean distance below the poverty line, expressed as a proportion of that line. The mean is formed over the entire population, counting the nonpoor as having a zero poverty gap.
- The squared poverty gap index introduced by Foster, Greer, and Thorbecke (1984), defined as the mean of the squared proportionate poverty gaps. Unlike the poverty gap index this measure is sensitive to distribution among the poor. A transfer of income from a poor person to a poorer person, for example, will not alter either the headcount index or the poverty gap index, but it will decrease the squared poverty gap index. Furthermore—and unlike the Sen (1976) distribution sensitive measure of poverty—the squared poverty gap index satisfies the “subgroup consistency” property; that is, if poverty increases in any subgroup (say the urban sector), and it does not decrease elsewhere, then aggregate poverty must also increase (Foster and Shorrocks 1991).

All three measures are members of the Foster-Greer-Thorbecke (FGT) class, for which the individual poverty measure is

$$(14) \quad p_{\alpha,i} = (l - x_i/z)^\alpha \text{ if } x_i \leq z \\ = 0 \text{ if } x_i > z$$

where x_i is consumption expenditure of the i th person in a population of size n , z is the poverty line, and α is a nonnegative parameter. Average poverty is simply

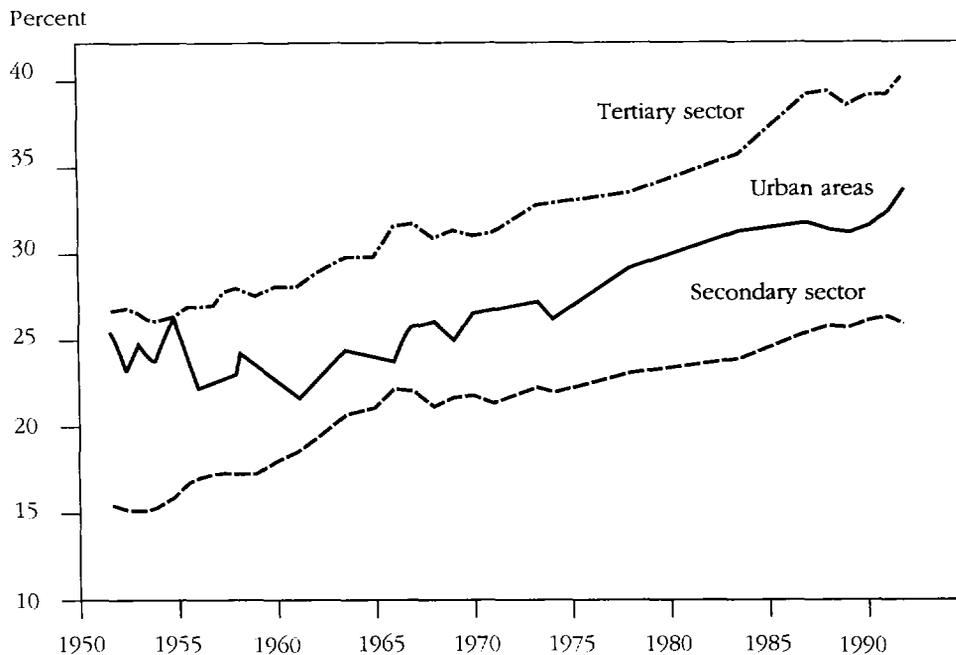
$$(15) \quad P_\alpha = \sum_{i=1}^n p_{\alpha,i}/n.$$

The headcount index is obtained when $\alpha = 0$, the poverty gap index when $\alpha = 1$, and the squared poverty gap index when $\alpha = 2$. The poverty measures are estimated from the grouped data on consumption distributions using parameterized Lorenz curves (see Datt and Ravallion 1992).

III. RESULTS

The urban sector's share of consumption has risen steadily since about 1960 (figure 1). Both the secondary and tertiary sectors' shares of national income

Figure 1. Sectoral Composition of Economic Activity in India, 1951–91



Note: The urban share is of total national consumption as estimated from National Sample Surveys. The secondary and tertiary shares are of net domestic product as estimated from the National Accounts Statistics.

Source: Authors' calculations from National Sample Surveys and National Accounts Statistics.

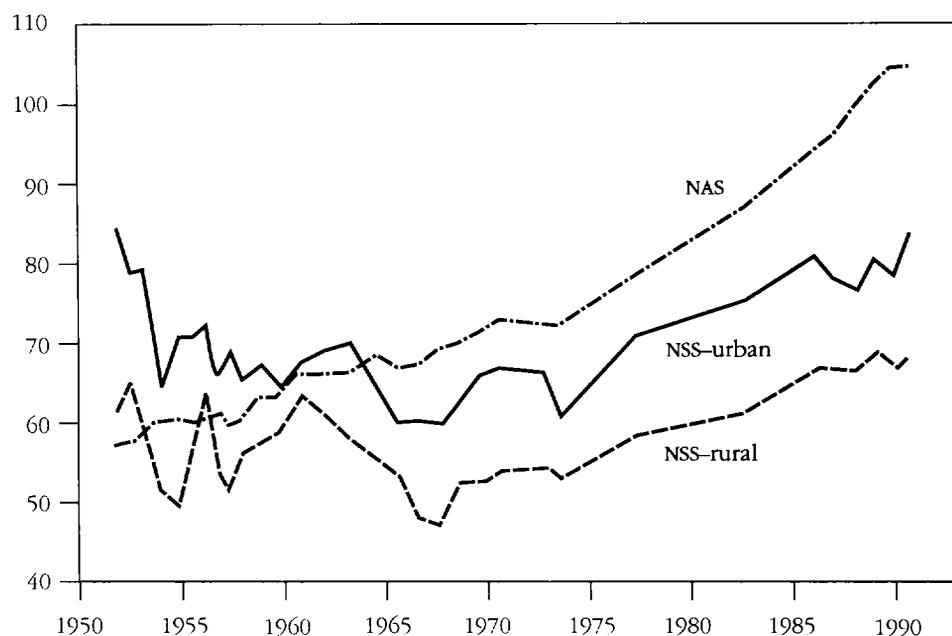
have been on a trend increase over the whole period (the balance is the primary sector).

There have been sizable fluctuations in the NSSO-based means of consumption, although some patterns are evident (figure 2). There was a contraction in the early 1950s, followed by a long period of stagnation, and a reasonably sustained period of growth since the mid-1970s. Throughout the entire period there is strong comovement between the urban and rural means (the simple correlation coefficient is 0.84; the correlation coefficient of the first differences between survey rounds is 0.49). Thus the historical gap in average living standards between the sectors was maintained: there is no significant time trend in the ratio of the rural to the urban mean.⁵ The consumption mean derived from the national accounts shows a reasonably strong trend increase over the whole period, and has been higher than even the urban NSSO-based mean since the mid-1960s. The discrepancy between the national accounts consumption numbers and those from the NSSO has been noted before, and we will not discuss the issue here. For

5. If the log of the ratio of the means is regressed on time and one corrects for the serial correlation in the errors, the implied rate of growth in the ratio of the urban mean to the rural mean is -1.4 percent per year, but the *t*-ratio is only 1.2.

Figure 2. *Average Consumption in India, 1951–91*

Mean consumption (rupees per month per person; 1973–74 prices)

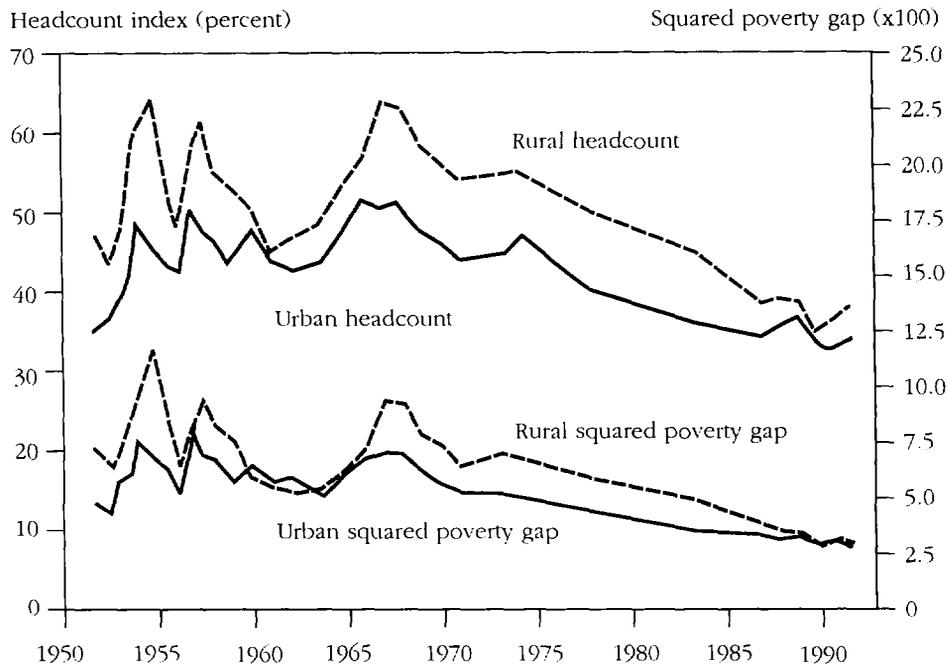


Source: Authors' calculations from National Sample Surveys (NSS) and National Accounts Statistics (NAS).

further discussion see Vaidyanathan (1986), Suryanarayana and Iyengar (1986), Minhas (1988), and Bhattacharya and others (1991).

The bulk of the consumption growth since about 1970 is attributable to growth within sectors; the Kuznets process of rural to urban migration, at given sector means, accounts for very little. Averaging the three survey rounds in 1969–71 and the three rounds in 1989–91, we find that only 6.4 percent of the increase in log consumption from 1970 to 1990 is attributable to population shifts (the third term in equation 4), while 20.0 and 73.5 percent are attributable to growth within the urban and rural sectors, respectively (given the initial urban population share).

Neither the headcount index nor the squared poverty gap index for either urban or rural sectors shows a trend increase or decrease until about 1975, when a trend decrease emerged (figure 3). The pattern of change over time is very similar for the poverty gap index (see Datt 1995 for details). This pattern also holds for urban poverty although the fluctuations seem less pronounced. Comovement is strong: the simple correlation coefficient between the contemporaneous sector values of the log headcount index is 0.92 (0.68 between the first differences). There are also signs of convergence between urban and rural areas by the end of the period, with the urban squared poverty gap overtaking the rural index. However, the rural sector still accounts for 74 percent of the

Figure 3. *Poverty Measures for India, 1951–91*

Source: Authors' calculations.

total number of poor at the end of the period, 70 percent of the average poverty gap index, and 68 percent of the average squared poverty gap index.

As with growth in mean consumption, the bulk of the poverty reduction after 1970 is attributable to gains within sectors rather than the population shift effect. For example, the impact of population shifts accounts for only 3.2 percent of the difference in the log headcount index between 1970 and 1990, while the urban and rural sectors account for 12.3 percent and 84.5 percent, respectively (the results are similar for the squared poverty gap).

The Growth Elasticities of National Poverty Measures

The elasticities of all three poverty measures with respect to the three measures of economic growth—the mean consumption per person as estimated by the NSSO, the mean consumption per person as estimated by the national accounts and population census, and the mean NDP (“income” for short) per person also taken from the national accounts and census—are estimated by regressing the first difference of the log poverty measure against the first difference of log mean consumption or income (table 1). We also give an “adjusted” estimate in which another variable was added, namely the first difference of the log of the ratio of the consumer price index for agricultural laborers to the national in-

Table 1. *Elasticities of National Poverty Measures to Economic Growth in India*

<i>Poverty measure</i>	<i>Elasticity with respect to</i>				
	<i>Mean consumption from national sample surveys</i>	<i>Mean private consumption from national accounts</i>		<i>Mean net domestic product</i>	
		<i>Unadjusted</i>	<i>Adjusted^a</i>	<i>Unadjusted</i>	<i>Adjusted^a</i>
Headcount index ($\alpha = 0$)	-1.33 (15.19)	-1.21 (4.04)	-0.90 (4.23)	-0.99 (3.38)	-0.75 (3.68)
Poverty gap index ($\alpha = 1$)	-1.88 (12.83)	-1.79 (4.02)	-1.36 (3.98)	-1.49 (3.44)	-1.15 (3.59)
Squared poverty gap index ($\alpha = 2$)	-2.26 (10.22)	-2.18 (3.73)	-1.67 (3.45)	-1.85 (3.32)	-1.45 (3.27)

Note: Absolute *t*-ratios in parentheses. Based on regressions of first differences of the log poverty measures against first differences of the log consumption or net product per person, using thirty-three surveys spanning 1951–91 for estimating the elasticity with respect to the surveys-based mean consumption and twenty-three surveys spanning 1958–91 for estimating elasticities to consumption or income from the national accounts. All regressions comfortably passed residual diagnostic tests for serial correlation, functional form, normality, and heteroskedasticity (see appendix for details).

a. The adjusted estimates include an additional regressor, that is the difference in the rates of inflation implied by the consumer price index and the national income deflator.

Source: Authors' calculations.

come deflator (that is, the difference in the rate of inflation implied by the two deflators). This variable was included to allow for possible bias in estimating the growth elasticity, which may arise because of the difference in the deflator used for the national accounts data and that used for the poverty lines.

The national poverty measures responded to all three measures of economic growth. The elasticities are higher if the NSSO estimate of mean consumption is used rather than the national accounts estimate, although the difference is not large for a given value of α . The elasticities are lowest for per capita NDP. This result may be due to intertemporal consumption smoothing, which may make poverty (in terms of consumption) less responsive to income growth than to consumption growth in the short term.

The Impact of the Urban-Rural Composition of Growth on Poverty

All of the regressions of equations 5, 7, and 8 fitted well and passed almost all standard tests on the residuals (table 2). However, a correction for serial correlation in the residuals was needed in some of the urban poverty equations. The appendix tables give results for the complete regressions and various statistical tests.

Table 2. *Impacts of the Urban-Rural Composition of Growth on Poverty in India*

Poverty measure	National poverty	Urban poverty	Rural poverty
<i>Urban growth</i>			
Headcount	-0.549 (1.367) [-0.142]	-0.560 (5.687) [-0.824]	-0.169 (0.542) [-0.053]
Poverty gap	-0.288 (0.449) [-0.075]	-0.623 (4.821) [-0.915]	0.278 (0.436) [0.087]
Squared poverty gap	0.234 (0.244) [0.061]	-0.559 (3.302) [-0.829]	0.777 (0.805) [0.243]
<i>Rural growth</i>			
Headcount	-1.461 (12.636) [-1.083]	-0.076 (2.951) [-0.320]	-1.141 (12.691) [-1.027]
Poverty gap	-2.123 (11.502) [-1.574]	-0.129 (3.977) [-0.543]	-1.979 (10.800) [-1.781]
Squared poverty gap	-2.651 (9.585) [-1.965]	-0.174 (4.113) [-0.739]	-2.446 (8.811) [-2.197]

Note: Absolute *t*-ratios in parentheses; elasticities at mean points in brackets (see appendix tables for detailed results). At the mean points, the urban share of national consumption was 0.259, and the primary-secondary-tertiary breakdown was 0.487, 0.202, 0.312. The urban share of total poverty was 0.176 for both the headcount index and the poverty gap index and 0.175 for the squared poverty gap.

Source: Authors' calculations.

There is strong evidence that the urban-rural composition of growth matters to India's rate of progress in reducing all three national poverty measures. The urban growth effect is not significantly different from zero in explaining the rate of poverty reduction nationally. But the rural growth term is highly significant. A Wald test of the null hypothesis that urban consumption growth has the same effect on national poverty as rural growth can be rejected in all cases (appendix tables A-1, A-2, and A-3). A stronger version of the test requiring uniform effects of urban and rural growth as well as sectoral population shifts was also rejected for the poverty gap and the squared poverty gap indexes, though we were unable to reject it for the headcount index (see the appendix tables for details). We found that the urban-rural population shift had no significant effects on poverty. Thus it appears that the strong growth effects evident in table 1 are largely attributable to rural consumption growth, with very little contribution from either urban growth or the Kuznets process.

Turning to the urban-rural decomposition of poverty reduction, we find that urban growth reduced urban poverty (table 2), but so did rural growth, which had a significant impact on poverty in both sectors for all three poverty measures. Indeed for the squared poverty gap the elasticity of urban poverty to rural growth is almost as high as it is to urban growth. The effect of urban growth is too small to be detected in the national average poverty measures.

The relatively low impact of urban growth on urban poverty and the propoor spillover effect of rural growth suggest significant distributional effects within urban areas. This proposition is confirmed by regressing the change between surveys in the (log) Gini index for urban areas on the growth rates in both urban and rural means:⁶

$$(16) \quad \Delta \ln Gini(urban) = 0.73 \Delta \ln mean(urban) - 0.41 \Delta \ln mean(rural).$$

(5.85) (4.15)

Urban consumption growth has been increasing inequality in urban areas, while rural growth has improved urban distribution. By contrast, performing the same regression for the rural Gini, the changes in either mean are not significant, either individually or jointly.

The Impact of the Output Composition of Growth on Poverty

In explaining the rate of progress in reducing poverty nationally, we find a marked difference between the primary and tertiary sectors on the one hand and the secondary sector on the other (table 3). Growth in both the primary and tertiary sectors was poverty reducing, the tertiary sector generating a larger impact, though the difference between these two sectors is not significant. By contrast, growth in the secondary sector had an adverse impact, though not significantly different from zero at the 5 percent level for any poverty measure.

6. Absolute *t*-ratios are given in parentheses. The R^2 is 0.65. A correction was made for serial correlation in the errors.

Table 3. *Impacts of the Output Composition of Growth on Poverty in India*

<i>Sector and poverty measure</i>	<i>National poverty</i>	<i>Urban poverty</i>	<i>Rural poverty</i>
<i>Primary sector growth</i>			
Headcount	-1.157 (2.964) [-0.563]	-0.316 (2.755) [-0.872]	-0.858 (2.625) [-0.507]
Poverty gap	-1.586 (2.615) [-0.772]	-0.432 (2.983) [-1.194]	-1.313 (2.341) [-0.776]
Squared poverty gap	-1.905 (2.192) [-0.927]	-0.471 (2.719) [-1.313]	-1.660 (2.040) [-0.979]
<i>Secondary sector growth</i>			
Headcount	3.409 (1.837) [0.688]	0.609 (1.176) [0.697]	2.531 (1.629) [0.620]
Poverty gap	5.816 (2.016) [1.174]	1.254 (1.917) [1.437]	5.162 (1.936) [1.265]
Squared poverty gap	7.026 (1.700) [1.418]	1.532 (1.960) [1.771]	6.338 (1.637) [1.550]
<i>Tertiary sector growth</i>			
Headcount	-3.418 (2.737) [-1.065]	-0.702 (2.009) [-1.240]	-2.373 (2.270) [-0.898]
Poverty gap	-5.869 (3.024) [-1.185]	-1.216 (2.755) [-2.151]	-5.124 (2.856) [-1.938]
Squared poverty gap	-7.274 (2.616) [-1.468]	-1.458 (2.763) [-2.601]	-6.449 (2.476) [-2.434]

Note: Absolute *t*-ratios are in parentheses; elasticities at mean points in brackets. These regressions were augmented for differences in the rate of inflation implied by the consumer price indexes (CPIs) and national income deflators (see appendix tables for details).

Source: Authors' calculations.

When we turn to the tests for output compositional effects on the rates of poverty reduction in the urban and rural sectors we find that primary and tertiary sector growth was poverty reducing in both urban and rural sectors (table 3). The highest elasticities were for tertiary growth, although tertiary growth started from a smaller base. By contrast, secondary sector growth had no significant impact on the rate of poverty reduction in either urban or rural areas.

One striking feature of the results in table 3 is that, for a given poverty measure, the coefficients on secondary and tertiary growth components are nearly equal in absolute value, although they have opposite signs. In fact, the null $\pi_3 = -\pi_2$ cannot be rejected at the 1 percent level for any poverty measure, and this result also holds for the urban-rural components of the change in poverty (ap-

pendix table A-4). In terms of equation 10, this result is telling us that the relationship can be simplified to

$$(17) \quad \Delta \ln P = \pi_1 s_1 \Delta \ln Y_1 + \frac{\pi_3 \Delta(Y_3 - Y_2)}{Y} + \varepsilon_Y$$

and our regressions indicate that π_1 and π_3 are negative. Thus it is not tertiary sector growth per se that is reducing poverty, but increases in the difference between tertiary sector output and the output of the (smaller) secondary sector.

At first sight this result seems odd, but it has a plausible interpretation. In India (as in other developing countries) the tertiary sector includes a hybrid of activities that are of varying importance to the poor. It combines, for example, formal sector finance and insurance firms with informal trade and transport activities. Let $Y_3 \equiv Y_{3f} + Y_{3i}$, where the subscripts $3f$ and $3i$ refer to the formal and informal tertiary sectors, respectively. Suppose that the true relationship between the rate of progress in reducing poverty and the composition of growth is

$$(18) \quad \Delta \ln P = \pi_1 s_1 \Delta \ln Y_1 + \pi_3 s_{3i} \Delta \ln Y_{3i} + \varepsilon_Y.$$

This equation assumes that (in addition to the primary sector) it is the informal tertiary sector that matters to the poor, and not the secondary sector or the formal tertiary sector. However, the formal tertiary sector is likely dependent on the secondary sector: secondary sector growth generates demand for outputs from the formal tertiary sector. Suppose, in particular, that average incomes in the secondary sector move so closely to those in the formal tertiary sector that the unobserved variable ΔY_{3f} is approximated well by ΔY_2 . Under these assumptions, equation 18 implies that equation 17 is an estimable model. According to this interpretation, the secondary sector is acting as a proxy for the formal tertiary sector, when in fact it is growth in the informal tertiary sector that matters to the poor.

Does the Poverty Measure Matter?

Tables 1–3 show that our qualitative results are robust to the choice of poverty measure. However, the growth elasticities tend to be higher (in absolute value) for higher values of α . To help interpret this result, note that the poverty gap indexes can be written in a nested form:

$$(19) \quad \begin{aligned} P_1 &= P_0(1 - \mu^p/z) \\ P_2 &= P_1 \left[1 + \mu^p/z + \frac{(\sigma^p/z)^2}{1 - \mu^p/z} \right] \end{aligned}$$

where μ^p and σ^p are the mean and standard deviation of consumption by the poor, respectively. As can be seen from equation 19, the higher growth elasticity of P_1 compared with P_0 implies that the depth of poverty (as measured by $1 - \mu^p/z$) is also reduced by growth. Similarly, the higher elasticity of P_2 relative to P_1 implies that inequality among the poor—as measured by the coefficient of

variation—is reduced by growth.⁷ Thus the effects of growth within and between sectors are not confined to households within a neighborhood of the poverty line.

IV. CONCLUSIONS

Despite the substantial sectoral shifts that have occurred over the last forty years, poverty in India is still overwhelmingly rural. At the beginning of the 1990s, 74 percent of the country's poor lived in rural areas. That fact alone does not imply that urban economic growth is unimportant. The nature of intrasectoral and intersectoral effects of growth and of rural-to-urban migration on poverty may mean that rural economic growth is far less important than the sheer size of the rural sector would suggest.

In fact, the main conclusion of this article holds that, if anything, the opposite is true: the relative effects of growth within and between each sector reinforced the importance of rural economic growth to national poverty reduction in India. Both the urban and rural poor gained from rural sector growth. By contrast, urban growth had adverse distributional effects within urban areas, which militated against the gains to the urban poor. And urban growth had no discernible impact on rural poverty. Nor did the (much researched) Kuznets process of growth through rural-to-urban migration significantly reduce poverty in India.

When we decompose growth in national income by sectors defined by output, we again find marked differences in the impact on poverty. Both primary and tertiary sector growth reduced poverty nationally and within urban and rural areas. By contrast, secondary sector growth had no discernible positive effect on the poor in either urban or rural areas. In the historical shift from the primary sector to the secondary and tertiary sectors it seems that it was the tertiary sector that delivered significant gains to India's poor.

Our investigation points clearly to the quantitative importance of the sectoral composition of economic growth to poverty reduction in India. Despite the rising urbanization of Indian poverty, it is likely to remain true for many years to come that—from the point of view of India's poor—it is the dog (the rural economy) that wags the tail (the urban sector), not the other way around. Fostering the conditions for growth in the rural economy—in both primary and tertiary sectors—must thus be considered central to an effective strategy for poverty reduction in India. But there is another more subtle implication for the future. We have studied the historical experience in a period in which India's development strategy (starting from the Second Plan in the 1950s) emphasized capital-intensive industrialization concentrated in the urban areas of a largely closed economy. It may not be surprising that urban economic growth fueled by such industrialization brought negligible gains to the poor. This result underlines the importance of making a successful transition to an alternative industrialization process; even then (we suspect), the tail will not wag the dog. But it could surely do a lot more to help it move.

7. Note that a higher growth elasticity for P_1 compared with P_0 implies that μ^p must be increasing in μ , and thus a higher elasticity for P_2 relative to P_1 must imply that σ^p is decreasing in μ .

Table A-1. *Change in Headcount Index as a Function of Urban and Rural Consumption Growth in India*

Variable or statistic	Change in national poverty		Components of change in national poverty			
			Urban		Rural	
	OLS	IV	AR(1)	IV	OLS	IV
Urban growth (π_1)	-0.549 (1.37)	-0.445 (0.937)	-0.560 (5.69)	-0.489 (4.29)	-0.169 (0.54)	-0.185 (0.50)
Rural growth (π_2)	-1.461 (12.64)	-1.498 (11.00)	-0.076 (2.95)	-0.087 (2.67)	-1.141 (12.69)	-1.154 (10.91)
Population shift (π_3)	-4.458 (1.31)	-4.718 (1.35)	-0.775 (1.25)	-0.908 (1.08)	-1.624 (0.61)	-1.534 (0.56)
R^2	0.895	0.894	0.761	0.732	0.886	0.886
Standard error of estimate	0.0295	0.0295	0.0068	0.0071	0.0229	0.0229
Autocorrelation (1)	2.555	2.494	n.a.	3.161	1.812	2.026
Functional form (1)	0.006	0.005	n.a.	0.191	0.071	0.062
Normality (2)	0.059	0.056	n.a.	0.613	0.552	0.412
Heteroskedasticity (1)	0.132	0.157	n.a.	0.224	0.634	0.544
Sargan's IV test (11)	n.a.	4.765	n.a.	4.903	n.a.	5.926
Wald test (2): $\pi_1=\pi_2=\pi_3$	4.10	3.881	n.a.	n.a.	n.a.	n.a.
Wald test (1): $\pi_1=\pi_2$	3.879	3.656	n.a.	n.a.	n.a.	n.a.

n.a. Not applicable.

Note: The table shows ordinary least squares (OLS) and instrumental variables (IV) parameter estimates for equations 5, 7, and 8. Absolute *t*-ratios are given in parentheses. The data are from thirty-three household surveys spanning from 1951 to 1991 (see text for details). The equations for urban poverty correct for first-order autocorrelation, AR(1). The following set of instruments were used in the IV estimation: date (midpoint) of the survey; time interval between the surveys; lagged rural and urban log real mean consumption; current rural and urban price indices (in logs) and their lagged values; change in log real per capita output from the primary, secondary, and tertiary sectors; and log real per capita consumption from the national accounts and its lagged value. The bottom part of the table reports a number of diagnostic tests; the test statistics are distributed as χ^2 with the degrees of freedom as noted in parentheses. The last two rows report Wald tests on the null of no compositional effects of growth on poverty. The stronger version tests the restriction that the effects on poverty of urban growth, rural growth, and sectoral population shift are the same; the weaker version tests for uniform effects of urban and rural growth only.

Source: Authors' calculations.

Table A-2. *Change in the Poverty Gap Index as a Function of Urban and Rural Consumption Growth in India*

Variable or statistic	Change in national poverty		Components of change in national poverty			
			Urban		Rural	
	OLS	IV	AR(1)	IV/AR(1)	OLS	IV
Urban growth (π_1)	-0.288 (0.45)	-0.116 (0.153)	-0.623 (4.82)	-0.534 (2.90)	0.278 (0.44)	0.399 (0.53)
Rural growth (π_2)	-2.123 (11.50)	-2.157 (9.92)	-0.129 (3.98)	-0.152 (3.52)	-1.979 (10.80)	-2.029 (9.40)
Population shift (π_3)	-9.284 (1.71)	-9.555 (1.71)	-1.327 (1.82)	-1.463 (1.69)	-7.595 (1.41)	-7.524 (1.35)
R^2	0.868	0.868	0.777	0.769	0.841	0.841
Standard error of estimate	0.0471	0.0471	0.0092	0.0095	0.0467	0.0468
Autocorrelation (1)	1.314	1.194	n.a.	n.a.	1.300	1.350
Functional form (1)	0.648	0.635	n.a.	n.a.	1.708	1.730
Normality (2)	0.088	0.105	n.a.	n.a.	0.463	0.528
Heteroskedasticity (1)	0.324	0.391	n.a.	n.a.	0.006	0.020
Sargan's IV test (11)	n.a.	9.968	n.a.	5.551	n.a.	11.398
Wald test (2): $\pi_1 = \pi_2 = \pi_3$	6.813	6.021	n.a.	n.a.	n.a.	n.a.
Wald test (1): $\pi_1 = \pi_2$	6.165	5.399	n.a.	n.a.	n.a.	n.a.

n.a. Not applicable.

Note: See note to table A-1.

Source: Authors' calculations.

Table A-3. *Change in the Squared Poverty Gap Index as a Function of Urban and Rural Consumption Growth in India*

Variable or statistic	Change in national poverty		Components of change in national poverty			
	OLS	IV	Urban		Rural	
			AR(1)	IV/AR(1)	OLS	IV
Urban growth (π_1)	0.234 (0.24)	0.258 (0.23)	-0.559 (3.30)	-0.558 (2.29)	0.777 (0.44)	0.786 (0.69)
Rural growth (π_2)	-2.651 (9.59)	-2.649 (8.14)	-0.174 (4.11)	-0.185 (3.23)	-2.446 (8.81)	-2.476 (7.58)
Population shift (π_3)	-13.578 (1.67)	-13.301 (1.59)	-1.924 (2.06)	-1.783 (1.56)	-11.733 (1.44)	-11.044 (1.31)
R^2	0.811	0.811	0.748	0.738	0.771	0.771
Standard error of estimate	0.0705	0.0705	0.0122	0.0126	0.0708	0.0708
Autocorrelation (1)	0.681	0.622	n.a.	n.a.	0.561	0.585
Functional form (1)	0.399	0.431	n.a.	n.a.	1.265	1.366
Normality (2)	0.250	0.256	n.a.	n.a.	0.275	0.292
Heteroskedasticity (1)	1.395	1.447	n.a.	n.a.	0.182	0.121
Sargan's IV test (11)	n.a.	10.105	n.a.	5.928	n.a.	11.024
Wald test (2): $\pi_1=\pi_2=\pi_3$	7.434	5.474	n.a.	n.a.	n.a.	n.a.
Wald test (1): $\pi_1=\pi_2$	6.790	4.889	n.a.	n.a.	n.a.	n.a.

n.a. Not applicable.

Note: See note to table A-1.

Source: Authors' calculations.

Table A-4. *Change in Poverty as a Function of the Primary-Secondary-Tertiary Composition of Growth in India*

Variable or statistic	Headcount index			Poverty gap index			Squared poverty gap index		
	Change in national poverty	Components of change in national poverty		Change in national poverty	Components of change in national poverty		Change in national poverty	Components of change in national poverty	
		Urban	Rural		Urban	Rural		Urban	Rural
Primary sector growth (π_1)	-1.158 (2.96)	-0.316 (2.76)	-0.858 (2.62)	-1.586 (2.62)	-0.432 (2.98)	-1.313 (2.34)	-1.905 (2.19)	-0.471 (2.72)	-1.660 (2.04)
Secondary sector growth (π_2)	3.409 (1.84)	0.609 (1.18)	2.531 (1.63)	5.816 (2.02)	1.254 (1.92)	5.162 (1.94)	7.026 (1.70)	1.532 (1.96)	6.338 (1.64)
Tertiary sector growth (π_3)	-3.418 (2.74)	-0.702 (2.01)	-2.373 (2.27)	-5.869 (3.02)	-1.216 (2.75)	-5.124 (2.86)	-7.274 (2.62)	-1.458 (2.76)	-6.449 (2.48)
Change in rural price index relative to NDP deflator	0.939 (5.63)		0.726 (5.20)	1.284 (4.96)		1.173 (4.90)	1.512 (4.07)		1.409 (4.05)
Change in urban price index relative to NDP deflator		0.254 (2.71)			0.350 (2.95)			0.467 (3.30)	
R^2	0.752	0.491	0.701	0.714	0.490	0.699	0.631	0.469	0.618
Standard error of estimate	0.0378	0.0095	0.0316	0.0587	0.0120	0.0543	0.0841	0.0144	0.0788
Autocorrelation (1)	0.143	0.002	0.158	0.147	1.024	0.001	0.273	4.084	0.101
Functional form (1)	2.813	0.191	2.762	5.036	0.086	3.513	5.953	0.109	3.975
Normality (2)	1.300	0.940	0.527	1.677	0.123	0.924	1.547	0.516	0.059
Heteroskedasticity (1)	0.060	1.693	0.145	0.226	0.075	0.820	0.297	0.018	0.669
Wald test (2): $\pi_1 = \pi_2 = \pi_3$	5.109	n.a.	n.a.	6.065	n.a.	n.a.	4.468	n.a.	n.a.
Wald test (2): $\pi_1 = \pi_3, \pi_2 = 0$	3.731	n.a.	n.a.	5.925	n.a.	n.a.	4.057	n.a.	n.a.
Wald test (1): $\pi_2 + \pi_3 = 0$	0.000	0.199	0.054	0.002	0.020	0.001	0.019	0.055	0.004

n.a. Not applicable.

Note: The table gives least squares parameter estimates for equations 10–12, $n = 23$. The associated absolute t -ratios are given in parentheses. The bottom part of the table reports a number of diagnostic tests. The test statistics are distributed as χ^2 with the degrees of freedom as noted in parentheses. The last two rows report Wald tests on the nulls of (a) no sectoral composition effects of growth on poverty (testing for uniform effects of primary, secondary, and tertiary sector growth); (b) the effects of primary and tertiary sector growth are the same, but secondary sector growth has a zero effect; and (c) the effects of secondary and tertiary sector growth are equal but of opposite signs.

Source: Authors' calculations.

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Is the Debt Crisis History? Recent Private Capital Inflows to Developing Countries

Michael Dooley, Eduardo Fernández-Arias, and Kenneth Kletzer

The outlook for economic development for an important group of middle-income countries has once again been buoyed by substantial private capital inflows in the 1990s. As in the 1970s, this development has been met with cautious optimism. This empirical study finds that although debt reduction and policy reforms in debtor countries have been important determinants of renewed access to international capital markets, changes in international interest rates have been the dominant factor. We calculate the effects of changes in international interest rates for a "typical" debtor country. We conclude that increases in interest rates associated with a business cycle upturn in industrial countries could depress the secondary market prices of existing debt to levels inconsistent with continued capital inflows.

The turnaround in the external financial position of many debtor countries since 1989 has been phenomenal. Improvement is particularly impressive in countries that had completed Brady Plan restructuring of their external debt at the time this article was prepared (Argentina, Costa Rica, Mexico, Nigeria, the Philippines, Uruguay, and Venezuela). In the first quarter of 1989 the external debt of these countries sold for an average price of only forty cents on the dollar and private capital inflows were largely restricted to concerted lending or interest arrears. Various plans for dealing with the debt overhang, including the Brady Plan announced on March 10, 1989, were widely characterized as inadequate to restore access to international capital markets. Some observers, in fact, predicted that debtor countries might not return to private international capital markets for a generation (see U.S. Senate 1990).

Today the recovery in real economic activity and capital formation in debtor countries is just beginning, but a financial recovery is well under way. These countries have experienced very large private capital inflows, real exchange rate appreciation, stock market booms, and dramatic increases in the prices of their external debt (Calvo, Leiderman, and Reinhart 1993). In some cases capital inflows have been associated with a return to resource transfers to these coun-

Michael Dooley and Kenneth Kletzer are with the Department of Economics at the University of California, Santa Cruz; Eduardo Fernández-Arias is with the Office of the Chief Economist at the Inter-American Development Bank, on leave from the World Bank. The authors acknowledge Nlandu Mamingi for his econometric work, and thank Stijn Claessens and Paul Armington for helpful comments.

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tries similar to those recorded in the 1970s, as measured by the emergence of sizable balance of trade deficits.

Do we understand enough about the 1982 crisis to predict that renewed accumulation of external debt can avoid a repeat of 1982 and the considerable costs that followed for debtor countries? Unless the memories of investors and residents of debtor countries are very short, they must believe that there is a difference in the expected outcome of this new round of international investment. Is the debt crisis dead, as suggested by several observers recently, or is it only sleeping?

To understand this turnaround in market access, it is necessary to identify the main factors that can account for the remarkable improvements in debtor countries' creditworthiness. We first argue that secondary market prices for syndicated credits are a useful measure of market access. We then show that changes in international interest rates and induced changes in real exchange rates and real domestic interest rates in debtor countries can account for all of the improvement in secondary market prices after the first round of Brady Plan restructuring agreements in early 1990. The empirical relationship between secondary market prices and international interest rates is robust to changes in model specification and to the period considered. In particular, the dominance of international interest rates holds both before 1989, when yields on sovereign credits rose over time—and prices declined—and after 1989, when yields generally declined—and prices rose. This is further confirmed by recent developments outside the period of our estimations. For example, during February and March 1994—after this article was prepared—U.S. interest rates increased substantially while secondary market prices dramatically declined.¹

The decline in real long-term interest rates on dollar-denominated debt is certainly reversible and, in fact, it might very well be reversed in the next year or so. If domestic real interest rates in debtor countries were also to rise, and real exchange rates were to decline—as would be normal—many developing countries would probably again experience debt servicing difficulties.

Section I develops the relationship between capital inflows and secondary market prices. Section II discusses factors that might explain secondary market prices for developing-country debt. Section III estimates a simple model of secondary market prices. Section IV applies these estimates to a composite Brady Plan country in order to evaluate the source of recent capital inflows. Section V summarizes the results.

I. CAPITAL INFLOWS AND SECONDARY MARKET PRICES

The secondary market price of commercial bank debt is a useful barometer for country creditworthiness. The secondary market price indicates the climate

1. The ten-year U.S. Treasury bond rate increased by 15 percent, from 5.7 to 6.6 percent per year, while the market price index fell by a similar proportion.

for private capital inflows to a debtor country, because it reflects both private investors' expectations concerning the ability of debtor governments to service existing debts and yields on alternative international investments. The secondary market price is a sensitive indicator because it is established in an active market for a relatively homogeneous financial instrument. Furthermore, it is also more up to date and accurate than private capital flow data, useful properties for an indicator.

Rising secondary market prices (falling yields) suggest that residents of the debtor country can issue new debt or equity on better terms than those on past debt. The rising prices reflect improvements in country creditworthiness that, to some extent, apply to all forms of external financing. We argue that the improvement in creditworthiness also results from the worsening in alternative returns in industrial countries. These improvements may fail to be powerful enough to eliminate substantial secondary market discounts and allow countries to regain access to similar commercial bank loans, but may be strong enough to allow access to and better terms for alternative forms of external finance that the market perceives as a safer instrument (for a formal model, see Fernández-Arias 1995). The important implication for understanding recent capital inflows is that a larger volume of new borrowing, or sales of equity, can credibly be serviced at lower yields. Thus, an improvement in secondary market prices was a precondition for recently observed private capital inflows to debtor countries. Moreover, a return of secondary markets to levels reached in 1989 would certainly stop and probably reverse recent capital inflows.

There are two fundamental reasons for changes in the terms on which investors hold new and existing claims on residents of developing countries. The first is changes in yields available on alternative investments as measured here by an appropriate risk-free dollar interest rate. The second is a change in investors' evaluation of the credit risk peculiar to the developing country. While easily observed secondary market prices undoubtedly reflect other factors such as the relative status of government and private debt, our working hypothesis is that the value of sovereign debt is closely related to the investors' overall assessment of the outlook for expected returns on existing and new investments in the debtor country relative to expected returns on alternative investments (Dooley and others 1990).

Capital inflows adjust to equalize alternative returns by financing marginal projects with lower domestic returns (flow adjustment) and by increasing overall exposure (stock adjustment) (Fernández-Arias 1995). Although several recent papers have attempted to directly explain private capital inflows, this has proven to be a difficult task. The fact that private inflows have been offset by official outflows, generally in the form of increases in international reserve assets, makes the existence of a stable relationship between expected yields and private capital flows unlikely. Different policy reactions over time clearly contaminate reduced-form relationships between expected yields and private capital flows. For this reason we focus on the expected yield of existing commercial

bank debt as the best proxy for the terms on which residents of emerging markets can issue new debt and equity. Analysis of this expected yield allows us to trace the underlying determinants of new capital inflows.

II. QUANTITATIVE EVALUATION OF FACTORS AFFECTING SECONDARY MARKET PRICES

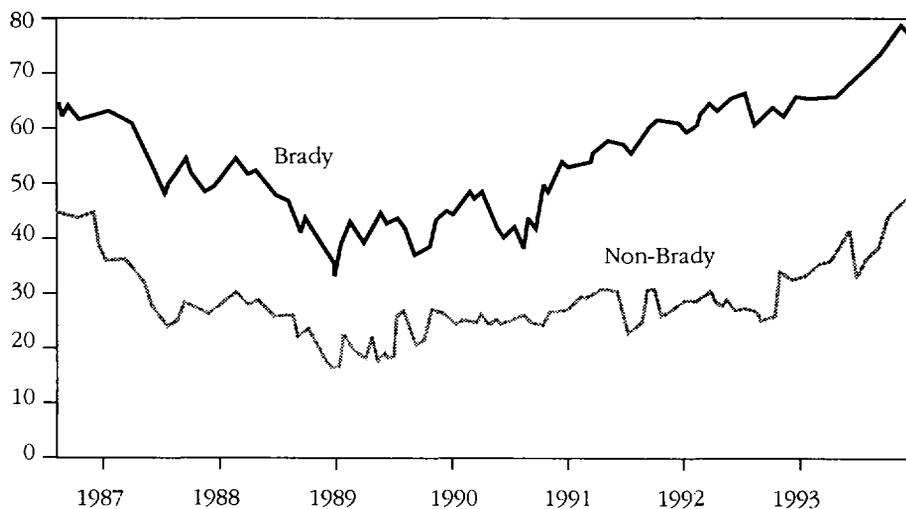
Although there have been a number of recent commentaries on the end of the debt crisis, relatively few quantitative analyses of what went right have been undertaken. While it is natural for disasters to get more attention than for fair weather, a careful evaluation of recent developments can help in analyzing the durability of the improvement. In this section we discuss measures of five factors that might explain secondary market prices for developing-country debt: debt reduction, economic policy reform, international interest rates, domestic interest rates, and exchange rates.

Debt Reduction

A simple model for secondary market prices sets the market price equal to the ratio of expected present value of debt service payments to the contractual value

Figure 1. *Debt Prices in Selected Countries, 1986-93*

Secondary market price
(cents on the dollar)



Note: Calculated as a weighted average based on commercial bank debt. Argentina, Costa Rica, Mexico, Nigeria, the Philippines, Uruguay, and Venezuela are Brady countries; Albania, Algeria, Angola, Bolivia, Brazil, Bulgaria, Cameroon, Chile, Congo, Côte d'Ivoire, Ecuador, Honduras, Hungary, Jamaica, Jordan, Morocco, Nicaragua, Panama, Peru, Poland, Senegal, and the Syrian Arab Republic are non-Brady countries.

Source: Salomon Brothers (various issues); *International Financial Review* (various issues); American Banker, Inc. (various issues); World Bank data.

of outstanding debt. It follows that secondary market prices rise when the numerator—that is, expected payments—rises relative to the denominator, the contractual value. Consequently, these prices are linked to country creditworthiness.² Debt or debt service reduction is expected to increase the price if the present value of expected payments does not fall proportionately with the reduction in the contractual value of the debt (see Dooley 1988 for a general discussion of buybacks and market prices). As documented by Bacha (1991) and World Bank (1992), increases in debt prices since the announcement of the Brady Plan in 1989 have been larger for Brady Plan countries than for other debtor countries (figure 1).

There is much less agreement concerning the quantitative importance of debt reduction. The initial skepticism about the Brady Plan on the part of many academic economists was based on a simple argument. The Plan was voluntary in the sense that banks would not be forced to exchange their existing claims for new claims with a lower expected market value. The implication was that debt reduction would be expensive in the sense that private debt retired by the Brady Plan would be purchased at a price higher than the market price that would prevail if the Plan were not implemented. As pointed out in Dooley (1988), the higher price would reflect the market value of debt remaining after the agreement was implemented if banks could free-ride as in open-market buybacks (see also Bulow and Rogoff 1988). If the banks were in a less strong bargaining position, the price would be lower, and more debt reduction would be possible for the same amount of resources. But the amount of debt reduction would always be limited by the banks' voluntary participation constraint. Given this constraint it is possible to calculate the range of debt reduction that would result, given the resources available to support the deal. As shown by Claessens, Diwan, and Fernández-Arias (1992), Brady operations led prices and debt reduction to fall within the theoretical ranges.

Table 1 provides a summary of the debt reduction obtained by various countries to date.³ The first column shows debt retired as measured by the reduction in the present value of debt service obligations. Debt reduction reflects reductions of contractual debt and interest service as well as collateralization and new money promises. An example is agreements where below-market interest rates

2. The relationship between prices and country risk is distorted in some of the instruments used in Brady operations by two factors. First, in the numerator, collateral enhancements increase the value of those instruments. Second, in the denominator, below-market interest rates such as those in Brady par bonds amount to a lower effective contractual value. These two biases counteract each other and may conceivably offset each other in the case of par bonds, which would justify the usual practice of using par bond prices. In general, however, *the two biases* do not offset each other and need to be adjusted to obtain the so-called stripped prices, whose level would better reflect country creditworthiness (see table 1 for details). The changes in these stripped prices caused by changes in international interest rates can be approximated by the changes in the prices of Brady bonds because most collateral enhancements are also interest-sensitive, and therefore stripping is not necessary for the econometric exercise.

3. After this article was prepared, Brazil, Bulgaria, the Dominican Republic, Ecuador, Jordan, and Poland completed Brady operations in 1994 and 1995.

Table 1. *Debt and Debt Service Reduction in Brady Plan Countries, 1990–93*

Country	Commercial bank <i>debt-reduction equivalent</i>		Total net payment to banks (millions of U.S. dollars)	Additional official loans (millions of U.S. dollars)	Overall net <i>debt-reduction equivalent</i>		Debt prices	
	Debt retired (millions of dollars)	Percentage of commercial bank debt			Millions of U.S. dollars ^a	Percentage of total debt	Pre-Brady ^c (cents to a dollar)	Postoperation stripped (cents to a dollar)
Argentina	10,723	37	3,732	2,117	8,606	14	18	63
Costa Rica	1,166	73	225	177	989	21	12	39
Mexico	19,033	40	6,812	3,732	15,301	16	36	51
Nigeria	4,221	79	1,681	0	4,221	14	21	45
Philippines ^b	3,553	54	1,451	154	3,399	12	40	76
Uruguay	807	50	413	140	667	15	56	73
Venezuela	5,153	27	1,949	687	4,466	14	37	59
Total	44,656	40	16,263	7,007	37,649	15	31	57

a. The amount is obtained by subtracting the additional official loans from the debt retired.

b. The debt reduction was completed in two phases.

c. Price in the month before the Brady Plan was announced (March 10, 1989).

Source: Claessens, Diwan, and Fernández-Arias (1992) and authors' calculations.

on collateralized par Brady bonds were exchanged for old floating-rate debt. We calculate the difference in the present value of the debt service obligations of the two bonds on the exchange day, assuming that each would be serviced in full as contracted. The methodology used is almost identical to the one used in Claessens, Diwan, and Fernández-Arias (1992). The only difference is the treatment of additional new money, whose negative effect on debt reduction is estimated as a fraction of its nominal value (the fraction being the *ex ante* price). Because banks' promises of new money were often conditional on countries' serving interest over a period of time (not a sure thing in the absence of the deal, as reflected in low prices), this estimation is probably better.

The third column in table 1 shows the net payment received by commercial banks. This cash was used to purchase collateral for new bonds or more directly for buybacks. In general, however, the reduction in the contractual present value of debt was largely independent of the financial engineering involved. These calculations indicate that the amount of resources devoted to the agreements are more than a third of the reduction in the contracted present value of private debt. Substantial additional official lending partially offset the reduction in commercial bank debt. The fourth column shows the dollar amount of additional loans made to the debtor government by international organizations and creditor governments to support the Brady Plan. Thus the *net* debt reduction represents only 15 percent of total debt (fifth and sixth columns). It is not difficult to see why many analysts doubted that this level of debt reduction would be decisive in reestablishing access to capital markets.

One way to evaluate the direct effects of debt and debt service reduction on secondary market prices is to analyze the market price of debt remaining after the restructuring. Prices of instruments are distorted by various features and attachments, such as collateral, new money promises, and below-market interest rates. Therefore, the last column in table 1 shows stripped prices, that is, the prices right after the operation, adjusted for these distortions. These prices are a good indication of the market view on country creditworthiness once the benefits of the operation are fully factored in. (Like the calculation of debt reduction equivalent, the methodology for estimating stripped prices is taken from Claessens, Diwan, and Fernández-Arias 1992, except for estimating the impact of additional new money.)

If future repayments to commercial banks are positively linked to the country's future performance, then the efficiency gains of these debt and debt service reduction operations can be gauged by analyzing the impact of the operation on prices. In fact, in the absence of efficiency gains, in proportional terms (stripped) prices would not be expected to increase beyond the decrease in commercial bank debt (second column in table 1). As pointed out by Dooley and others (1990), a full evaluation of the impact of debt reduction on the value of remaining private debt should consider the relative seniority of the various types of debt and the probability that the debtor would have received the loans for another purpose. A hypothesis consistent with

the findings in Demirgüç-Kunt and Fernández-Arias (1992) and in Bulow, Rogoff, and Bevilaqua (1992) is that all creditors have the same implicit seniority and share the net present value of repayments in proportion to exposure. If this is true, then, in the absence of efficiency gains, (stripped) prices would not increase beyond the decrease in total debt (sixth column in table 1). Any excess price increase over the no-efficiency-gain benchmark could then be safely attributed to efficiency gains.

Unfortunately, the task of estimating the increase in prices caused by the debt-reduction operation is extremely difficult because the appropriate counterfactual price—the price prevailing in the absence of the operation—is not observable. Long before the operation was consummated, prices reflected the market expectations on the outcome of the future operation, and thereby contaminated the observed prices to an unknown extent. For example, if the last price quoted before the operation incorporates a perfect forecast of the operation, its comparison with the stripped price does not provide any meaningful information on the effects of a given operation.

Prices before the Brady announcement in March 1989 may not be subject to this contamination, but they do not reflect the changes in economic fundamentals over the period leading to the operation date. For this reason, results based on these prices (shown in the seventh column of table 1) need to be taken with caution. Nevertheless, as analyzed in the next section, the evidence shows significant variation only in international interest rates after most of the first-round Brady operations had taken place. Therefore, except for the recent operations and especially in Argentina, estimations and inferences made on the basis of prices prevailing before the Brady announcement appear reasonable.

Economic Policy Reform

It is plausible that the conditionality associated with the Brady Plan agreements explains the increased market value of existing debt and the turnaround in access to external markets. It is difficult to quantify the effects of economic reform on market valuations of external debt, but it certainly appears that policies changed for the better in Brady Plan countries. The widespread adoption of market-oriented reform programs along with aggressive fiscal reform may have been an additional important channel through which the Brady Plan workouts improved the financial position of debtor countries. It is perhaps not surprising that creditor governments emphasized this aspect of the plan. What may have been surprising, however, was how consistently and aggressively some of the debtor countries implemented fiscal reform changes. This suggests that the impact of fiscal reforms was not fully credible at the time of the debt exchanges (actual execution of the Brady operation). The effect of improved fiscal policies on secondary market prices may have been gradually incorporated into market prices in countries where the reform in fact occurred.

One measure of a number of important policy changes is the increase in government revenue net of expenditures other than debt service—what is usually

Table 2. *The Primary Fiscal Surplus (PFS) and the Operational Fiscal Surplus (OFS) in Selected Countries, 1985–92*
(percentage of GDP)

Country	1985	1986	1987	1988	1989	1990	1991	1992
<i>Argentina</i>								
Primary fiscal surplus	0.8	1.8	-0.9	-1.0	-6.3	1.6	3.5	3.8
Operational fiscal surplus	-6.0	-4.7	-5.6	-6.3	-21.9	-2.9	-0.2	1.5
<i>Brazil</i>								
Primary fiscal surplus	2.1	0.6	-2.8	-0.5	-0.5	2.2	1.0	2.5
Operational fiscal surplus	-4.3	-3.6	-5.7	-4.8	-6.9	1.3	-2.2	-2.2
<i>Chile</i>								
Primary fiscal surplus	0.6	0.5	2.5	6.6	7.5	5.0	2.2	—
Operational fiscal surplus	-2.9	-6.0	-1.0	-1.2	3.1	1.0	-1.2	—
<i>Mexico</i>								
Primary fiscal surplus	3.9	2.2	5.8	8.1	8.4	7.6	8.8	8.7
Operational fiscal surplus	-3.3	-7.0	1.8	-3.6	-1.7	2.3	6.7	6.0
<i>Morocco</i>								
Primary fiscal surplus	0.7	1.2	1.2	2.2	1.8	5.6	5.0	—
Operational fiscal surplus	-5.5	-6.8	-2.6	-1.1	-1.4	2.1	1.5	—
<i>Nigeria</i>								
Primary fiscal surplus	4.7	2.6	2.4	-0.1	5.5	6.5	5.8	—
Operational fiscal surplus	-1.8	-5.4	-4.3	-5.9	0.5	0.4	0.2	—
<i>Philippines</i>								
Primary fiscal surplus	2.4	-1.3	2.7	3.2	1.4	1.1	1.0	—
Operational fiscal surplus	-2.1	-6.1	-0.7	-0.1	-1.6	-2.7	-3.0	—
<i>Venezuela</i>								
Primary fiscal surplus	4.7	0.9	-1.1	-6.1	3.8	6.1	7.1	-0.5
Operational fiscal surplus	-0.2	-9.9	-3.6	-9.9	-1.0	2.1	3.5	-4.5

— Not available.

Source: Goldman Sachs (1991, 1992).

called the primary fiscal surplus.⁴ As shown in table 2, some Brady Plan debtors have made very impressive budgetary progress and can finance a considerable percentage of debt service payments through taxation rather than through additional borrowing. Another useful measure of fiscal performance is the operational fiscal surplus (OFS). This is the primary surplus less real interest payments on both domestic and external debt. Improvements in this surplus relative to the primary surplus are caused by a fall in domestic or international real interest rates or a fall in the stock of debt. The impressive improvement of the operational balances in table 2 reflects the combined impact of all of these factors. In

4. Proceeds from privatization are included as revenue.

Table 3. *The Public Debt Ratio in Selected Countries, 1985–92*
(percentage of GDP)

Country	1985	1986	1987	1988	1989	1990	1991	1992
Argentina	72.2	78.6	89.9	95.9	112.3	94.3	68.5	62.0
Brazil	50.6	48.0	48.7	45.6	42.2	40.1	47.1	46.5
Chile	76.9	85.6	83.7	67.7	52.2	39.8	—	—
Hungary	42.5	46.7	56.9	52.6	55.5	54.0	—	—
Mexico	51.9	59.2	54.5	61.7	56.1	48.5	35.0	25.0
Morocco	137.1	127.5	136.3	125.3	117.3	105.2	—	—
Nigeria	50.1	88.2	133.6	118.7	113.3	114.3	—	—
Philippines	57.6	69.5	76.6	73.5	67.3	71.7	—	—
Poland	43.2	48.5	67.2	65.0	73.0	88.9	—	—
Venezuela	41.2	59.9	54.6	53.8	70.4	54.1	46.3	52.0

— Not available.

Note: The public debt ratio includes domestic and external indebtedness of the public sector minus official reserves.

Source: Goldman Sachs (1991, 1992).

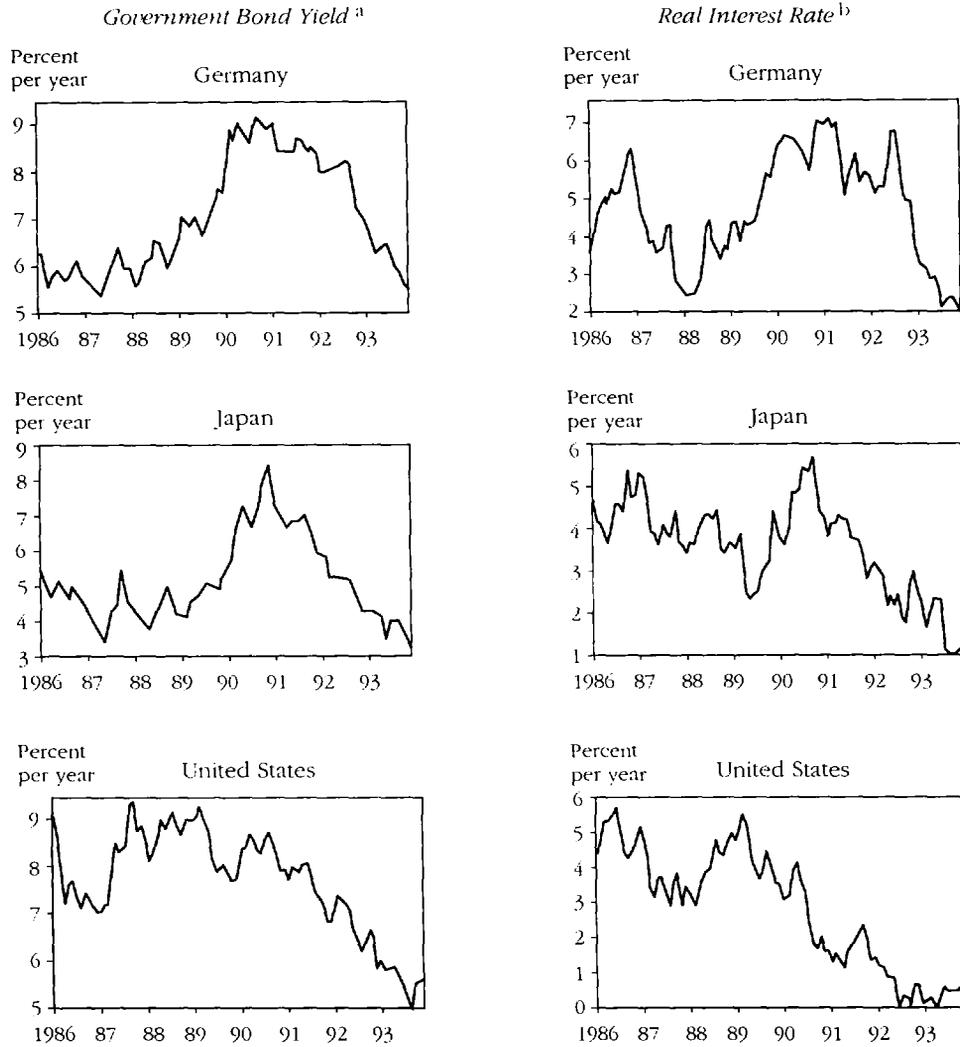
the empirical work that follows we assume that changes in these fiscal balances are correlated with a variety of policy reforms that are difficult to quantify. Although these measures are quite incomplete, it seems unlikely that strong changes for the better in policy regimes would not be closely related to improvements in these fiscal balances.

Improvement in the operational balance has been much more pronounced compared with improvement in the primary balance. An important challenge for evaluating the future is to identify what part of the reduction in real interest payments is a permanent part of the debtor countries' positions. One aspect that is clearly permanent is real debt amortization. A surplus for this operational budget balance for past years means that the real value of outstanding debt is being reduced. As shown in table 3, some debtor countries have made substantial gains in reducing the real value of their net government debt through a normal amortization of domestic and foreign debt. For some countries this has been more important than the debt reduction discussed above. It is also possible that the fiscal reform will generate a permanent reduction in the default premia incorporated in interest rates.

International Interest Rates

Another potential source of improvement in debtor countries' positions has been the change in the external environment. The dominant change after 1989 was a fall in nominal and real interest rates in the United States and, to a certain extent, in other major industrial countries (figure 2). As shown in Dooley and Stone (1993), the rise in international interest rates is the only variable in a regression analysis that has much power in explaining the widespread decline in secondary market prices through 1989. This result is consistent with the hypothesis that the expected present value of payments by debtor countries fell as

Figure 2. *The Government Bond Yield and the Real Interest Rate in Germany, Japan, and the United States, 1986–93*



a. Line 61 in IMF (various years).

b. Six-month London interbank offered rate (LIBOR) (line 60eb) minus inflation (calculated as the change in the consumer price index, line 64).

Source: IMF (various years).

international interest rates rose. Thus, the rise in debt prices after the Brady speech would be consistent with the observed fall in market interest rates.

The potential importance of the fall in international interest rates arises from two sources. First, there are good theoretical reasons to believe that the value of both fixed- and floating-rate Brady bonds should rise more than proportionally to percentage declines in international interest rates. Second, domestic interest

rates paid by debtor governments should fall with international rates, and there are good theoretical reasons to predict that the reduction will be more than proportional.

To evaluate the effects of changes in international interest rates, it is necessary to identify a relevant "discount rate" at which investors translate expected payments from the debtor government into a present value. Since most of the external debt is denominated in U.S. dollars, the appropriate discount rate is a risk-free real interest rate available on a dollar-denominated investment that is similar in terms of maturity and in the terms on which the contractual interest rate is adjusted over time. This is not a straightforward problem. In particular, it would at first seem natural to compare floating-rate sovereign debt to floating-rate risk-free debt. The problem with this approach is that, for risk-free floating-rate instruments, changes in market interest rates alter the nominal value of expected payments in future time periods. But this is exactly offset by the change in the discount rate so that the present value of these payments is unchanged.

With floating-rate sovereign credits that trade at a considerable discount, the effect of a change in the real risk-free rate is quite different. Assuming that the change in the real risk-free rate does not change the government's ability or willingness to pay, the value of expected payments in future time periods does not change. It follows that the present value of these payments does change. Thus, both floating-rate sovereign credits and stripped prices respond to a fall in international interest rates in a manner usually associated with fixed-rate long-term bonds. To the extent that repayments are shared by foreign creditors in proportion to contractual debt service, the response of fixed-rate sovereign credits would be even more pronounced because it would increase the share of fixed-rate debt service obligations in total debt service.

If future payments are expected to grow over time, as can be expected in a growing economy, then the increase in their present value would be proportionally larger than the decrease in the risk-free rate. Furthermore, if the foreign debt is lower in priority of payment to other types of debtor government expenditure, secondary market prices will tend to rise by more than the percentage increase in the present value of total expected payments. This is a potentially important aspect in understanding the relationship between international interest rates and secondary market prices. Unlike substantially risk-free instruments, a fall in the discount rate increases the present value of both floating- and fixed-rate debt of overindebted countries.

Domestic Interest Rates

Recent empirical research has documented a strong link between international interest rates and domestic rates in developing countries (Frankel 1994; Glick and Moreno 1994). Most internal debt is rolled over several times a year in debtor countries, and so real debt service payments are very sensitive to changes in domestic real interest rates. This is an interesting part of these governments' expenditures because, relative to real interest payments to foreign creditors, real

interest rates paid on their domestic debt show a much higher variance and much higher average levels before 1990. Although internal debt is typically smaller than external debt for these countries, changes in ex post real domestic interest payments have been an important component of total debt service costs.

A rise in domestic debt service payments should, for a given overall capacity to pay, reduce expected payments on external debt and in turn lower secondary market prices for external debt. If changes in international interest rates generate qualitatively similar changes in domestic rates, as would be expected if capital markets are at all integrated, this would clearly reinforce the effect of international interest rates on secondary market prices.

Exchange Rates

Government revenue in domestic currency can cover greater debt service payments if the foreign currency value of revenues rises, as happens when the local currency appreciates. Other things being equal, the real appreciation of currencies in debtor countries, shown in figure 3, increased the dollar value of government revenues devoted to external debt service. As with the other variables discussed above, the relevant measure of the real exchange rate is that expected to prevail over the life of the contract. For lack of a better prediction, we can take the current value as an unbiased, but certainly poor, prediction of its future values. Of course, the real exchange rate is not an exogenous variable, so other things are probably not equal. Our assumption that the real exchange rate follows a random walk is a weak but reasonable one, because structural models of exchange rate determination have not performed better than the random walk. It is also possible that changes in the real exchange rate do affect the domestic currency value of the fiscal deficit. For example, the dollar value of oil revenues does not change following a real exchange rate shock. In the empirical work we simply expect a positive relation between the terms of trade and debt prices.

As with domestic interest rates, it is also important to consider the relationship between exchange rates and international interest rates. If capital inflows associated with low international interest rates induce exchange rate appreciation, it follows that we underestimate the effects of exogenous changes in international interest rates on debt prices. Thus, the assumption that real exchange rates are unrelated to other variables in the model probably works against our main hypothesis.

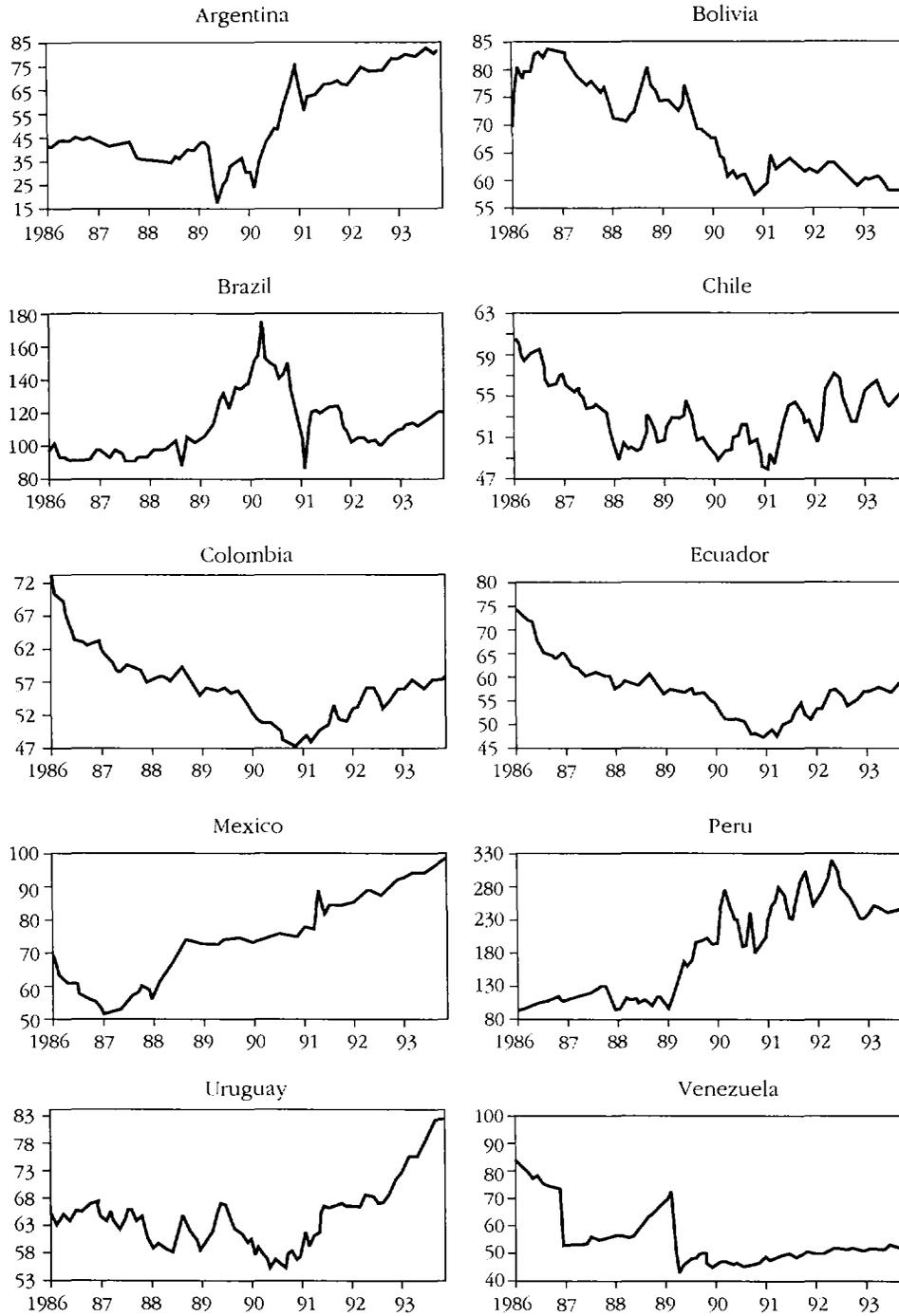
III. A SIMPLE MODEL OF PRICE CHANGES

The arguments developed in section II suggest the following regression hypothesis:

$$(1) \quad p_{it} = c + \alpha_i + \beta LTX_{it} + \gamma LTG_{it} + \delta RCT_{it} + \varepsilon_t + u_{it}$$

where $t = 1, 2, \dots, T$ is the time index; $i = 1, 2, \dots, N$ is the country index; p is the logarithm of secondary market prices; LTX is the logarithm of the ratio of

Figure 3. Index of Real Effective Exchange Rates in Selected Debtor Countries, 1986-93



Note: An increase in the index denotes a real exchange rate appreciation.
 Source: IMF Information Notice System data base.

total long-term debt to exports; LTG is the logarithm of the ratio of total long-term debt to GNP; RCT is the logarithm of the ratio of commercial debt to total long-term debt; r is the logarithm of the long-run (ten-year) U.S. interest rate; c is the common constant term; α_i are the country specific intercept terms; and u is the usual error term.

Since our purpose is to show that the substantial increase in the debt prices of Brady countries after 1989 can be easily explained by changes in international interest rates (and the purely arithmetic effect of debt reduction), and therefore does not point to fundamental improvements in the countries' economic prospects, we chose to use a parsimonious empirical model. The above specification simply adds the international interest rate to the usual basic determinants of commercial bank debt prices in the literature: the most common indicators of country creditworthiness (the debt-to-exports and debt-to-GNP ratios) and the share of commercial bank debt in total debt.

In line with the empirical literature, the explanatory variables were assumed to be statistically exogenous. This assumption is clearly justified in the case of the international interest rate, the key variable introduced in this analysis. The use of the change in the debt share caused by exchange rate effects as an instrument for the commercial bank debt share indicates that that explanatory variable, which is largely predetermined, can be also assumed to be exogenous (see Bulow, Rogoff, and Bevilaqua 1992). The resource variables, exports and GNP, are flows during the year prior to the point in time at which prices and debt stocks are measured, and are therefore predetermined. Bulow, Rogoff, and Bevilaqua (1992) also experiment with instruments for these and other variables and conclude that instrumental variable estimation is not needed. The underlying notion behind these models is that, under credit rationing, the value of commercial bank claims as a whole amounts to a piece of the country's resources, which are in turn largely exogenous (there is an analogy here with the value of claims against an insolvent firm). The above specification in terms of price rather than market value (price times stock) is best seen as the rescaling of an underlying value equation corrected for stock-related heteroskedasticity. As a result, the equation was estimated based on a least-squares method, taking into consideration the panel nature of the observations (see the appendix for more details).⁵

As shown in Dooley and Stone (1993), conventional regressors for secondary market prices, such as the debt-export and debt-GDP ratios, measures of the composition of debt, and fiscal variables, explain cross-section differences in prices from 1986 through 1990. But the international interest rate is the domi-

5. Additional variables have been used in the empirical literature to explain secondary debt prices, such as the reserve-import ratio or the proportion of debt in arrears (see, for example, Stone 1991). The endogeneity of these variables is clearly a significant potential problem. External variables other than international interest rates may be also relevant for explaining the comovement of prices across countries. To the extent that external variables are not correlated with interest rates, their exclusion should not induce serious estimation biases.

Table 4. *The Impact of Debt and Interest Rate Variables on Secondary Market Prices in Twenty Developing Countries, 1986–92*

<i>Variable</i>	<i>Coefficient</i>
Ratio of total long-term debt to exports, <i>LTX</i>	-0.50 (-3.10)
Ratio of total long-term debt to GNP, <i>LTG</i>	-0.36 (-2.30)
Ratio of commercial debt to total long-term debt, <i>RCT</i>	0.09 (0.86)
Long-run (ten-year) U.S. interest rate, <i>r</i>	-0.87 (-3.17)
Constant term, <i>c</i>	5.67 (8.70)
R^2	0.36
Adjusted R^2	0.22

Note: Generalized least squares (GLS) was used to estimate the panel regression equation. The dependent variable is secondary market prices. All variables are in logarithms. *t*-ratios are in parentheses. The twenty countries in the sample are Argentina, Bolivia, Brazil, Chile, Colombia, Côte d'Ivoire, Costa Rica, Ecuador, Guatemala, Jamaica, Mexico, Morocco, Nicaragua, Nigeria, Panama, Peru, the Philippines, Senegal, Uruguay, and Venezuela.

Source: Authors' calculations.

Table 5. *The Impact of Debt, Interest Rate, and Fiscal Surplus Variables on Secondary Market Prices in Seven Developing Countries, 1986–92*

<i>Variable</i>	<i>Coefficients for model</i>			
	<i>Excluding PFS and OFS</i>	<i>Including PFS and OFS</i>	<i>Including OFS</i>	<i>Including PFS</i>
Ratio of total long-term debt to exports, <i>LTX</i>	-0.30 (0.16)	-0.23 (0.19)	-0.24 (0.19)	-0.24 (0.18)
Ratio of total long-term debt to GNP, <i>LTG</i>	0.22 (0.14)	0.20 (0.16)	0.22 (0.15)	0.20 (0.15)
Ratio of commercial debt to total long-term debt, <i>RCT</i>	-0.05 (0.13)	-0.06 (0.14)	-0.07 (0.14)	-0.05 (0.13)
Long-run (ten-year) U.S. interest rate, <i>r</i>	-2.66 (0.47)	-2.57 (0.48)	-2.61 (0.47)	-2.58 (0.48)
Transformed primary fiscal surplus, <i>LPFS</i> ^a		-0.03 (1.19)		0.32 (0.50)
Transformed operational fiscal surplus, <i>LOFS</i> ^a		0.33 (0.74)	0.37 (0.80)	

Note: Generalized least squares (GLS) was used to estimate the panel regression. The dependent variable is secondary market prices. All variables are in logarithms. Standard deviations are in parentheses. The seven countries in the sample are Argentina, Brazil, Chile, Mexico, Morocco, the Philippines, and Venezuela.

a. *LPFS* and *LOFS* are positive transformations of *PFS* and *OFS* as a fraction of debt outstanding.

Source: Authors' calculations.

nant determinant of the time-series behavior of prices. A similar finding is reported in Cohen and Portes (1990). An important reason to doubt this result is a clear common trend for prices and interest rates over the 1986–89 time period. In this article we extend the sample period to 1992, a period in which there was a clear reversal in the trend for both interest rates and prices. Results re-

Table 6. *The Impact of Debt and Interest Rate Variables on Secondary Market Prices in Seventeen Developing Countries, 1986–89 and 1989–92*
(full sample)

<i>Variable</i>	<i>1986–89</i>	<i>1989–92</i>
Ratio of total long-term debt to exports, <i>LTX</i>	–0.071 (–3.76)	–0.48 (–2.47)
Ratio of total long-term debt to GNP, <i>LTG</i>	–0.053 (–3.13)	–0.55 (–3.24)
Ratio of commercial debt to total long-term debt, <i>RCT</i>	–0.20 (–1.47)	–0.07 (–0.55)
Long-run (ten-year) U.S. interest rate, <i>r</i>	–4.91 (–9.25)	–0.75 (–3.24)
Constant term, <i>c</i>	13.96 (12.01)	4.96 (8.01)
<i>R</i> ²	0.73	0.52
Adjusted <i>R</i> ²	0.61	0.33

Note: Generalized least squares (GLS) was used to estimate the panel regression equation. The dependent variable is secondary market prices. All variables are in logarithms. *t*-ratios are in parentheses. The seventeen countries in the sample are Argentina, Bolivia, Brazil, Chile, Côte d'Ivoire, Costa Rica, Ecuador, Jamaica, Mexico, Morocco, Nicaragua, Panama, Peru, the Philippines, Senegal, Uruguay, and Venezuela.

Source: Authors' calculations.

ported in table 4 summarize panel regressions for annual data for twenty developing countries over the 1986–92 time period. Results for seven countries for which we have data for fiscal balances are reported in table 5. (See the appendix for details on data and econometric methods.)

For the larger sample (table 4), the conventional measures of debt relative to the economic resources available to service the debt have the expected signs, and are statistically significant at conventional levels. These variables presumably capture the impact of debt reduction and improvements in the debt service capacity of the debtor country. For the smaller sample of countries (table 5) the basic model is less satisfactory; inclusion of the primary fiscal surplus does not improve the statistical properties of the basic model, and is not a significant variable. This is consistent with results reported in Dooley and Stone (1993). Our primary interest, however, is on the size and stability of the interest rate effect. As shown in table 4, for the larger sample the interest rate has the expected negative sign and is near the expected value of negative unit elasticity. That is, a 1 percent change in the long-term U.S. Treasury bond interest rate, for example from 5 to 5.05 percent, generates about a 1 percent fall in market price.

To test the robustness of this result, we also divided the larger sample into two periods roughly corresponding to the period of generally falling prices before 1989 and generally rising prices thereafter (table 6). Again, the interest elasticity has the expected sign and is statistically significant, although the absolute size of the elasticity in the earlier time period is implausibly large. While the interest elasticity is –4.91 in the 1986–89 period, it is –0.75 for the period 1989–92. This discrepancy can perhaps be explained in terms of an omitted

variable that would measure increasing investor pessimism. Thus, the elasticity is biased downwards when interest rates made a negative contribution (1986–89) and upwards when interest rates made a positive contribution (1989–92). Such an interpretation is further confirmed when a time dummy is included in the specification of table 4: the time dummy is significantly negative, and the overall estimated interest rate elasticity becomes -1.70 . Interest rates exerted a substantial effect in the expected direction during both periods. This is reassuring because interest rates increased in the first period and declined in the second period.

Our interpretation of this evidence is that changes in international interest rates have had an important influence on market prices of existing debt of developing countries and, in turn, on the reentry of residents of these countries to international credit markets. The remarkably parallel evolution of prices in Brady and non-Brady countries shown in figure 1 further confirms the notion that the international interest rates are the key underlying factor.

IV. A SIMULATION EXERCISE

In this section we use the results reported in the previous section to assess the importance of interest rate changes and other factors to the evolution of secondary market prices for a composite Brady Plan country. The econometric results support the use of the following simplified model for country i :

$$(2) \quad p_{it} = (c_i * B_{it})/r_t \text{ where } B_{it} = (x_{it})^{1/2} (g_{it})^{1/2}$$

where x denotes the exports-to-debt ratio and g denotes the GNP-to-debt ratio. This simple model has a unitary interest rate elasticity and is homogeneous in the country-specific variables exports, GNP, and debt. One implication of this model is that what matters for the price of commercial bank debt is total debt rather than commercial bank debt. This is similar to findings in other empirical studies, for example, Bulow, Rogoff, and Bevilaqua (1992). We stop short of concluding that all creditors have equal seniority status, however, because this condition is necessary but not sufficient unless restrictive burden-sharing models are assumed (for a discussion, see Demirgüç-Kunt and Fernandez-Arias 1992).

A more concrete assessment of the factors discussed in section II can be generated by this simple model. For the purpose of illustration, the Brady deals concluded in 1990–92 (Costa Rica, Mexico, Nigeria, the Philippines—Phases I and II, Uruguay, and Venezuela) are aggregated, adding up all values as if they were a single country.⁶ Consider this composite Brady country in March 1989, when the broad outline of the plan was presented to the market in a speech delivered by Secretary Brady. The contractual value of the outstanding commercial bank debt was about \$81 billion, and the average market price was about

6. The Argentina operation is not included because, as noted above, its analysis is complicated by the inapplicability of pre-Brady prices as benchmarks. Although these problems are also present to some extent in other Brady operations, the size of the Argentina operation may significantly distort the average.

\$0.35. Total external debt was about \$196 billion. The reduction in contractual value of the debt generated by the completed deals as measured by the debt-reduction equivalent was about \$34 billion in commercial bank debt and a total net debt reduction of about \$29 billion. The stripped price of the remaining commercial bank debt immediately after the restructuring was about \$0.54 (computed at the time of each country's restructuring).

The expected present value of payments to commercial banks after the restructuring can be estimated as the stripped price times the debt equivalent outstanding, about \$26 billion. The pre-Brady value of the commercial bank debt was about \$29 billion. This simple calculation suggests that if the expected value of official debt was unchanged, the initial market reaction to the Brady Plan focused on the debt reduction but did not generate a measurable revision of expectations about the payments on the debt that could be clearly associated with efficiency gains. This interpretation is consistent with the view that official creditors are senior to the banks.

Alternatively, the hypothetical assumption can be made that all creditors are equally senior. (Notice that this assumption is consistent with the simplified model in which prices depend on total debt, rather than commercial bank debt.) In that case, pre-Brady and stripped prices would apply to total debt. Under this assumption, the total expected present value of payments increased from about \$69 billion in the absence of the Brady operation to \$92 billion after the operation. This would suggest that, in the market's view, Brady operations entail effects that go beyond the arithmetic effect of debt reduction.

For the purpose of this article, there are two important points. First, whatever the improvements brought about by the operations, they are relatively permanent and therefore unlikely to contribute to a down-side risk of falling secondary market prices. Second, after the operations, sovereign risk in these countries, as measured by stripped prices, remains substantial.

We now analyze the evolution of the stripped price in the composite Brady country after the operations to show that improvements thereafter can be fully accounted for by the decline in international interest rates. This implies that, contrary to widespread belief, these improvements in creditworthiness need not be associated with new positive developments in fundamentals in the domestic economy or with the market's learning that the benefits of the Brady operations were larger than anticipated as reflected in the initial market prices. At the completion of the deals, the ten-year U.S. Treasury bond rate was 8.59 percent. In March 1993 the rate stood at 5.85 percent. Other things being equal, our simplified model would predict that this decrease would generate a 46 percent rise in the secondary market price, from \$0.43 to 0.63.⁷ The actual market price on May 8, 1993, was about \$0.66. This is a disturbing result. For the composite

7. We assume here that the expected long-run inflation rate for the United States did not change over this interval. If expected inflation fell, the predicted change in the price would be less because in this case the dollar value of expected payments should increase.

Brady country, virtually all the increase in secondary market prices since March 1989 can be accounted for by the purely arithmetic effect of one permanent factor, debt reduction, and one reversible factor, international interest rates.

Moreover, the remaining increase in market prices can easily be accounted for by real exchange rate appreciations that averaged about 15 percent from March 1990 to March 1993, especially if the market expected this to be a permanent improvement. The corresponding increase in GNP measured in dollars would lead the model to predict a rise in market prices of about \$0.03, bringing the predicted price to the actual price of \$0.66.

An interesting possibility is that even this calculation may underestimate the role of international interest rates and that the rise in market prices can be overexplained when the indirect beneficial effect on growth (and therefore the increase in the exports and GNP ratios x and g) is taken into account. It seems quite likely that the decline in the dollar risk-free interest rate also accounts for the fall in domestic real interest rates in debtor countries. As discussed above, a fall in international rates should put downward pressure on domestic rates through interest arbitrage. In addition, each of these governments pays a premium to domestic holders of public debt, which in many cases reflects expected inflation and exchange rate depreciation. A change in international interest rates that casts doubt on the ability of the government to finance debt service without resorting to the inflation tax could generate an immediate increase in nominal and real domestic interest rates. Thus, a rise in international rates could generate even larger changes in domestic real rates. If a rise in international interest rates is associated with a more than proportionate rise in domestic rates, the possibility of a large fall in secondary market prices is even more likely.

This suggests that policy reforms may not have been crucial for the composite country. The explanation is that the change in the primary fiscal surplus for the composite country has been strongly negative since 1989. As mentioned above, Mexico has managed a small increase in its operational surplus since 1989, but this is more than offset by Venezuela.

It is possible that the impressive levels of primary surpluses and expectations about improved policies have also played an important role in the observed capital inflows. The difficult question is whether or not these permanent factors could sustain market access if international interest rates and secondary market prices fell to levels seen only three years ago.

It could be argued that the volume of private capital inflows recorded in developing countries is evidence that the improved outlook for these countries is robust to plausible changes in the economic environment. After all, investors are surely aware that international interest rates could rise as the industrial countries recover. The answer to this may be that the volume of private capital inflows is a poor indicator of expectations. In particular, we can think of the debtor-country government as offering foreign investors short-term, dollar-denominated investments that carry an interest rate far in excess of what can be currently earned in the creditor countries.

This is not to say that the debtor governments have again made the mistake of guaranteeing dollar-denominated debts of their residents explicitly as they did with syndicated credits. In this case the exchange and credit guarantees are both implicit. The dominant form of private capital inflow this time is a domestic currency claim on the debtor government, domestic banks, and other domestic firms. The dollar value of these positions depends on the debtor governments' commitment to defending an exchange rate with the dollar. In many cases the government's commitment is strong because it has based its inflation target on a fixed exchange rate. In these circumstances, a devaluation is seen as a major departure from the objective of price stability.

The government's commitment is to some extent credible because it has accumulated a substantial war chest of reserves to be used to defend the exchange rate policy. In recent years, about one-half of the private inflow to Latin American debtor countries has been matched by an increase in official reserves. Thus the investor has some comfort in the fact that the high domestic currency interest rate will also be a high dollar interest rate. Moreover, by keeping investments in the banking system or in government securities, the investor has some assurance that these investments will be backed by the government even if domestic firms become insolvent. This is all quite reminiscent of the late 1970s in that, as long as the private capital flows in and the official capital flows out, there is no reason to limit the size of the capital inflow. In effect, the government is acting as a financial intermediary that lends cheap and borrows dear. The only limiting factor on the volume of such a business is the net worth of the intermediary.

Suppose that the debtor government let the exchange rate be determined in a clean float. Would private capital inflows continue to be very large? Our guess is that they would not, and in fact would not even match the very large current account deficits now being recorded.

V. CONCLUSIONS

Secondary market prices may be more informative as a barometer of the financial strength of a debtor country as compared to the volume of observed private capital inflows. A reversal in U.S. interest rates could generate real trouble for debtor countries, particularly if it spreads to domestic markets. The related fall in secondary markets would signal a halt of recent capital inflows, rapid declines in international reserves, and exchange rate depreciation. Fiscal reform has been impressive in a few countries, but in general has not built the kind of cushion into the finances of most debtor countries that could easily offset the debt service payments that would result from an increase in U.S. interest rates. Moreover, additional fiscal adjustment might draw much less popular support if it merely underpins increased service payments.

There have been important permanent improvements in many debtors' financial positions. Debt reduction, both through external debt restructuring and

amortization through operational budget balances, has reduced the vulnerability of a few debtor countries. Moreover, permanent reforms of fiscal systems have strengthened the debt service ability of some countries. Nevertheless, recent capital inflows have not been restricted to countries with strong economic adjustment programs. Falling dollar interest rates have dramatically reduced secondary market discounts, and in many cases brought them close to zero (the limiting situation that characterizes the unrestricted access to markets of solvent sovereign debtors). It seems likely that rising dollar interest rates could reverse this situation.

APPENDIX. DATA AND ECONOMETRIC METHODS

The investigation covers the period 1986–92 for seventeen countries and 1988–92 for three countries for which secondary market prices are available. The countries considered starting in 1986 are Argentina, Bolivia, Brazil, Chile, Côte d'Ivoire, Costa Rica, Ecuador, Jamaica, Mexico, Morocco, Nicaragua, Panama, Peru, the Philippines, Senegal, Uruguay, and Venezuela. Because of lack of availability of secondary market prices prior to 1988, the following three countries have a reduced time period (1988–92): Colombia, Guatemala, and Nigeria.

Annual data were used because some of the relevant data are not available at higher frequencies. Using annual data should alleviate serial autocorrelation caused by omitted variables. The bulk of the data for secondary market prices comes from Salomon Brothers (end-of-year price). The world interest rate is captured here by the long-run (ten-year) U.S. interest rate from IMF (various years). Nominal interest rates are used because of the difficulty of estimating long-term *ex ante* real interest rates.⁸ The other variables, that is, GNP, total long-term debt, commercial debt, and exports, are extracted from World Bank (1992). Note that the 1992 figures for the latter variables are projected figures. The total long-term debt includes interest arrears. Commercial debt includes bond debt and interest arrears.

The statistical procedure used in this panel sample was generalized least squares (GLS), where country-specific intercepts were considered random. To the extent that random effects are uncorrelated with the explanatory variables, GLS estimators are consistent and efficient. This hypothesis was tested and accepted at usual confidence levels using the Hausman misspecification test.

The homogeneity implicit in the use of the (log) ratios of total long-term debt to exports, total long-term debt to GNP, and commercial debt to total long-term debt was tested and not rejected at the 95 percent confidence level in the context of a more general model involving the (log of) exports, GNP, commercial debt stocks, and total debt stocks.

8. To the extent that they are correlated, nominal rates are suitable proxies. See Fernández-Arias (1994) for a justification.

Serial autocorrelation does not appear to be a problem according to the Sargan-Frazini test. Correcting for autocorrelation using the Prais-Winsten transformation introduces only marginal changes to the estimations of interest.

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The Surge in Capital Inflows to Developing Countries: An Analytical Overview

Eduardo Fernández-Arias and Peter J. Montiel

After being excluded from world capital markets during the debt crisis, many developing countries have experienced large capital inflows during the past five years. The challenges that these inflows pose for domestic policy in recipient countries have generated a substantial literature. This article presents an overview of that literature, describing the characteristics of the new inflows, analyzing the policy issues they raise, assessing their causes and likely sustainability, and evaluating potential policy responses. The desirable policy response is tied to characteristics of the flows themselves as well as to the characteristics of the recipient economy.

Flows of foreign financial capital to developing countries have been episodic in the past two decades. The period 1973–81 witnessed massive capital flows to countries in many parts of the developing world, largely in the form of private syndicated bank loans directed to the public sector. Such lending effectively dried up for many (but not all) developing countries during the period of the debt crisis, 1982–89. But in recent years several developing countries around the world have again begun to receive substantial flows of foreign capital. These flows are notable because of their magnitude and because they represent a break from the period of the debt crisis for many of the recipient countries.

Although reduced access to foreign savings was once perceived as a serious constraint to growth for many developing countries, the recent surge in capital inflows has not been taken as an unmitigated blessing. Indeed, the surge of inflows has triggered a new literature investigating the appropriate policy response of the recipient countries. The urgency of this issue increased following the Mexican financial crisis at the end of 1994. This article assesses the state of this literature. It summarizes what is currently known about the new episode of capital inflows, focusing specifically on its causes and sustainability, and evaluates suggested policy responses on the part of the recipient countries. The article does not treat policy issues that may arise either in the creditor countries or for the international financial community in association with the new patterns of capital movements (for the latter, see Bacha 1993).

Eduardo Fernández-Arias is currently with the Office of the Chief Economist at the Inter-American Development Bank (on external service from the World Bank), and Peter J. Montiel is with the Department of Economics at Oberlin College. The authors would like to thank William Easterly, Leonardo Hernández, Carmen Reinhart, and Luis Servén for helpful comments on an earlier draft.

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I. CHARACTERISTICS OF THE NEW INFLOW EPISODE

The volume of private capital inflows received by developing countries is measured in table 1 as the net change in the liabilities of domestic agents to foreign private creditors. For developing countries as a group, a break with prior experience is suggested in 1991 but is not clearly evident until 1992–93. It is evident that, measured as a proportion of exports or national product, inflows were very large in the early 1990s compared with those in the 1982–89 debt crisis period, but somewhat smaller than in the preceding inflow episode, 1978–81. In the developing world as a whole, average capital inflows increased from their debt crisis levels by 1.5 percentage points of gross national product (GNP) to reach almost 3 percent of GNP in 1990–93. Indeed, although inflows over 1990–93 were somewhat smaller relative to GNP than those observed before the debt crisis, their magnitudes have been similar in the last two years.

The surge of inflows has been widespread, and especially strong in East Asia and Latin America. A break from prior experience is already suggested by 1990 for East Asia and by 1991 for Latin America. In both cases the pace of inflows accelerated after 1991. Table 2 suggests that the phenomenon may recently have become more pervasive, reaching South Asia as well as Sub-Saharan Africa in 1993. Impressionistic evidence suggests that the phenomenon has recently become important in India and Pakistan as well as in Kenya and Uganda.

Table 1. *Annual Private Capital Net Flows, All Developing Countries*

<i>Net flow</i>	1978–81	1982–89	1990	1991	1992	1993	1990–93
<i>Long-term</i>							
Billions of U.S. dollars	53.5	34.6	44.5	57.6	99.0	157.7	89.7
Percentage of exports	12.3	5.9	5.4	6.5	10.9	16.6	10.1
Percentage of GNP	2.7	1.2	1.1	1.4	2.4	3.7	2.2
<i>Short-term</i>							
Billions of U.S. dollars	22.6	5.4	13.1	23.4	28.9	33.5	24.7
Percentage of exports	5.2	0.9	1.6	2.7	3.2	3.5	2.8
Percentage of GNP	1.1	0.2	0.3	0.6	0.7	0.8	0.6
<i>Total</i>							
Billions of U.S. dollars	76.1	40.0	57.6	81.0	127.8	191.2	114.4
Percentage of exports	17.5	6.8	7.0	9.2	14.1	20.2	12.8
Percentage of GNP	3.8	1.4	1.4	2.0	3.1	4.5	2.8

Note: Includes all developing countries in the Debtor Reporting System of the World Bank as reported in World Bank (1994). Private long-term net flows comprise long-term debt net flows from private creditors and equity net flows, both direct and portfolio, as reported in World Bank (1994). Private short-term net flows are total short-term debt net flows as reported in World Bank (1994), which excludes the International Monetary Fund (IMF). Therefore, imputed flows due to the accumulation of interest arrears and to debt stock reduction operations are not included. Percentages of exports and gross national product (GNP) are based on accumulated flows over the entire period reported, so they may differ from the simple averages of annual percentages.

Source: World Bank (1994).

Table 2. Annual Long-Term Private Capital Net Flows, by Region

Flows by region	1978-81	1982-89	1990	1991	1992	1993	1990-93
<i>Sub-Saharan Africa</i>							
Billions of U.S. dollars	4.7	2.5	0.9	1.5	0.7	2.1	1.3
Percentage of exports	9.8	6.0	1.7	3.0	1.3	4.4	2.6
Percentage of GNP	2.7	1.5	0.6	1.0	0.4	1.3	0.8
<i>East Asia and the Pacific</i>							
Billions of U.S. dollars	7.9	9.6	20.5	25.6	42.5	62.8	37.8
Percentage of exports	9.0	6.5	8.2	8.9	12.9	17.2	12.3
Percentage of GNP	1.8	1.5	2.3	2.6	3.9	5.4	3.7
<i>Latin America and the Caribbean</i>							
Billions of U.S. dollars	28.9	10.3	10.7	22.8	27.9	57.7	29.8
Percentage of exports	27.4	8.0	6.0	12.7	14.6	28.7	15.9
Percentage of GNP	4.4	1.4	1.0	2.1	2.3	4.0	2.5
<i>Middle East and North Africa</i>							
Billions of U.S. dollars	4.1	3.5	0.2	-0.1	1.6	1.6	0.8
Percentage of exports	7.3	6.0	0.2	-0.2	1.9	2.2	1.0
Percentage of GNP	2.2	1.2	0.1	0.0	0.6	0.7	0.3
<i>South Asia</i>							
Billions of U.S. dollars	0.7	2.8	2.6	3.0	1.8	5.6	3.3
Percentage of exports	3.4	9.8	6.5	7.0	4.1	11.1	7.4
Percentage of GNP	0.4	1.0	0.7	0.9	0.5	1.7	1.0
<i>Europe and Central Asia</i>							
Billions of U.S. dollars	7.3	5.8	9.6	4.6	24.3	27.8	16.6
Percentage of exports	6.1	3.2	4.3	1.9	11.6	13.3	7.5
Percentage of GNP	2.3	0.8	0.7	0.4	2.3	3.0	1.4

Note: Net flows are as reported in table 1, and regions are defined as in World Bank (1994). Percentages of exports and GNP are based on accumulated flows over the entire period reported, so they may differ from the simple averages of annual percentages.

Source: World Bank (1994).

The composition of assets acquired by external creditors during the current inflow episode stands in stark contrast to what transpired during the period of debt accumulation before 1982. First, as indicated in table 3, there is a shift away from debt instruments in favor of equity instruments, both direct and portfolio. Second, within debt flows, syndicated bank loans are relatively unimportant. And third, in contrast to the entire period of 1978-89, portfolio flows have increased immensely in importance. The last two rows of table 3 suggest that there has been a drastic change in the sectoral composition of capital inflows during the recent episode, relative to the period of the debt crisis and the previous inflow episode. Recent capital inflows have been directed overwhelmingly to the private sector of recipient countries.

Table 3. *Asset and Sectoral Composition of Long-Term Private Capital Net Flows*

(percent)							
<i>Asset and sector</i>	<i>1978-81</i>	<i>1982-89</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>1990-93</i>
Foreign direct investment	18.0	38.7	55.9	61.1	46.0	41.3	47.6
Portfolio equity flows	0.1	2.3	8.5	13.1	14.2	29.7	20.1
Portfolio debt flows	3.3	7.6	7.2	17.9	10.7	25.2	17.8
Other debt flows	78.7	51.4	28.5	7.8	29.1	3.8	14.5
Equity	18.1	41.0	64.3	74.3	60.2	71.0	67.7
Debt	81.9	59.0	35.7	25.7	39.8	29.0	32.3
To the private sector	38.3	40.7	85.4	89.4	81.5	82.0	83.4
To the public sector	61.7	59.3	14.6	10.6	18.5	18.0	16.6

Note: Net flows are as reported in table 1. Breakdowns follow World Bank (1994) classifications: portfolio debt flows comprise bond debt, and other debt flows are obtained as a residual; equity flows comprise direct and portfolio equity flows; debt flows comprise portfolio debt flows and other debt flows; private sector destination comprises all equity flows and private nonguaranteed debt flows; and public sector destination comprises public and publicly guaranteed debt flows.

Source: World Bank (1994).

II. THE POLICY PROBLEM

Despite the urgency with which indebted countries sought renewed access to world capital markets, the surge in capital inflows has been perceived as presenting a policy problem for the recipient countries. This section addresses why this might be so. We proceed in two steps. First, we describe the textbook conditions under which external borrowing can be welfare enhancing. Second, we examine how deviations from the ideal conditions assumed in the textbook case can cause capital inflows to be welfare reducing.

The Case for Capital Inflows

At first glance it is not obvious why an inflow of foreign savings to developing countries should arouse concern over policy. For a small economy facing perfect international capital markets, the optimal textbook policy—the policy that would be chosen by a planner maximizing the discounted utility of a representative agent—calls for investing until the marginal return from that investment equals the given cost of capital, and choosing a consumption path that distributes consumption optimally over time and satisfies the economy's intertemporal budget constraint. Such an economy would import capital to smooth consumption or to finance profitable investment opportunities if the level of domestic savings was insufficient. Note that this analysis concerns *net* capital flows. *Gross* flows also serve an important economic purpose—they enable portfolio managers to diversify, and therefore improve the risk-return tradeoff they would face under financial autarky. The paths of consumption, investment, and external borrowing that would be chosen by the planner would also be generated by decentralized, com-

petitive private economies as long as there were no distortions associated with the private allocation of foreign savings. To determine how capital inflows might have harmful consequences and to address the policy issues raised by the current capital inflow episode, it is necessary to understand how the case for free capital mobility based on the textbook analysis of optimal borrowing may fail.

Microeconomic Distortions and Macroeconomic Stability

If external borrowing is centralized in the hands of a planner who is either unwilling or unable to maximize the welfare of the representative domestic agent, then the economic outcomes associated with external borrowing may not be desirable. In the previous inflow episode, when external borrowing was primarily undertaken by the public sector, the benevolence and competence of the planner was relevant. However, this issue is much less important for the current episode, in which most external borrowing has been undertaken by private agents.

What is at issue in the context of the current episode is whether decentralized borrowing by private agents will reproduce the desirable outcomes that would be generated by a benevolent and omniscient planner. There are two broad classes of reasons why it may not—the potential incidence of domestic microeconomic distortions and the effects of inflows on macroeconomic stability. Neither of these issues are addressed in the textbook argument for the welfare-enhancing role of capital inflows. The analysis in the textbook case, based on the behavior of atomistic agents operating in perfectly competitive markets, neglects the possible role of a wide variety of distortions that could affect the efficiency with which external resources are allocated in the capital-importing countries. Allowing for such distortions qualifies the case for *laissez faire*. Macroeconomic instability, on the other hand, is not well captured in the representative agent models.

At the microeconomic level the presence of distortions creates the possibility that the resources absorbed in association with capital inflows will be misused, even if such resources are primarily absorbed by the private sector. Resource misallocation can arise because of distortions in the domestic financial sector or the real economy. Microeconomic distortions can also arise because of an inadequate macroeconomic policy framework. In either case domestic distortions can interact with capital inflows in two ways: the welfare consequences of existing distortions can be aggravated by capital inflows, which arise from an unrelated cause, and excessive capital inflows can be directly induced by changes in distortions. There are several potential microeconomic distortions:

- Distortions to the perceived private cost of foreign capital could arise because of externalities associated with aggregate country risk and credit rationing, resulting from limited cross-border contract enforceability. (This cause is discussed further in section V.)
- As mentioned by Calvo, Leiderman, and Reinhart (1993b), distortions in the financial sector could give rise to improper financial intermediation. Such distortions, in the form of preexisting, improperly priced (possibly

implicit) government deposit insurance or speculative bubbles in particular domestic asset markets (such as equity and real estate), could promote excessive foreign borrowing.

- Real sector distortions, such as imperfect competition, externalities, or wage rigidity, may result in inappropriate private sector adjustment (such as suboptimal adjustment of the tradable sector to fluctuating exchange rates), even if the financial system is functioning well.
- Microeconomic distortions may be created by macroeconomic policies that are not expected to endure, such as “incredible” trade liberalization or price stabilization. This is discussed in Calvo (1989) and Calvo and Vegh (1991). In both papers the result is excessive external indebtedness.¹

The first three distortions could occur regardless of the availability of external capital, but the cost of the distortion would increase when external capital becomes more plentiful (that is, its supply schedule shifts downward). Consequently, in each of these cases the costs of domestic microeconomic distortions that arise independently of foreign capital inflows are aggravated when foreign capital becomes more plentiful for any reason. The distortions are aggravated because of increased borrowing, increased intermediation through the domestic financial system, or increased domestic aggregate demand. The fourth distortion differs from the others in that it attributes the capital inflow itself to the creation of a new domestic distortion. Because of these distortions, the resources associated with capital inflows may be devoted to consumption that has low social value or invested in projects that have low social returns, at the expense of high-value future consumption, which will have to be sacrificed to service the accumulated liabilities.

The problems that have occupied most observers, however, have concerned short-run macroeconomics. Although a reduction in foreign real interest rates is a favorable shock for countries that are net external borrowers, macroeconomic policymakers cannot ignore its implications. An analogy can be made to the case of “Dutch disease,” in which a favorable terms of trade shock can complicate macroeconomic management. Although the shock is favorable, the economy’s macroeconomic adjustment mechanism may generate undesirable side effects. The mitigation of such effects provides the rationale for adjusting macroeconomic policies. Specifically, surges in capital inflows have been associated with a loss of monetary control. In turn, this loss is feared to result in (see Schadler and others 1993):

- Upward pressure on asset prices, an expansion of demand for home goods, and consequent increase in economic activity, which is associated with an acceleration in domestic inflation.

1. We omit from this list the possibility that external lending would be characterized by multiple “bank-run” equilibria. Although this phenomenon would undoubtedly pose a policy problem by making capital flows extremely volatile, it does not represent a separate distortion from the perspective of the capital-importing country.

- A real exchange rate appreciation (resulting independently or because of upward pressure on asset prices) and a deterioration of the current account of the balance of payments. The real appreciation may undermine the progress of trade reforms and retard improvement in long-run external competitiveness by eroding the profitability of the traded-goods sector.
- A potential increase in macroeconomic instability, to the extent that capital inflows are themselves unstable.

If distortions lead decentralized economies far from the allocations that would be generated by a benevolent planner, or if the receipt of foreign capital disrupts the domestic macroeconomic equilibrium, a policy response may be called for. It is important to emphasize, however, that the possibility that capital inflows may be welfare reducing does not mean that they are invariably harmful. On microeconomic grounds, not only can capital inflows triggered by external events arrive in a domestic environment that is free of distortions, but such flows can also be attracted by the removal of distortions. Under these alternative scenarios the receipt of foreign capital may be welfare enhancing at a microeconomic level. On macroeconomic grounds, the stimulus to aggregate demand provided by the arrival of inflows may be welcome in economies with excess productive capacity. Moreover, if the inflow of capital is sustained, it need not be associated with increased macroeconomic instability. The upshot is that the nature of the policy problem posed by the receipt of capital inflows depends on a complex array of factors, such as the allocative efficiency of the domestic economy, the causes of the inflow, the domestic macroeconomic context, and factors that determine the sustainability of inflows.

III. CAUSES OF CAPITAL INFLOWS

Among the factors that determine the nature of the policy problem, the existing literature has devoted most attention to the identification of causes of inflows. In addition to the reasons given above, the assessment of causes is important for two other reasons that have to do with policy design. First, forecasting the likely evolution of the inflows requires the identification of causal factors; second, choosing instruments of response, and thus designing effective public policy, depends on the nature of the underlying causes. Here, a domestic-foreign causal dichotomy is relevant. If causes are external, they are by definition exogenous, and only indirect, compensatory policies can be considered. If causes are domestic, however, more direct measures may be feasible.

An Analytical Framework

A useful analytical framework separates potential domestic causes into those that operate at the project and country levels. Building on Fernández-Arias (1995), suppose that capital flows can occur in the form of transactions in n types of assets, indexed by s , where $s = 1, \dots, n$. The domestic return on an asset of type

s is decomposed into a project expected return D_s and a country creditworthiness adjustment factor C_s , which is bounded by zero and one. The project return depends inversely on the vector F of net flows to projects of all types (based on a diminishing marginal productivity argument), and the creditworthiness factor is a negative function of the vector of the end-of-period stocks of liabilities of all types, denoted $S = S_{-1} + F$.² Voluntary capital flows (components of the vector F) are determined by the arbitrage condition:

$$(1) \quad D_s(d, F)C_s(c, S_{-1} + F) = W_s(w, S_{-1} + F)$$

where W_s is the opportunity cost of funds of type s in the world economy, assumed to depend on the stock of liabilities S to reflect the portfolio diversification considerations of external creditors. The shift factors d , c , and w are associated, respectively, with the domestic economic climate, country creditworthiness, and any creditor-country financial conditions relevant for developing-country investment (such as financial returns and capital market regulations). We adopt the convention that the functions D_s , C_s , and W_s are increasing in the shift parameters. Equation 1 defines the equilibrium value of F implicitly. Explicitly, it is given by

$$(2) \quad F = F(d, c, w, S_{-1}).$$

Thus changes in capital flows can be determined by any combination of changes in d , c , or w for given values of S_{-1} —that is, by changes in domestic factors operating both at the project and country levels, as well as in factors relating to the external environment. The assumptions made above imply that the components of the vector F are increasing in d and c but decreasing in w and S_{-1} .³ Initial stocks S_{-1} are of course dynamically endogenous. Over time, the sequence of flows F depends on the path of the underlying factors d , c , and w as well as the initial value of S . Increases in d and c or decreases in w could generate a sustained surge in inflows, like the one observed in practice.

Plausible empirical causes of the recent inflow episode can be associated with each of these variables (see Schadler and others 1993; Calvo, Leiderman, and Reinhart 1993a). Domestic factors operating at the project level (underlying d) include the following:

- Improved policies that increase the long-run expected rate of return or reduce the perceived risk on real domestic investment, such as major domestic structural and institutional reforms. Improved domestic macroeconomic policies, particularly successful inflation stabilizations accompanied by fiscal adjustment widely perceived as sustainable, would also have this effect.
- Short-run macroeconomic policies—such as tight monetary policy—that increase the expected rate of return on domestic financial instruments,

2. The project return depends on the beginning-of-period capital stock, as well as the flow of new capital, but the former can be suppressed for our purposes.

3. Weak assumptions regarding stock effects across types of assets are also needed.

resulting in ex ante positive interest rate differentials, for given values of the structural determinants of the marginal product of capital.

- Policies that increase the openness of the domestic financial market to foreign investors, such as removal of capital controls and liberalization of restrictions on foreign direct investment.
- Structural or macroeconomic policies that, because of their lack of credibility, distort intertemporal relative prices—that is, incredible trade liberalizations and price stabilization programs. Tariff cuts under domestic price rigidities, for example, may create expectations that the relative price of imports will rise over time when tariff levels are restored (Calvo, Leiderman, and Reinhart 1993a).

We can interpret country creditworthiness C as depending on the expected present value of resources available for external payments relative to the country's liabilities. One way to conceptualize this present value measure is to express the component c in the form

$$(3) \quad c = Y/(R - g)$$

where Y is some current measure of available resources, assumed to grow at the rate g , and the discount rate R (relevant to claimholders) reflects world financial returns available at comparable maturities. Note that the country creditworthiness parameter c depends not only on domestic factors (such as Y and g) but also on foreign returns R . This unconventional channel of foreign interest rate effects has been emphasized and quantified by Fernández-Arias (1995).

Domestic factors operating at the country level (through c) include:

- Debt-equity swaps and sustainable debt and debt service reduction agreements, as in Brady operations.
- Stabilization and structural policies that affect the aggregate efficiency of resource allocation.
- Shocks to national income in the form of changes in international terms of trade.
- Policies that affect the level of domestic absorption relative to income.

Finally, exogenous factors affecting the external opportunity cost of funds w include:

- Foreign interest rates and recessions abroad.
- Easing of regulations affecting the cost of access to capital markets in creditor countries.
- Bandwagon effects in international capital markets, either resulting from the efficient signaling of information on fundamentals or from speculative bubbles.

Equation 2 implies that any combination of these factors could operate simultaneously to influence the observed magnitude of capital inflows. Disentan-

gling the separate contributions of these factors is therefore an empirical problem. Because several of these factors changed at nearly the same time in the domestic and external environments during the current inflow episode, it has been difficult to identify the causes of the episode empirically.

The Evidence

The task of understanding the causes of the current inflow episode has not been attempted in a comprehensive fashion; most observers have favored one of two views. The “pull” view holds that inflows are attracted to the recipient countries because of an improved domestic policy environment (some combination of changes in parameters d and c in equation 1). In support of this view, case studies of individual countries that have received large capital inflows can almost invariably identify substantial changes in policy regimes immediately preceding the inflow episode (see Montiel 1995). The “push” view emphasizes the role of lower returns available in the creditor countries (decreases in R , operating through c and w). The widespread and persistent nature of the inflow phenomenon would seem to favor global, persistent factors and rule out idiosyncratic, volatile factors. Consistent with the push view, aggregate private capital inflows to all developing countries exhibit a strong negative association with U.S. interest rates (figure 1). Thus plausible cases can be made for either perspective. As equation 2 demonstrates, the two explanations are not mutually exclusive: the issue is assessing their relative empirical importance.

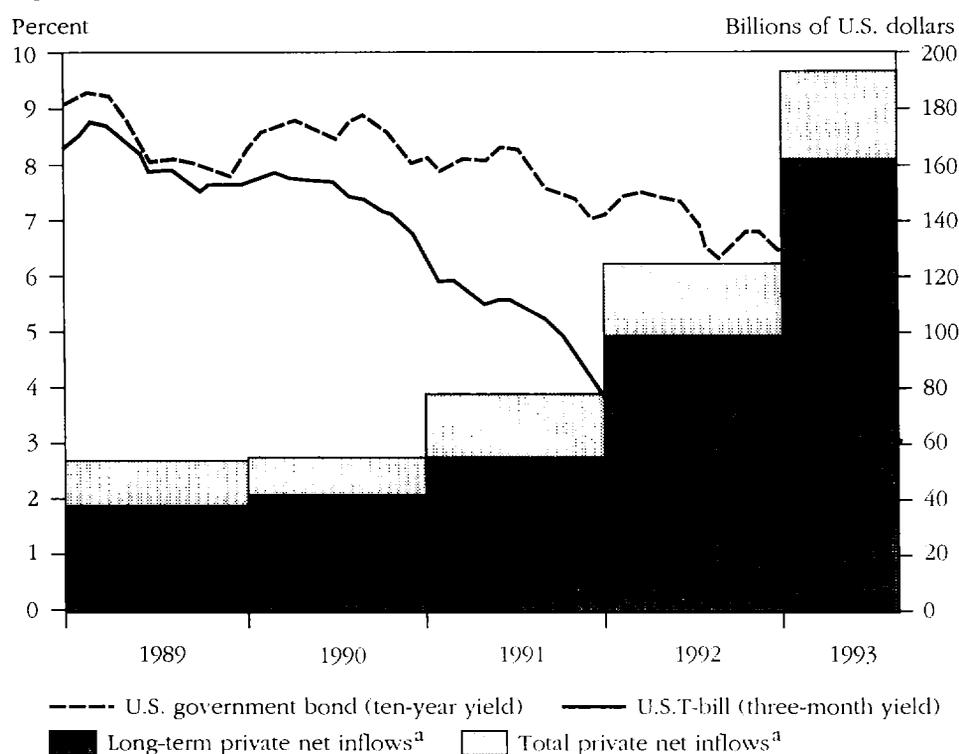
A survey of the formal evidence accumulated on this issue is presented in Fernández-Arias and Montiel (1995). Overall, the weight of the evidence reviewed there favors the push view—that falling U.S. interest rates have played a dominant role in driving capital flows to developing countries. The strongest arguments for pull factors rely on the observed geographic variation in the distribution of capital inflows, described in section I, suggesting that country-specific factors have played a role. But this reasoning can be problematic. Although it is true that not all countries have been recipients of the new inflows, it is also true that flows have not been restricted to countries with well-established track records of macroeconomic and structural adjustment. Both Peru and Brazil, for instance, received substantial inflows in 1992, a year in which both countries confronted severe macroeconomic imbalances.

Moreover, cross-country variation in the magnitude of capital flows may convey little information about what has driven changes in capital flows in countries that have experienced the surge phenomenon. Differentiating equation 2, we derive equation 4,

$$(4) \quad dF = F_1 dd + F_2 dc + F_3 dw$$

holding S_{-1} constant (subscripts denote partial derivatives). Because the F_i are functions of the country-specific variables d and c (as well as of the nonspecific variable w), changes in the external variables w that are uniform across countries may differ in their impacts on individual countries. Thus differences in

Figure 1. Interest Rates and Private Capital Inflows to Developing Countries



a. Includes all developing countries in the Debtor Reporting System of the World Bank as reported in World Bank (1994).

Source: IMF (various years) and World Bank (1994).

levels of capital inflows across countries confirm the relevance of country-specific characteristics, but they do not imply that *changes* in such country-specific factors caused the inflows, as implied by the pull story.⁴

Despite these arguments supporting the push view, the most reasonable conclusion to draw from existing evidence is that, although decreases in international interest rates R have undoubtedly been important in explaining the observed magnitude of increases in F for many countries, we cannot infer, for several reasons, that changes in domestic factors—or, for that matter, in external variables other than rates of return on financial assets—have not played a role as well.

4. It is important to note that even a situation in which some countries receive no new capital inflows is consistent with the push view. The solution for F from equation 1 may entail an extremely low level of capital inflows or capital outflows (negative values of various components of F), implying transfers of resources that the country is unwilling to undertake. Under such circumstances the solution for F would be subject to an inequality constraint of the form $F \geq F^*$. If this constraint is binding, such voluntary capital flows would cease, and equation 1 would become an inequality, no longer determining any observed (involuntary) capital flows. As long as fluctuations in external conditions leave this constraint binding, capital inflows would be unchanged.

The main reason is that such pull variables are hard to measure. In theory, inflows are endogenous with respect to a wide range of domestic policies, and no single indicator is likely to represent the broad thrust of such policies with the same degree of accuracy as external interest rates do for foreign financial conditions. Indeed, pull factors have been proxied in very rough ways in past studies. In Fernández-Arias (1995), for example, pull factors are proxied by a shifting intercept term. In Dooley, Fernández-Arias, and Kletzer (1996) their contribution is captured in the unexplained portion of the secondary debt price, a procedure that is sensitive to the validity of the underlying burden-sharing model. A second reason is that much of the existing literature has been restricted to explaining portfolio flows. As shown in section I, foreign direct investment has been at least as important in many cases, and this type of flow may be more sensitive to domestic factors than the more-liquid portfolio flows.

Moreover, a complete story about the factors driving the new inflows must account for changes in the composition of assets acquired by external creditors. These changes present a dramatic contrast between the current and previous inflow episodes. The push story based simply on low U.S. interest rates fails to address this issue. External shocks have been proxied by foreign rates of return in the empirical literature. As a result, the role of structural changes in creditor-country financial markets, which have eased access for developing-country borrowers, has not been considered. The existing literature is unable to distinguish between changes in the degree of financial integration (except for factors pertaining to country default risk) and changes in relative ex ante rates of return. The distinction is crucial for the central question that has motivated this literature—the question of sustainability. To the extent that the new flows represent a one-time portfolio adjustment driven by permanent changes in the degree of world financial integration, their high level is not sustainable, but they are less likely to be reversed than if they are driven by temporarily low U.S. interest rates.

Thus a consistent story about the factors driving and directing the recent surge in capital inflows should feature some combination of push and pull factors. One such story would proceed as follows. The combination of low interest rates and recession forced low rates of return on industrial-country assets (particularly in the United States), creating an incipient capital outflow as investors in these countries sought higher-yielding assets for their portfolios. The restoration of perceived creditworthiness was necessary for potential debtor countries to have access to these funds, and thus capital flowed initially to those countries whose creditworthiness was not severely impaired during the 1980s—largely the rapidly growing countries in East Asia that never suffered a debt crisis. The Brady Plan, announced in mid-1989, broadened the geographic scope for such inflows to include the heavily indebted countries in Latin America, in part by writing down the face value of debt, in part by supporting policy adjustments, and in part by providing information externalities, leading to bandwagon effects. Where none of these factors have come into play—that is, in most of Sub-Saharan Africa—capital inflows have not materialized.

Implications for Policy

Although the weighing of push and pull factors is informative for policy, it represents at best a point of departure for policy analysis because the mapping from pull or push views to policy is highly imperfect. As indicated above, policy design requires the specific identification of both causal factors and country circumstances. The implicit assumption that capital inflows attracted by improved domestic policies do not present a policy problem, but those driven by expansionary monetary policy abroad do, is unwarranted. Even a pull exerted by moving from a distorted to a completely undistorted domestic microeconomic environment could generate macroeconomic instability, calling for a macroeconomic policy response. On the other hand, a pull generated by either a partial removal of domestic distortions or the introduction of new distortions could be welfare reducing on microeconomic grounds as well. Similarly, the implications for policy of an inflow generated by a foreign push are ambiguous in general, depending crucially on the characteristics of the domestic economy.

IV. SUSTAINABILITY

The concern that inflows may threaten macroeconomic stability arises in part from a fear that the flows may be transitory. Although even permanent inflows can create adjustment problems, inflows that are not sustained can potentially destabilize the domestic economy when they arrive and when they depart. The issue of sustainability can be decomposed into two parts. First, what is the expected time path of the factors driving the inflow episode (for example, how long are the conditions likely to persist)? Second, what are the corresponding implications for capital inflows? Specifically, is the alternative to the current level of inflows a continuation of inflows at a reduced rate (soft landing), a cessation of inflows (hard landing), or pressure for the reversal of capital flows and a balance of payments crisis (crash)? Unfortunately, the literature to date has shed little light on these questions, apart from the identification of causes. In this section we address the issue in a preliminary way.

The first of the two questions is of interest to policymakers in the recipient country to the extent that the factors driving inflows are exogenous to their actions. As indicated in the previous section, evidence suggests that a substantial external shock in the form of lower interest rates in the United States has been a key driving factor determining the magnitude of capital flows to creditworthy developing countries. Empirically, therefore, the current inflow episode contains an important exogenous component. This being the case, it is meaningful to ask how long the favorable external shock is expected to last and what the likely consequences would be of a reversal of these external circumstances or of domestic policies.

Duration of the External Shock

One way to gauge the likely duration of the foreign interest rate shock is by examining the implicit predictions of future interest rates captured in the term

structure. Interest rates steadily declined in the period 1989–93 and started to increase in 1994. As of the third quarter of 1994, when this article was prepared, the term structure of interest rates for the United States suggested that interest rates were expected to rise during the subsequent five years, approaching their 1989 levels. Thus markets did not expect the favorable external interest rate shock to persist.

Increases in interest rates in creditor countries would, of course, reduce the incentives for reallocating portfolios to developing countries. Equations 1 and 3 suggest that such incentives would be reduced through increases in the opportunity cost of funds and increases in country risk. Thus, both mechanisms have a bearing on the sustainability of inflows.

Consider first country risk, which has been the key to extreme forms of unsustainability, such as the debt crisis. Equation 3 shows that this mechanism operates through the market valuation of the present and future resources available to the country to service its external liabilities. Beyond a threshold point, country risk may be too high to sustain voluntary inflows. In this case equation 1 would yield inflow levels less than what the domestic economy could feasibly generate. If so, capital rationing and financial crisis are the likely consequences. Below we construct a simple creditworthiness index to measure the pressure on repayment capacity exerted by the service of foreign liabilities, which can be used to shed light on the likelihood of a crisis.

An Index of Creditworthiness

Because in the current inflow episode foreign liabilities have primarily been incurred by the private sector (see table 3) and to a large extent denominated in domestic currency, country risk is likely to be associated with balance of payments crises, the attendant likelihood of devaluation, and the imposition of capital controls rather than with fiscal problems. This was illustrated by the recent Mexican crisis. (For the role of fiscal problems in the previous inflow episode, see Montiel 1993.) Under these circumstances the country's repayment capacity can be taken to depend on its ability to generate a trade surplus—that is, to expand exports and contract imports—which depends on its potential to produce traded goods. From the perspective of external creditors, the operational significance of the quality of the domestic policy environment is reflected in this variable. Because the present and future values of maximum trade surpluses are unobservable, for the purpose of constructing a sustainability index, capacity to pay can be proxied by a fraction f of total production of traded goods, T .

The present value of this capacity to pay can be compared with an accumulated stock of foreign liabilities S to assess whether the country's resources can support the accumulation of additional liabilities. Such a comparison forms the basis for our operational measure of creditworthiness. The present value of resources is given by an expression similar to equation 3 with Y equaling fT and g the long-run growth rate of traded goods production. Let S be the accumulated stock of foreign liabilities and suppose that RS is a reasonable estimate of their

future average service.⁵ Under these assumptions a solvency-based creditworthiness index can be constructed:

$$(5) \quad C = a(R - g)S/T$$

where a is an arbitrary constant to base the index.⁶ The index C_t represents the ratio of the stock of external liabilities outstanding at date t to the projected present value of the resources available to service those liabilities from that date forward, expressed relative to the same ratio during the base period. Thus C measures creditworthiness in relative terms. An increase in this index has adverse implications for creditworthiness, and thus for the sustainability of external finance.

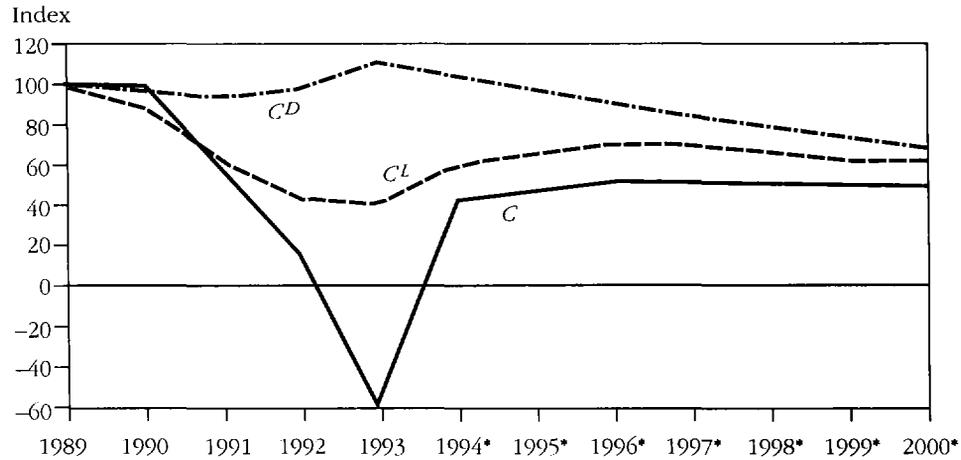
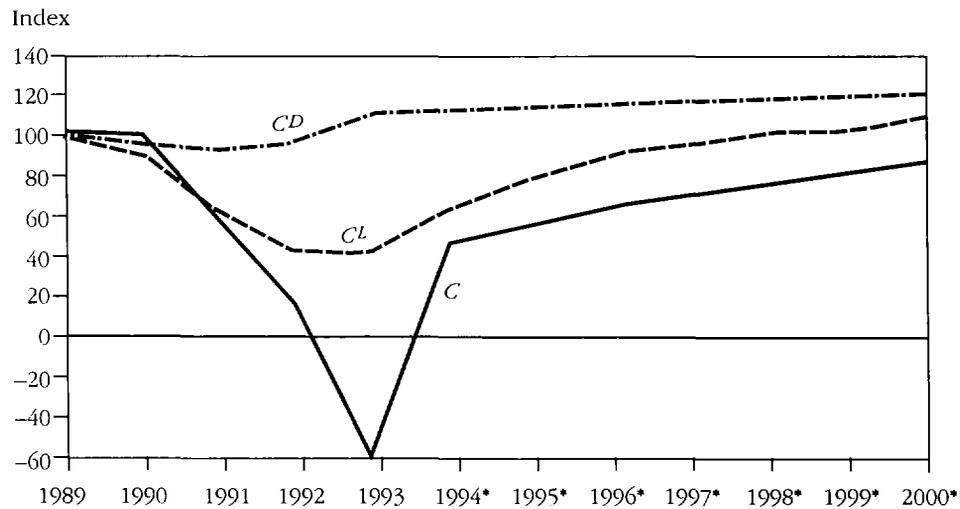
A simple, alternative index could be based on the extent to which current capacity to pay meets short-term obligations, gauged by a liquidity-based ratio such as $C^l = a'R'S/T$, where R' is a short-term interest rate. Although this index lacks the theoretical foundations underlying C , it provides an interesting benchmark. An even simpler alternative can be constructed by expanding the conventional debt-export ratio to include all external liabilities and all traded-goods production. In this case the index could be written as $C^D = a''S/T$. The three indexes are plotted in figure 2a for an aggregate of capital-inflow recipient countries.

For predicting the level of the indexes in future years, projections of the production of traded goods and interest rates are needed. In figures 2a and 2b, the level of traded goods, T , is projected to grow at the rate g observed in the period 1989–93. The long- and short-term interest rates, R and R' , respectively, are obtained from the implied forward rates of the maturity structure referred to above.

We note four main points in comparing C to C^l and C^D (figure 2a). First, the relative evolution of the creditworthiness indexes is very sensitive to the evolution of interest rates. The path of C tracks fairly closely that of market interest rates, both in the historical period, between 1983 and 1993, and in the projection period. Second, creditworthiness improved according to our preferred measure, even as capital flowed into developing countries, until end-1993, contrary to what the traditional index would suggest. In that sense this more refined index can better explain the surge in inflows. Third, creditworthiness declined in 1994 and continues to do so in the projection period. Fourth, in spite of this decline, the index remains below its 1989 value throughout the projection period. This result reflects the fact that growth in T offsets projected increases in interest rates. We interpret this evidence as indicating that if the output of traded goods

5. This coincidence with the discount rate requires that returns on foreign investments adjust quickly to market conditions, as in the case of equity investments, floating-rate debt, or rolled-over short-term debt.

6. Note that we are assuming that the growth rate of T is unaffected by changes in interest rates. This is a strong assumption, and to the extent that it fails to hold the conclusions may be excessively optimistic. Moreover, the index C is based on fundamentals. If the fundamentals are themselves vulnerable to perceptions of noncreditworthiness, creating scope for self-fulfilling runs, our optimistic conclusions would need to be qualified.

Figure 2a. *Creditworthiness Indexes with Constant Stocks of Liabilities*Figure 2b. *Creditworthiness Indexes with Growing Stocks of Liabilities*

*Projected rates.

Note: $C = a(R-g)S/T$; $CL = a'R'/S/T$; $CD = a''S/T$. The constants a , a' , and a'' were determined such that $C = C' = CD = 100$ at the start of 1990. T is the level of traded goods projected to grow at the rate g observed in the period 1989–93. R and R' are, respectively, the long- and short-term interest rates. S is the stock of total foreign liabilities comprising debt and foreign equity (obtained by accumulating equity net flows since 1970). In the projection period in figure 2a, S is held constant at its end-1993 level. In the projection period in figure 2b, S grows at the rate observed in the period 1989–93. Data are for all developing countries as reported in World Bank (1994).

Source: Authors' calculations based on data from World Bank (1994).

grows at its estimated historic rate and market interest rates move as projected, the sustainability of the existing level of external liabilities will not be impaired by creditworthiness considerations, in that the creditworthiness index does not surpass values that were compatible with substantial capital inflows in the past. This interpretation suggests that creditworthiness considerations need not associate rising market interest rates with pressures for a reversal of capital flows and crisis.

But can the inflow continue under such circumstances at rates comparable to those recently observed? To answer this question, an alternative measure of the index that incorporates growth in the stock of external liabilities S at the average rate observed during the recent surge episode is used (figure 2b). These indexes assess whether creditworthiness would be impaired if inflow levels were to be sustained at levels on the order of those observed in recent years. Under these circumstances our preferred index C deteriorates over the projection period, but remains below its 1989 level by 2000. The implication is that considerations of country creditworthiness are unlikely to evolve in a way that will constrain inflows in the near term. This does not imply, however, that portfolio considerations operating through the opportunity cost term W_s in equation 1 will not restrain such flows.

Stocks and Flows

Even if, as these results indicate, rising market interest rates do not necessarily portend a deterioration in C to critical levels, they do imply an increase in w in equation 1, which itself has implications for the vector of flows F . These implications depend on how existing stocks S enter equation 1. We refer to a situation in which S enters equation 1 through the function C or W as one of stock adjustment, and refer to the alternative, in which all adjustment occurs through flows, as flow adjustment.

To the extent that S enters C or W , even if the new inflows were purely a function of permanently improved domestic policies, it is unlikely that the magnitude of the initial flows would be sustained. The reason is that initial inflows would cause cumulative changes in stocks that would diminish the incentives for new inflows (by reducing C or increasing W , or both), and make the inflows a one-time event to some extent (see Fernández-Arias 1995 for a formal analysis of the relative importance of flow-stock adjustment and the dynamics involved under expansion and contraction). For example, in the extreme case in which stocks are important for portfolio balancing reasons and domestic returns adjusted for country risks are constant (F enters equation 1 only on the right-hand side), after the initial stock adjustment of foreign investors' portfolios is completed, subsequent inflows would represent only the share of new saving devoted to the acquisition of developing-country assets—that is, their magnitude would be limited by the rate of growth of foreign investors' overall portfolios.

If stocks are important, the question of sustainability becomes one of how inflows can be expected to decrease under plausible scenarios, not whether in-

flows will continue at their current levels. The answer depends on the permanence of the changes in the variables driving the inflows as well as on how much of the observed inflow in each country reflects an initial stock adjustment. Given the projected increase in international interest rates, capital inflows should fall for developing countries as a group, all other things being equal, continuing their estimated reduction during 1994. Nonetheless, in countries in which inflows have primarily resulted from an improved domestic economic environment that is expected to be maintained, there is no reason for the bulk of the stock adjustment to be reversed, even when external conditions change. Thus, although flows may taper off in such a case, reflecting both the completion of the initial stock adjustment and the change in external circumstances, a crisis is not likely to develop. If, instead, the contribution of domestic factors has been relatively minor, or even negative, and inflows have thus reflected primarily lower foreign interest rates, the stock adjustment can be expected to be reversed if and when foreign assets become more attractive.

So far, the only evidence on the empirical role of stock adjustment in the current inflow episode has been provided by Fernández-Arias (1995), who found no evidence that flows responded to accumulated stocks. The importance of this issue for the prospective magnitude of postsurge inflows and the likelihood of crisis warrants more research.

Speed of Adjustment

The third and final component of the sustainability issue concerns the speed with which a desired stock reversal can be effected by external creditors. In equation 1, adjustments are assumed to be costless and therefore instantaneous. But in practice the speed of adjustment depends on the ease with which such creditors can liquidate their positions. In this regard the current inflow episode differs from the previous one. On the one hand, the bonds and equities acquired by external creditors in the current episode are more easily liquidated than syndicated bank loans. Even FDI can be liquidated effectively by borrowing domestically and transferring the funds abroad, particularly if outflows have been liberalized, as has been common in debtor countries during recent years. On the other hand, the assets acquired by external creditors in the present example are denominated in domestic currency in many cases. This characteristic enhances liquidity while rendering the foreign-currency value of such assets susceptible to capital taxation through their exposure to devaluation. With assets that are relatively liquid and denominated in domestic currency, portfolio adjustments are likely to be effected rapidly in response to new information.

V. POLICY RESPONSES

The question of an appropriate policy response has received substantial attention, and the menu of policies considered has been extensive (see, for example, Calvo, Leiderman, and Reinhart 1993a; Schadler and others 1993). The

desire to counteract the pressures for exchange rate appreciation in the face of substantial net capital inflows has typically led to very active Central Bank intervention and rapid increases in international reserves. Policies motivated by the desire to ameliorate this impact of capital inflows on the external component of high-powered money include:

- Direct intervention to reduce gross inflows, by imposing controls or taxes on capital imports.
- The removal of restrictions on capital outflows to reduce net inflows.
- Trade liberalization, intended to switch spending from domestic to foreign goods and thus increase the trade deficit.
- Increased exchange rate flexibility.

In the last case the central bank fails to satisfy all of the demand for high-powered money created by capital inflows, allowing some of that demand to be reflected in an appreciation of the domestic currency. This could be accomplished, for example, by allowing the currency to move within a band.

An alternative approach is to accept some increase in the external component of the monetary base, but to counteract the potential effects of such an increase on domestic aggregate demand by using the conventional tools of macroeconomic policy, including tight fiscal policy and restrictive monetary policy, in the form of sterilized intervention or increases in marginal reserve requirements.⁷

The first set of policies is aimed at reducing net inflows. If inflows have an external cause, these policies can be seen as general-purpose policies that attempt to reduce the size of the shock disturbing the economy. The other policies are likely to have feedback effects on the level of net inflows, however. Tight fiscal policy would reduce inflows by easing pressures on domestic interest rates and the trade deficit, while restrictive monetary policy would tend to increase inflows.

The rest of this section examines how the nature of the appropriate policy response is affected both by the causes of the inflows and by the economic characteristics of the recipient country.

Microeconomic Distortions Worsened by Exogenous Changes in Capital Inflows

Consider first the case in which new capital inflows triggered by exogenous events aggravate the negative welfare consequences of a preexisting domestic distortion. A first-best policy response is to remove the distortion and absorb the capital inflow. Consider, for example, the case of improperly priced government deposit insurance. It may be impossible for the government to credibly eliminate such insurance. If this is the case, the insurance should be priced properly to avoid subsidizing excessive risk taking (financed by both foreign and domestic deposits) on the part of depository institutions. Removal of the distortion would

7. Unsterilized intervention is not included as a policy response because it represents the status quo, and thus reflects a passive policy stance.

have been the prescribed policy even without the inflow. But if the first-best policy is infeasible, then direct intervention in the form of capital controls or taxation to reduce the inflow emerges as a possible second-best policy response.

Another important distortion emanates from the imperfect enforceability of cross-border contracts underlying country risk. An increase in foreign liabilities makes capital rationing and debt crises more likely. The increase in the probability of such events represents a cost that is external to domestic borrowers to the extent that other domestic agents share such costs, either through the actions of external creditors or through the socialization of losses through the domestic political system. Such a borrower would thus have an incentive to attract too much foreign capital. This situation appears particularly relevant in countries that are close to their foreign capital carrying capacity. In this case the distortion cannot be removed to any substantial extent, which again leads to a second-best approach to the problem. If an excessive level of foreign indebtedness is directly caused by this distortion, a Pigouvian tax on capital inflows or equivalent capital control may yield the required lower level of capital inflows and achieve the first-best outcome (since in this case the policy acts directly on the source of the distortion).

Inflows Induced by Changes in Microeconomic Distortions

Excessive capital inflows can be induced by introducing new microeconomic distortions or removing old ones, for example, removing constraints on inflows. When inflows are triggered by the introduction of new distortions, the first-best policy response is to remove the distortions. (This point is made by Corbo and Hernández 1993.) The domestic distortions most frequently mentioned in the role of attracting capital inflows are incredible trade liberalizations and price stabilizations. The solution to this type of distortion depends on the reason credibility is absent. If it is absent because of the failure to set policy fundamentals (typically the fiscal deficit) on a sustainable path, the solution is to adjust the fundamentals to attain credibility. If, however, such adjustments have been undertaken and credibility remains elusive, then direct intervention in the form of capital controls may again represent a second-best alternative. There is an obvious analogy here to the use of wage and price controls in heterodox stabilization programs, in which adjustment in the fundamentals is complete, but lack of credibility or inherent wage-price inertia threatens to derail the stabilization program.

Capital inflows can also arise because of the removal of distortions or constraints. Microeconomic examples include the lifting of capital controls, the removal of barriers to direct foreign investment, and measures to enhance access to creditor-country financial markets. In addition, the adoption of a comprehensive package of credible stabilization policies accompanied by liberalizing policy reforms can be thought of as the comprehensive removal of widespread distortions. To the extent that such policies restore a country's creditworthiness, for example, they have the effect of removing a prospective tax on its creditors.

In the absence of additional distortions, the removal of distortions constraining capital inflows would move the economy to a nondistorted Pareto optimum, and thus improve welfare. In general, a capital inflow associated with the welfare-enhancing removal of distortions, whether in specific markets or as part of a generalized package of policy reforms, does not call for countervailing policies on microeconomic grounds. If other distortions are present, however, the outcome may be ambiguous, as second-best theory would predict. A preexisting distortion may be part of a second-best policy package, and removing it may result in a reduction in welfare when capital flows in. For example, as noted above, capital controls or taxes on external borrowing may be optimal in the presence of borrowing externalities arising from country risk considerations. Removing the policy “distortion” would induce capital inflows associated with overborrowing and thus produce an inferior welfare outcome. In such cases the correct policy stance is to retain controls.

Capital Inflows and Macroeconomic Equilibrium

We are left with the issue of macroeconomic instability—the question of how to use policy to preserve the macroeconomic equilibrium in the face of a foreign real interest rate shock. The first point to make with respect to macroeconomic policy goals is that it may prove optimal to leave policy unchanged. The shock will typically be expansionary. This may not be true if the recipient country operates a freely flexible exchange rate regime, as discussed below, but few of the countries that have been the recipients of the recent surge in capital inflows fit this description. Difficulty arises in the case of an economy operating at full capacity that seeks to preserve price stability. What are the policy options in this case?

First, note that in the absence of any policy response the magnitude of the effect of a given fall in foreign real interest rates on domestic aggregate demand is likely to depend on whether the reduction is widely perceived to be temporary or permanent—that is, whether a fall in short-term rates is matched by a fall in long-term rates. The reason is that the capitalization of future income streams will depend primarily on whether long-term rates fall. A temporary reduction in foreign short-term rates may be associated with a capital inflow, but such an inflow is likely to be short-lived and perceived as such. Because it has little effect on domestic demand conditions, it creates no need for a stabilizing policy response.

If the change is perceived as permanent, the full panoply of policy options described at the beginning of this section is potentially relevant. The most direct option is to attempt to limit the size of net inflows arising from portfolio reallocations. To this end, controls on gross inflows could be introduced, in the form of ceilings or taxes, explicit or implicit, on foreign borrowing or on foreign direct investment. But it has been argued that this policy is not feasible because these limitations are always circumvented. Although it can be argued that even then the policy may be effective as long as tax avoidance is costly because it

reduces the return to investors, the social cost resulting from the attendant inefficient financial intermediation may disqualify this policy.

More important, however, although capital controls could conceivably be a first-best solution if they respond to the microeconomic distortion directly inducing the capital inflows, or a second-best solution in circumstances such as those described above, capital controls are hard to justify in other cases. If the problem is macroeconomic in nature, the imposition of effective capital controls means introducing a microeconomic distortion. Macroeconomic stability may be preserved, but the costs of the distortion would remain. It would clearly be preferable to maintain stability without introducing a distortion by relying on more traditional tools of stabilization policy. As in the case of microeconomic distortions described above, justification for capital controls would require a second-best argument based on the ineffectiveness of such tools (and relative effectiveness of controls) or on the high costs of employing them relative to the costs of the distortions introduced by controls.

Alternatively, gross outflows could be promoted by liberalizing capital outflows. Assuming no other distortions, liberalization would be desirable even in the absence of a foreign financial shock. Moreover, the argument that it is not feasible to impose controls applies to this case, too, and implies that outflows are already *de facto* liberalized. Even if effective, outflow liberalization could be counterproductive. Because limitations to capital repatriation are a concern to foreign investors, their removal is equivalent to the removal of a tax on foreign investment. Consequently, outflow liberalization will lead to increased gross inflows, which may more than offset the direct effect on increased gross outflows.

Current account liberalization, by contrast, may not cause the balance of payments to deteriorate, since under plausible circumstances liberalization may cause domestic saving to increase and (less plausibly) investment to decline (see Ostry 1991). Consequently, liberalization—of either the capital or the current accounts—may not relieve the upward pressure on the monetary base emanating from capital inflows.

If the net inflow is not prevented from materializing through these means, a case can be made for undertaking a stabilizing macroeconomic policy response. However, the way in which the foreign financial shock is transmitted to domestic aggregate demand—and thus the nature of the macroeconomic problem created by the shock—as well as the set of feasible macroeconomic policy responses is likely to differ from country to country.

A key factor determining this response is the exchange rate regime. Under fixed exchange rates an autonomous capital inflow driven by a reduction in foreign interest rates leads to inflation and lower real domestic interest rates if monetary policy is passive and limited to unsterilized intervention. To avoid this outcome, the authorities could switch to sterilized intervention. This policy has the appeal of supplying foreigners with the domestic interest-bearing assets that they demand while still adhering to a domestic money supply target for stabili-

zation purposes. (Reisen 1993 has been a forceful advocate of this policy.) Contrary to what is sometimes asserted, sterilization does not necessarily imply that the inflow will be perpetuated, since the inflow will end once portfolio composition has adjusted to accommodate rate-of-return differentials.⁸

Sterilization, however, is not a panacea. It may not imply the infinite perpetuation of the inflows, but it will tend to magnify the size of the cumulative inflow. Moreover, it may not insulate the domestic economy. If domestic financial assets are regarded as imperfect substitutes by foreign investors and if the instrument used to sterilize is not demanded by foreign investors, then domestic portfolio equilibrium will require an adjustment in relative rates of return among domestic assets. Even if it insulates successfully, sterilization cannot be a permanent solution—as long as the inflow persists, the central bank will be exchanging high-yielding domestic assets for low-yielding foreign ones, and this policy may have important fiscal implications. Financing the quasi-fiscal deficit that arises from such asset swaps would require a permanent transfer from the government to the central bank that is passed on to foreigners in the form of returns that are elevated relative to what they could earn at home. Even if fiscally feasible, such a policy is unlikely to prove palatable for very long. Finally, sterilization may turn out to be infeasible even in the short run if capital mobility is sufficiently high.

Alternatively, a tighter monetary policy could be pursued by increasing minimum reserve requirements on banks' short-term foreign liabilities. These amount to a tax on foreign borrowing, which, like other taxes on capital inflows, may be difficult to implement. A specific problem with this approach is that it is likely to redirect capital inflows to domestic borrowers through channels other than the domestic banking system—such as through markets for equity and real estate. If this disintermediation is effective, the macroeconomic stabilization problem would remain. The scope for circumventing the domestic banking system depends on the menu of domestic assets available to foreigners and thus on the degree of sophistication of the domestic financial system.

Under flexible exchange rates the foreign interest rate shock will result in an appreciation of the domestic currency and possibly a small decrease in domestic interest rates, which would result, with a fixed money supply, from the price-level effects of a nominal appreciation. The external interest rate shock may prove to be contractionary, as expenditure switching adversely affects the demand for home goods. Stability in this case would require a monetary expansion, resulting in a combination of domestic interest rates that are lower than they would have been without the shock, but higher than under fixed exchange rates and a passive monetary policy. In addition, the exchange rate would appreciate relative to what it would have been without the shock, but depreciate relative to what it would have been without monetary expansion.

This outcome is the basis for the policy advice proffered by both by Calvo, Leiderman, and Reinhart (1993b) and Schadler and others (1993), advocating a

8. This result can be derived from simple portfolio models.

role for exchange rate appreciation in adjusting to the external interest rate shock. Again, however, this advice may not be universally applicable. Countries that rely on the exchange rate as a nominal anchor will be reluctant to move the rate for fear of eroding the credibility of the peg. In addition, the degree of real appreciation may exceed that which would occur with a fixed peg, and thus this policy may hurt competitiveness. If these constraints are binding, the monetary policy options available are those outlined previously.

These considerations suggest that policy may need to be prepared to accommodate a reduction in domestic interest rates with an unchanged nominal peg. If so, the set of remaining policy options is narrow indeed. To preserve macroeconomic stability under such circumstances, the induced increase in private absorption would have to be offset through tighter fiscal policy.

VI. SUMMARY AND CONCLUSIONS

The current capital inflow episode represents a sharp break from the experience of the debt crisis of the 1980s. The magnitude of flows nearly matches that which preceded the debt crisis. Although this surge constitutes a welcome relief from the constraints of credit rationing for many countries, it also poses structural and macroeconomic policy challenges. The structural challenge is to ensure that the resource inflow is efficiently used in order to avoid a repetition of the debt crisis. Although certain characteristics of the current inflows are reassuring in this regard, potential disruption from several distortions implies that a *laissez-faire* stance is not necessarily warranted. Moreover, though capital inflows may represent the outcome of a favorable external shock from the perspective of indebted developing countries, their effect on macroeconomic stability may call for a policy response on these grounds as well.

Why have capital flows to developing countries resumed on a large scale? In the aggregate the role of foreign interest rates as a push factor driving capital inflows and determining their magnitude is well established by the systematic empirical work undertaken on this issue. At the same time, theoretical considerations suggest that the creditworthiness of the recipient country must have played an important role in determining both the timing and geographic destination of the new capital flows. We know little about the relative weights to assign to domestic and foreign factors in attracting capital to individual countries and consequently even less about the role of specific types of domestic shocks. The existing evidence also sheds little light on the roles of domestic or external structural factors. Our analysis suggests that this type of information is crucial for designing policies. Specifically, more country-specific information is required about the possible role of domestic microeconomic distortions in motivating these inflows and channeling them to the final borrowing sector.

This discussion makes clear that sustainability has an important endogenous component. The loss of creditworthiness due to a deterioration of the domestic policy stance is sufficient to stop inflows quickly, and given the nature of stock

adjustment, the liquidity of the assets acquired by external creditors, and their vulnerability to exchange rate changes, inflows are likely to be replaced by substantial outflows or an outright balance of payments crisis. Recent events in Mexico provide strong support for this assertion. Even if creditworthiness is retained, however, the early level of inflows is unlikely to be sustained. The nature of shock adjustment would make the level of inflow diminish over time, even with stable external financial conditions, and, more so, the favorable foreign financial shock that triggered the episode may not persist. Whether the outcome is a gradual reduction in flows since the early 1990s or an actual reversal depends on the path followed by foreign interest rates as well as on the role of stock adjustment. The key gap in knowledge concerns how large the temporary stock adjustment component of the recent inflows has been relative to the permanent flow component.

What are the implications for policy in the recipient countries? Establishing the feasibility of controls that would prevent the arrival of capital inflows is problematic and likely to prove country-specific. A case for direct intervention as a first-best policy can be made only when the negative welfare consequences of a distortion that cannot be removed arise from induced external borrowing. This circumstance is likely to apply in the context of country-risk externalities and may also apply in the presence of “incredible” reforms. In both situations, however, the appropriate intervention is a Pigouvian tax (or equivalent control) rather than a ban on capital inflows. Beyond this case, direct intervention would have to be based on second-best considerations, either on microeconomic or macroeconomic grounds. On the other hand, the receipt of capital inflows may strengthen the case for the removal of certain microeconomic distortions, either because they aggravate the costs of such distortions or because they ease the perceived constraints (typically balance of payments constraints) that originally motivated their adoption.

To the extent that capital inflows are permitted to materialize, the desirability of foreign exchange intervention depends on the requirements for macroeconomic stability. Either competitiveness considerations or use of the exchange rate as a nominal anchor in the context of a stabilization program may preclude nominal appreciation. If not, then permitting a (temporary) appreciation of the nominal exchange rate by restricting the scale of foreign exchange intervention—perhaps in the context of an exchange rate band—will dampen, and may reverse, the expansionary effect of the foreign interest rate shock on domestic aggregate demand by appreciating the real exchange rate and possibly raising the domestic interest rate. This outcome will be desirable if domestic macroeconomic conditions are such that policymakers seek to avoid stimulating aggregate demand. Alternatively the authorities can avoid aggregate demand stimulus with a fixed exchange rate through sterilized foreign exchange intervention. But this policy is feasible only if capital mobility is imperfect. The higher the degree of capital mobility, the larger will be the accumulation of reserves associated with a policy of sterilization. This policy has associated

quasi-fiscal costs, since the central bank exchanges high-yielding domestic assets for low-yielding reserves, and the magnitude of these costs will be greater the higher the degree of capital mobility and the larger the gap between domestic and foreign rates of return. Moreover, even if successful, this policy may not insulate the economy from the expansionary effect of the foreign shock if substitution among domestic assets is imperfect and the asset demanded by external creditors is not that used in intervention.

If sterilization is incomplete, the implication of the inflow is an expansion in the monetary base. Monetary expansion can still be avoided by a commensurate reduction in the money multiplier achieved through an increase in reserve requirements. In this case quasi-fiscal costs are avoided through implicit taxation of the banking system. The economic implications of this tax will depend on how the tax burden is ultimately shared among the banks, their depositors, and their loan customers. Whether such measures can avoid an increase in aggregate demand depends on the structure of the domestic financial system, which determines the scope for disintermediation. Finally, if domestic monetary expansion is not avoided, or if an expansionary financial stimulus is transmitted outside the banking system, the stabilization of aggregate demand will require a fiscal contraction.

The key message is that choices confront macroeconomic policymakers at each step in this progression. Not only the intended effect on aggregate demand, but also the feasibility and relative desirability of alternative macroeconomic policy packages to achieve that effect will be functions of country circumstances. Relevant considerations include the economy's level of capacity utilization, the identity of its nominal anchor, the sterilization tools available to the central bank, the degree of capital mobility, the financial health of domestic banks, the sophistication of the financial system, and the flexibility of fiscal policy, among others. In view of the multiplicity of factors that should in principle influence the response of macroeconomic policies, no single combination of policies is likely to be optimal in all cases.

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A SYMPOSIUM ON
FERTILITY IN SUB-SAHARAN AFRICA

Introduction: Fertility in Sub-Saharan Africa

Martha Ainsworth

During the 1980s the population of Sub-Saharan Africa grew at a rate of 3.1 percent per year, the highest of any developing region (World Bank 1993). The population of South Asia, the developing region with the next highest rate, grew at 2.2 percent annually. Recent demographic surveys in Sub-Saharan Africa found that the average total fertility rate (TFR)—the number of children a woman would have in her lifetime at prevailing age-specific fertility rates—is generally between six and seven children per woman. Child mortality has declined steadily since World War II, but infant and child mortality remain relatively high (Hill 1990). In fifteen Sub-Saharan African countries, the infant mortality rate exceeds 100 per 1,000 live births, and in four countries the rate is greater than 140 per 1,000 (World Bank 1995). There are signs of fertility decline in a few countries (Botswana, Kenya, and Zimbabwe), but even in these cases total fertility is relatively high at five or more children per woman.

Economic growth in Sub-Saharan Africa has lagged behind population growth. Between 1965 and 1988, the gross national product (GNP) per capita grew by only 0.2 percent annually for the region; during the 1980s, average income per capita declined (World Bank 1990, 1993). Levels of human capital in the form of schooling and other training are low, and school enrollment rates have actually fallen in many countries. Although conditions vary a great deal, many countries, if not most, face the prospect of a rapidly growing labor force with low levels of human capital. Changing this scenario will require not only policies that help restore economic growth but that also enable families to have fewer children and to invest more in the quality of each child. To this end, most African countries have adopted or have endorsed public provision of subsidized family planning services, which provide families with not only the means to implement their fertility preferences but also to improve maternal and child health. However, levels of modern contraceptive use in all but a handful of Sub-Saharan African countries are still below 10 percent.

The persistent high levels of fertility and low levels of contraceptive use in most Sub-Saharan African countries have fostered a lively debate on two questions relevant to the design of population and human resource policies. First, is Africa different from other developing regions in terms of the factors influencing the demand for children? If it is sufficiently different, will the policies or factors that have affected the decline of fertility in other developing regions be

Martha Ainsworth is with the Policy Research Department at the World Bank.

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effective in Sub-Saharan Africa? Second, are these outcomes due primarily to low levels of economic development that encourage large families or to insufficient provision of family planning information and methods? The articles in this symposium speak to both of these issues.

I. IS AFRICA DIFFERENT?

Both the demographic and anthropological literatures point to important cultural institutions in Sub-Saharan Africa that encourage high fertility and spread the costs and benefits of children beyond the couple in question. Caldwell, Orubuloye, and Caldwell (1992), for example, mention the importance in traditional society of maintaining a lineage and leaving descendants, the separate budgets and decisionmaking between spouses, the spreading of child costs across the extended family through child fostering, and communal land tenure systems that favor large families. These institutions arose in an environment that favored high fertility. Are they impediments to demographic change?

The first two articles in the symposium (Ainsworth, Beegle, and Nyamete and Benefo and Schultz) show that despite these cultural influences, African fertility and contraceptive use are sensitive to policies associated with fertility decline elsewhere in the world. Perhaps one of the strongest associations worldwide is the negative relation between female schooling and fertility. Ainsworth, Beegle, and Nyamete confirm this relationship in a cross-national study of individual fertility determinants in fourteen Sub-Saharan African countries. Their study is important because it controls for other exogenous correlates of fertility and contraceptive use to isolate the relation with female education at the microlevel, and it does this in a comparable way across a large group of countries. Further, the authors distinguish between the effect of the early and late years of primary schooling, a point that has received a great deal of attention in bivariate analyses of female schooling and fertility. The most intriguing results are the important differences found across countries in the magnitude of the negative schooling-fertility relationship and in the relative impact of female and male schooling. What might explain these differences? The authors point to several possibilities—underlying differences in the quality of schooling, the labor market, child health, family planning programs, and the status of women. The data sets used did not permit an analysis of these factors, but the results suggest avenues for additional research, which could yield important policy insights. In the meantime the results of this article and others speak to an urgent need to raise the stunningly low levels of completed schooling among African women in order to lower fertility and improve child quality (see Montgomery, Kouamé, and Oliver 1995).

High levels of child mortality are also thought to be an impediment to fertility decline in Sub-Saharan Africa. Benefo and Schultz show that high levels of child mortality in Côte d'Ivoire and Ghana are resulting in higher fertility through a child "replacement effect." The estimated effect is relatively small, but it might

be expected in an environment where child mortality rates are very high and have not fallen below the critical threshold at which a response of lower fertility might be anticipated. Côte d'Ivoire and Ghana are adjacent countries with many cultural and geographic similarities, yet the determinants of fertility and child mortality are remarkably different in the two countries. This belies their different colonial experience and economic and social policies since independence. Ghana, for example, has equalized educational opportunities between men and women to a far greater extent than Côte d'Ivoire.

II. FAMILY PLANNING PROGRAMS AND THE DEMAND FOR CHILDREN

A recent study of the prospects for fertility decline in Sub-Saharan Africa concluded that there are small groups of women who want fewer children and who do not have easy access to family planning (van de Walle and Foster 1990). But, by and large, desired family size is still high—between six and nine children per woman. Thus, lowering fertility and raising contraceptive use will depend both on lowering the demand for children and increasing the availability of family planning services and information.

The last two articles (Feyisetan and Ainsworth and Thomas and Maluccio) assess the relative importance of family planning services and the factors affecting the demand for children in determining contraceptive use. The case studies analyze two countries at different stages in the demographic transition. Nigeria is the most populous country in Africa with limited female schooling and a nascent family planning program. Fewer than 5 percent of women are using modern contraception. At the other end of the spectrum is Zimbabwe, where extensive public investments in female schooling, family planning, and health infrastructure since independence in 1980 have already brought about a modest fertility decline. More than a third of Zimbabwean women are using modern contraceptive methods, one of the highest rates in Sub-Saharan Africa.

By linking women to the results from parallel service availability and “situation analysis” surveys, the authors attempt to control for the woman’s characteristics as well as the quality, availability, and (in Nigeria) the price of family planning methods in their analyses of contraceptive use. This approach has recently been used to examine the impact of public health services on morbidity and child nutrition (Alderman and Lavy 1996) and the choice of medical provider (Mwabu, Ainsworth, and Nyamete 1993) in a number of African countries. Female schooling is a pervasive and very strong correlate of contraceptive use in both Nigeria and Zimbabwe despite their different stages in the demographic transition.

Feyisetan and Ainsworth find that the low availability of health and family planning services is constraining contraceptive use in Nigeria but that outpatient consultation fees are not. Broadly similar evidence emerges from Zimbabwe where, in addition, Thomas and Maluccio highlight differences in the impact of family planning programs on behaviors of poorer and better-off women.

They report that the system of community-based distributors is associated with higher adoption of contraceptives among better-educated women, whereas improved quality of distributors benefits the least educated more. The Nigerian and Zimbabwean studies are important reminders that different aspects of family planning services may be relatively more influential in raising contraceptive use at different phases of the demographic transition in Sub-Saharan Africa. They also make a strong case for strengthening the capacity to evaluate program interventions in Africa through random assignment and phased implementation of services to experimental and control communities.

Taken together, these four papers suggest that Sub-Saharan African fertility, although subject to unique cultural influences, can be expected to respond to many of the policies that have been found to lower fertility and raise investments in children in other parts of the world. They also point to fruitful avenues of research on the extent to which observed differences across countries can be attributed to differences in public policies.

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The Impact of Women's Schooling on Fertility and Contraceptive Use: A Study of Fourteen Sub-Saharan African Countries

Martha Ainsworth, Kathleen Beegle, and Andrew Nyamete

This article examines the relationship between female schooling and two behaviors—cumulative fertility and contraceptive use—in fourteen Sub-Saharan African countries where Demographic and Health Surveys (DHS) have been conducted since the mid-1980s. Average levels of schooling among women of reproductive age are very low, from less than two years to six. Controlling for background variables, the last years of female primary schooling have a negative relation with fertility in about half the countries, while secondary schooling is associated with substantially lower fertility in all countries. Female schooling has a positive relationship with contraceptive use at all levels. Among ever-married women, husband's schooling exerts a smaller effect than does female schooling on contraceptive use and, in almost all cases, on fertility. Although the results suggest commonalities among these Sub-Saharan countries, they also reveal intriguing international differences in the impact of female schooling, which might reflect differences in the quality of schooling, labor markets, and family planning programs, among others.

There is considerable debate in the literature as to whether high fertility and high desired family size in Africa are caused by low levels of economic development that favor large families (see World Bank 1984, 1986), or by unique cultural features (see Caldwell and Caldwell 1987, 1990). Without denying the possibility that cultural traits may contribute to higher demand for children in Africa than in other developing regions, most studies have found differentials in current or total fertility by socioeconomic class, even in high-fertility countries

Martha Ainsworth is with the Policy Research Department at the World Bank; Kathleen Beegle is with the Department of Economics at Michigan State University; and Andrew Nyamete is with AIDS Control and Prevention (AIDSCAP). This article was written as background for the research project on "The Economic and Policy Determinants of Fertility in Sub-Saharan Africa," financed by the World Bank Research Committee (RPO 67691) and sponsored by the Africa Technical Department and the Policy Research Department of the World Bank. The authors are grateful to the World Bank Research Committee and the Africa Region for financial assistance and to John Caldwell, Cynthia Cook, David Cornelius, Joy de Beyer, Barbara Herz, Cynthia Lloyd, Gora M'Boup, Amolo Ngwero, Lant Pritchett, Fred Sai, Guillaume Seladcek, David Shapiro, Paul Shaw, Duncan Thomas, and Barbara Torrey for comments on earlier drafts. The authors also acknowledge Evina Akam, Clara Fayorsey, Mouhamadou Guèye, Alice Kouadio, Katharine Namuddu, and others who offered comments at dissemination seminars in Cameroon, Côte d'Ivoire, Ghana, Kenya, and Mali. A special debt of gratitude is extended to Susmita Ghosh and Kathy Burke for assistance.

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(see Cochrane and Farid 1990 and United Nations 1987, for example). Among the factors thought to be the most conducive to the high demand for children are high child mortality and low levels of female schooling.

This article estimates the relationships between female schooling and fertility and between female schooling and contraceptive use in fourteen Sub-Saharan African countries where Demographic and Health Surveys (DHS) were conducted from the mid-1980s to the early 1990s. Multivariate analysis of the determinants of fertility and contraceptive use allows a precise exploration of the relationship with women's schooling, while controlling for variables like age, area of residence, wealth, ethnicity, and religious affiliation. Results across the countries, for both national and subnational samples, are compared and form the basis for future research to explain international differences.

Section I describes the posited relationships between women's schooling and fertility and between women's schooling and contraceptive use and summarizes the evidence to date on these relationships in Sub-Saharan Africa. Section II presents the empirical model and describes the data sets. Section III provides descriptive statistics—both from the data sets and from outside sources—on economic and demographic indicators for the fourteen countries under study. Section IV describes the results for determinants of fertility, and section V describes the results for the determinants of contraceptive use. Section VI reviews the results and proposes areas for additional research.

I. WOMEN'S SCHOOLING, FERTILITY, AND CONTRACEPTIVE USE

Women's schooling is posited to result in lower fertility and, by inference, higher contraceptive use, through four main channels.

- *Wage effects.* By raising the opportunity cost of women's time in rearing children, schooling raises the "price" of children (who are time-intensive) as well as the wage that women can earn in the work force. The wage benefits of schooling may also induce women to get more schooling, thereby delaying the onset of childbearing. This is likely to result in lower fertility and higher rates of female participation in the labor force.
- *Higher demand for child schooling.* Women with more schooling may develop higher aspirations for their own children's schooling. These aspirations may lead them to have fewer children and to invest in more schooling per child. This is the quantity-quality tradeoff observed in other parts of the world but examined only recently in Sub-Saharan Africa (Kelley and Nobbe 1990; Montgomery, Kouamé, and Oliver 1995). There are many initiating factors for this tradeoff, including the levels of wages and employment expected by graduates and the quality and price of schooling.
- *Lower child mortality.* Women with more schooling are likely to be more effective in producing healthy children, which lowers child mortality. As the "wedge" between live births and surviving children is narrowed, couples find that they can have fewer children to reach a target number of surviving

children.¹ In a cross-national study, Schultz (1994) found that fully half of the effect of female schooling in lowering fertility was operating through its effect in lowering child mortality.

- *More effective use of contraception.* Educated women can learn about and use contraception more effectively than uneducated women, reducing the number of unanticipated pregnancies.

It has been suggested that female schooling can indirectly raise fertility by improving maternal health, reducing pathological sterility, and reducing the duration of breastfeeding and its contraceptive benefits (Alam and Casterline 1984; Bongaarts, Frank, and Lesthaeghe 1984; Casterline and others 1984; Cleland and Rodriguez 1988; Cochrane 1979, 1988; Jejeeboy 1992; and World Bank 1984). Female education is also thought to facilitate fertility decline by increasing the bargaining power of women, allowing them greater control over their destiny, and improving husband-wife communication (Jejeeboy 1992; United Nations 1987).

There have been several studies of the differentials in aggregate measures of fertility between urban and rural areas and among women according to their level of schooling, using data from the World Fertility Survey (WFS) (Alam and Casterline 1984; Cleland and Rodriguez 1988; Cochrane 1988; Cochrane and Farid 1990; and United Nations 1987). The total fertility rate (TFR) is the number of children a woman would have in her lifetime if she bore children according to current age-specific fertility rates. Table 1 presents differentials in the TFR by area of residence and female education for African countries that participated in the more recent DHS. The TFR measured in these fourteen countries is very high—generally in the range of six to seven children. However, in every country it is significantly lower in urban than in rural areas.

One reason for these urban-rural differentials is the concentration of women with secondary and higher levels of schooling in urban areas. Women who have completed primary schooling or who have some secondary schooling universally have a lower TFR than women without schooling. The differential between the fertility of women with primary schooling and those with no schooling is smaller and sometimes follows an unanticipated direction: in Burundi, Cameroon, Kenya, and Nigeria, women with some primary schooling actually have a higher TFR than those with no schooling. Note, however, that the TFR for those who completed the primary cycle is substantially lower than for women with no schooling in all cases, including Kenya and Nigeria. Results that indicate a positive relation between some primary schooling and the TFR cast doubt on the effectiveness of less-than-complete female primary schooling in lowering fertility, suggesting that schooling does not have a depressing effect on fertility until the secondary level (Cleland and Rodriguez 1988; Cochrane 1979, 1988; United

1. See Benefo and Schultz (1994) and Pitt (1995) for evidence of the relation between female schooling and child mortality in Sub-Saharan Africa.

Table 1. *Total Fertility Rates for Women Age 15–49, by Residence and Education, Fourteen Sub-Saharan African Countries*

Country	Year	Residence			Education			
		All	Urban	Rural	None	Primary ^a	Completed primary	More than primary
Tanzania	1991–92	6.3	4.0 ^b	6.6 ^c	6.5	6.4 ^d	6.0	4.2
Uganda	1988–89	7.3	5.7	7.5	7.7	7.2 ^d	7.3	6.7/5.1 ^e
Burundi	1987	6.8	5.3	6.9	6.8	7.2	—	5.5
Mali	1987	6.7	6.1	7.0	6.8	6.2	—	n.a.
Niger	1992	7.4	6.7	7.5	7.5	6.3 ^f	—	—
Nigeria	1990	6.0	5.0	6.3	6.5	7.2 ^d	5.6	5.1/4.2 ^g
Kenya	1993	5.4	3.4	5.8	6.0	6.2 ^d	5.0	4.0
Ghana	1993	5.5	4.0	6.4	6.7	6.1	—	4.7/2.9 ^e
Togo	1988	6.6	4.7	7.0	6.8	5.7	—	4.5
Zambia	1992	6.5	5.8	7.1	7.1	6.8	—	4.9
Zimbabwe	1988	5.5	4.1	6.2	7.0	6.0	—	3.8
Senegal	1992–93	6.0	5.1	6.7	6.5	5.7	—	3.8
Cameroon	1991	5.8	5.2	6.3	6.2	6.4	—	4.5
Botswana	1988	5.0	4.1	5.4	6.0	5.2 ^d	4.6	3.3

n.a. Not applicable.

— Not reported.

Note: Countries are listed in order of 1991 gross national product (GNP) per capita, from lowest to highest (see table 2).

a. In Botswana, Kenya, Tanzania, Uganda, Zambia, and Zimbabwe, primary schooling includes seven years of instruction. For all other countries this figure is six years. Unless otherwise noted, primary refers to any primary schooling, including completed primary.

b. The figure for Dar es Salaam is 4.0; for other urban mainland, 5.6; for Zanzibar, 6.4.

c. Mainland only.

d. Some primary.

e. First figure is for middle school, second is for secondary and higher in Ghana and secondary 4 and higher in Uganda.

f. Any schooling (primary or more).

g. First figure is for some secondary, second is for completed secondary and higher.

Source: DHS country reports, available from IRD/Macro International, Inc., Calverton, Md. Following are countries and publication dates of each report: Botswana (1989); Burundi (1988); Cameroon (1992); Ghana (1994); Kenya (1994); Mali (1989); Niger (1993); Nigeria (1992); Senegal (1994); Tanzania (1993); Togo (1989); Uganda (1989); Zambia (1993); and Zimbabwe (1989).

Nations 1987; World Bank 1984). However, these patterns are not apparent in the relation between women's education and contraceptive use: in African countries covered by the DHS, women with more schooling are also increasingly likely to be practicing contraception (Castro Martin 1995). In fact, even bivariate studies of the correlates of contraceptive use conducted in the 1960s found that use increased with levels of male and female education (see Cochrane 1979, table 5.6).

The comparison of aggregate measures of fertility and contraceptive use by socioeconomic status is a useful starting point for analysis, but has many shortcomings. First, the two-way comparisons do not simultaneously control for other factors that influence fertility and contraceptive use. Income, for example, may be highly correlated with schooling but may have an opposite (positive) effect on fertility (Ainsworth 1989, 1990; Farooq 1985; National Research Council

1993). Failure to control for these other correlated variables may confound the independent effects of schooling, other policy variables, and exogenous factors like ethnicity.

Second, the total fertility rate does not represent the completed fertility of any individual or cohort of women; rather, it is the number of children a woman would have over her reproductive lifetime if she were to bear children at prevailing age-specific fertility rates. Thus, cohort effects of schooling on the timing of births over the life cycle are not reflected in the comparisons of TFR for schooled and unschooled women. As a larger share of each successive cohort is educated, the relation between schooling and fertility for any given cohort is likely to change.

Third, the policy objective is to lower aggregate measures of fertility by influencing individual decisions on the number of children. At the individual level, the policy objective is therefore to influence cumulative and completed fertility.

Finally, if there are any nonlinearities in the relationship between policy variables and fertility, they will not necessarily be reflected in, and cannot be studied with, aggregates like the total fertility rate (Anker 1985; Schultz 1992). For these reasons, multivariate analysis of individual data may yield greater insights on the likely impact of policies, such as female schooling, on cumulative fertility.

A number of multivariate studies have examined the relation between female schooling and cumulative fertility in Sub-Saharan countries, controlling for the woman's age, area of residence, and sometimes her religion, ethnic group, and household income (see Ainsworth, Beegle, and Nyamete 1995, table 2). Six studies that controlled for household permanent income—using proxies such as husband's schooling, husband's income, household consumption, land ownership, and cattle—found either a significant negative relation (Ainsworth 1989; Okojie 1990, 1991; Snyder 1974) or no relation (Anker and Knowles 1982; Farooq 1985) between women's schooling and cumulative fertility at low levels of female schooling. At higher levels, female schooling was correlated with substantially lower fertility. Burafuta and Shapiro (1992) found a positive relation between primary schooling and fertility in Burundi, but secondary schooling was associated with lower fertility relative to women with no schooling. They were, however, unable to control for income. Shapiro and Tamashe (1994) found similar results in Kinshasa, Zaire, while controlling for "economic status." Fairlamb and Nieuwoudt (1991) found a large and significant negative effect of the years of female schooling on children ever born, but the results were confounded by endogenous regressors, and the study had no control for exogenous income.

Ahn and Shariff (1994) found that seven or more years of schooling reduce the progression to first birth in Togo and Uganda. Husband's education had a positive relation with cumulative fertility in four studies that did not have any other measures of income (Okojie 1990, 1991; Snyder 1974; United Nations 1987), but had a negative relation when women's education and a proxy for household permanent income were controlled for (Ainsworth 1989). A United Nations (1987) study of twelve African countries in the World Fertility Survey

found a negative relation between schooling and fertility for women with ten or more years of schooling and who had been married for at least three years. For levels of schooling less than ten years, the relationship was cited as positive. However, the statistical significance of the coefficients on lower years is not reported and female schooling was significant in only five to six of the countries. Husband's schooling at all levels had a positive relation with fertility, but was significant in only six of the countries.

Multivariate studies of Sub-Saharan Africa at the individual level have shown a consistently positive relation between female schooling and contraceptive use in Sub-Saharan Africa.² In comparing the determinants of contraceptive use over time using data from the 1977-78 Kenya Fertility Survey and the 1989 Kenya Demographic and Health Survey, Njogu (1991) found that educated women at all levels are significantly more likely to use contraception compared with women with no education, and that the impact of education rises with its level. An unpublished study of contraceptive use in Ouagadougou, Burkina Faso, showed similar positive effects of women's literacy and schooling on ever use of modern contraception (Fenn, McGinn, and Charbit 1987). All levels of schooling, including primary schooling, significantly raised the probability of contraception among a sample of nonpregnant women in Kinshasa, Zaire (Shapiro and Tambashe 1994). Similar results were found for a sample of all women of reproductive age in Burundi (Burafuta and Shapiro 1992). Castro Martin's (1995) results indicated, even at low levels of female schooling, statistically significant effects on contraceptive use among currently married women in ten African countries. Beegle (1995), Feyisetan and Ainsworth (1994), Oliver (1995), and Thomas and Maluccio (1995) found strong effects of female schooling on contraceptive use when controlling for the availability (in Tanzania), quality (in Nigeria), and price of family planning services (in Ghana and Zimbabwe). In multivariate studies in other regions, women's education has a uniformly direct relation with contraceptive use and husband's education also has a direct but less powerful relation (Castro Martin 1995; Cochrane 1979).

These studies suggest a negative but nonlinear relation between women's schooling and fertility and demonstrate the potentially confounding effects of other variables correlated with schooling (such as household income) in interpreting the results. However, many of the studies included potentially endogenous regressors in the analysis of fertility, variables such as the age at first birth, child spacing intervals, child schooling, and women's labor force participation (Snyder 1974); contraceptive use, breastfeeding, child survival, and the desired level of child schooling (Anker and Knowles 1982); and age at marriage (United Nations 1987). In multivariate analysis of contraceptive use, endogenous regressors have included fertility,

2. The National Research Council (1993) study conducted a multivariate analysis of the determinants of contraceptive use in sixty-eight regions of Sub-Saharan Africa using as regressors mean completed female schooling, urban residence, the percentage of women in polygamous unions, and the percentage of women who practiced Muslim and traditional religions. The results confirmed the very strong effect of female schooling relative to other factors.

women's labor force participation, current enrollment status (Burafuta and Shapiro 1992; Castro Martin 1995; and Shapiro and Tambashe 1994); marital status (Fairlamb and Nieuwoudt 1991; Fenn, McGinn, and Charbit 1987; Shapiro and Tambashe 1994); and fertility intentions (Fairlamb and Nieuwoudt 1991; Njogu 1991; Shapiro and Tambashe 1994). Decisions concerning marriage, timing of first births, child schooling, and labor force participation are jointly determined with fertility. Their inclusion will lead to biased results.

An additional problem is that most of the studies used samples of currently married women. By conditioning on marriage, they have not captured the full effect of socioeconomic variables on fertility (through delayed marriage) or contraceptive use (before marriage). Further, since marriage and childbearing could be thought of as a joint decision, studies that use married samples have introduced a potential sample selection bias in favor of women with higher demand for children. Snyder (1974) and Chernichovsky (1985) studied an even more selective sample—women with children. Shapiro and Tambashe (1994) studied contraceptive use in a sample of nonpregnant women and Castro Martin (1995) in a sample of currently married nonpregnant women. United Nations (1987) studied marital fertility in a group of women married for at least three years.

We seek to avoid many of these pitfalls by using a common set of exogenous regressors on samples of all women, regardless of marital status. Further, by examining similar specifications, results can be compared across countries using the most up-to-date data.

II. EMPIRICAL MODEL AND DATA SETS

The empirical model of fertility determinants regresses a measure of cumulative fertility—children ever born to each woman—on a set of independent variables that are assumed to be exogenous to fertility decisions but that influence either the demand for or supply of children. This reduced-form model of fertility determinants can be written as

$$y = \beta_0 + \beta_1 x_1 + \beta_{12} x_1^2 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \mu$$

where y is the dependent variable, children ever born; β_0 is an intercept; x_1 is the woman's age, entered in quadratic form to control for biological factors affecting the supply of births; x_2 is the woman's schooling, in various specifications; x_3 indicates urban residence; x_4 is the woman's ethnic group; x_5 is the woman's region of residence; x_6 is the woman's religion; and x_7 is a group of variables proxying the household's income or wealth. The empirical models for contraceptive use are identical, except for the dependent variable, which is a dichotomous (dummy) variable that takes on the value zero or one, indicating current use of modern contraception.

To examine in more detail the nonlinearities of schooling effects and fertility, the results from four different specifications of female schooling are presented: (a) years of completed schooling as a linear term; (b) years of completed school-

ing in quadratic form (schooling and schooling squared); (c) linear splines for the level of schooling reached—lower primary (one to three years), upper primary (four to six years or four to seven), lower secondary (seven to ten years or eight to ten) and higher levels (eleven years and more); and (d) dummy variables for individual years of completed schooling.³ Relationships for the national sample as well as for urban and rural subsamples are presented here. Results by cohort are presented in Ainsworth, Beegle, and Nyamete (1995).

The choice of independent regressors has been influenced by the availability of information in the data sets. The analysis uses data from fourteen Sub-Saharan African countries collected by the DHS in the late 1980s and early 1990s. The DHS samples are large—from 3,000 to 9,000 women aged fifteen to forty-nine. The large size of the samples is important because in many countries only a small proportion of women have had any schooling (fewer than a third of women in Burundi, Mali, and Senegal, for example). There are, unfortunately, no measures of household income or consumption in the DHS data sets. We use instead four variables that serve as proxies for income and wealth: household ownership of a radio, a television, or a bicycle, and the quality of housing. The latter is a dichotomous variable that indicates whether the floor of the household's residence is cement, tile, polished wood, or parquet; the default categories are mud, sand, or clay in most countries.

The number of children ever born is censored from below at zero, and can take on only zero or positive integer values. Under these conditions, least squares regression coefficients are inconsistent and, when the dependent variable and regressors are normally distributed, are biased downward in proportion to the degree of censoring in the sample (Greene 1981). Depending on the data set, roughly a quarter of the women in the samples (ranging from 16 percent in Mali to 30 percent in Burundi) have had no live births. Although there are econometric models capable of dealing with this problem, we have opted to use the easier-to-interpret ordinary least squares (OLS) estimation for the fertility regressions.⁴ This censoring problem does not arise for the contraceptive use regressions, in which the dependent variable is dichotomous. Maximum likelihood logit is used in estimation of the parameters (Maddala 1983).⁵

3. In six countries the primary cycle is completed in seven years (Botswana, Kenya, Tanzania, Uganda, Zambia, and Zimbabwe). In these instances the upper primary and lower secondary variables are set equal to four to seven and eight to ten years, respectively. Cameroon has a dual system, with those in the Francophone areas completing primary schooling in six years, and those in the Anglophone areas in seven years. The upper primary school spline used in Cameroon is set to reflect incomplete or complete primary schooling for the system in which the woman was enrolled.

4. The Tobit model, for example, takes into account the censoring of the dependent variable at zero, although not its integer nature. A Poisson count model takes into account both the censoring and integer nature of the dependent variable, and the coefficients would be unbiased, even if the mean and variance of the dependent variable are not equal (as is implied by the Poisson model). For all subsamples except young women and possibly urban women, Tobit and Poisson models produce results identical in sign and significance and very similar in magnitude to OLS coefficients (Ainsworth 1989).

5. Standard errors in both the fertility and contraceptive use regressions are corrected for heteroskedasticity and cluster effects.

A second censoring issue involves the inclusion of women who have not completed their fertility. One way of dealing with this problem would be to predict the completed fertility of younger women on the basis of the determinants of fertility found among women who had already completed or nearly completed childbearing. However, in most African countries this would restrict the analysis to an older sample of women (over forty) that has had very little schooling. Further, we anticipate that the relation between schooling (as well as other independent variables) and fertility may be changing over time. As the aggregate proportion of schooled women increases, the quality and price of schooling change, family planning becomes more widely available to younger women, and other socioeconomic conditions (such as income) evolve. To account for the fact that women in the samples have been exposed to the risk of pregnancy for differing amounts of time and for the fact that fecundity over the fifteen-to-forty-nine age range rises with age, peaks, and then declines, we control for the woman's age and age squared.

A third censoring issue of unknown magnitude, relevant to both the fertility and contraceptive use regressions, is the possibility that some of the younger women in the sample may not have completed their schooling. The DHS data sets did not record whether the women in the sample were currently enrolled in school. However, given the limited amount of schooling in all of the national samples at the primary and especially the secondary level, we do not anticipate that upper censoring of the completed schooling variable is a major problem in this analysis.

III. DESCRIPTIVE STATISTICS

The fourteen Sub-Saharan African countries included in this study span the continent in terms of their geographic location, colonial heritage, and level of economic development. Half of the countries are West African, four are in Eastern and Central Africa, and three are in Southern Africa. Five countries are French-speaking (Burundi, Mali, Niger, Senegal, Togo); eight are English-speaking, and Cameroon uses both as official languages. The countries range in size from Botswana, with slightly more than one million people, to Nigeria, the largest country in Sub-Saharan Africa, with a population of nearly 100 million (table 2). Most of these countries have very low incomes; as shown in table 2, seven had incomes per capita of less than US\$400 in 1991. Among the twelve countries for which data are available, eight had negative rates of growth of gross national product (GNP) per capita in the 1980s, and for two others GNP per capita grew at less than 1 percent a year. Scribner (1995) has characterized the population policies of most of the countries in this study, including policies on family planning, child health, and women's legal status.

There are wide divergences in female enrollment and infant mortality rates. As recently as 1990, for example, female primary enrollments represented only 17 percent of primary-age girls in Mali, 21 percent in Niger, and only

Table 2. *Economic and Social Indicators, Fourteen Sub-Saharan African Countries*

Country	GNP per capita, 1991 (U.S. dollars)	Growth rate of		Population		Infant mortality rate, 1991 ^a	Female gross primary enrollment ratio, 1990	Female gross secondary enrollment ratio, 1990
		GNP per capita, 1980-91 (average annual percent)	Population, mid-1991 (millions)	growth rate, 1980-91 (average annual percent)	Urban population (percent)			
Tanzania	100	-0.8	25.2	3.0	34	115	63	4
Uganda	170	—	16.9	2.5	11	118	63 ^b	—
Burundi	210	1.3	5.7	2.9	6	107	64	4
Mali	280	-0.1	8.7	2.6	20	161	17	4
Niger	300	-4.1	7.9	3.3	20	126	21	4
Nigeria	340	-2.3	99.0	3.0	36	85	63	17
Kenya	340	0.3	25.0	3.8	24	67	92	19
Ghana	400	-0.3	15.3	3.2	33	83	67	31
Togo	410	-1.3	3.8	3.4	26	87	80	10
Zambia	420 ^c	—	8.3	3.6	51	106	91	14
Zimbabwe	650	-0.2	10.1	3.4	28	48	116	46
Senegal	720	0.1	7.6	3.0	39	81	49	11
Cameroon	850	-1.0	11.9	2.8	42	64	93	21
Botswana	2,530	5.6	1.3	3.5	29	36	112	47

— Not available.

Note: Countries are listed in order of 1991 GNP per capita, from lowest to highest.

a. Per 1,000 live births.

b. 1992 data.

c. 1990 data.

Source: World Bank (1992, 1993, 1995).

half of the primary-age girls in Senegal (table 2). By comparison, the inclusion of over-age girls in primary enrollments in Botswana and Zimbabwe raises their gross female primary enrollment rates to over 100 percent. In only three countries—Botswana, Ghana, and Zimbabwe—do female secondary enrollments equal or exceed 30 percent of the women in that age group. Perhaps not coincidentally, demographers believe that fertility decline is under way in two of these three countries—Botswana and Zimbabwe (van de Walle and Foster 1990). Infant mortality rates (IMRs) also show great variation. Botswana and Zimbabwe have IMRs lower than 50 per 1,000, but six countries have rates greater than 100 per 1,000 (table 2). Despite these differences in economic and social indicators, levels of fertility and population growth rates in the fourteen countries are high and remarkably similar. With the exception of four countries, population growth rates were between 3 and 4 percent per year during the 1980s. Recall from table 1 that the total fertility rates were between 5.0 and 7.4 children per woman.

Descriptive statistics for the fourteen DHS data sets and the year of data collection are presented in table 3. Only four of the data sets are nationally self-weighted samples that achieved total coverage (Ghana, Senegal, Togo, and Zimbabwe). Thus, the unweighted sample statistics for other countries may not be nationally representative. A description of the sample design and coverage of the fourteen surveys is in appendix table A-1. The average woman in the samples in table 3 was twenty-seven to twenty-nine years old and, with the exception of Botswana, Ghana, and Zimbabwe, had three or more live births. Except for Botswana, Kenya, and Zimbabwe, fewer than 10 percent of the sampled women were using a modern method of contraception.⁶ Levels of urbanization in the samples were highest in Botswana, Cameroon, Mali, Nigeria, Senegal, and Zambia, where 40 percent or more of sampled women were living in urban areas. In Botswana, Cameroon, Mali, Niger, and Nigeria, urban women were oversampled. National levels of urbanization are reported in table 2.

Women of reproductive age in these samples had very little schooling. The highest levels of schooling are for women in Zimbabwe, where the average woman in the sample had completed six years of schooling and where only 13.6 percent of the sample had no formal schooling. In Burundi, Mali, Niger, and Senegal, levels of schooling are lower: mean schooling was less than two years, and roughly three-quarters or more of the women had received no schooling. Since the DHS oversampled urban women in Burundi, Mali, and Niger, these statistics overstate the true levels of education at the national level.

Figure 1 shows the distribution of women according to their years of completed schooling. Countries are ordered from lowest to highest 1991 GNP per capita. Even in countries with relatively higher per capita incomes, like Senegal, a very large share of women have had no schooling. In fact, the French-speaking

6. Modern methods include female sterilization, vasectomy, pill, intrauterine device (IUD), injectable contraceptives, condoms, spermicides, and diaphragm.

Table 3. *Demographic and Health Survey Sample Statistics, Fourteen Sub-Saharan African Countries*

Country	Year	Sample size	Mean number of children ever born	Women using modern contraceptives (percent)		Women living in urban areas (percent)	Mean years of female schooling	Distribution of women by years of schooling (percent)				
				Currently	Ever			0	1-3	4-6	7-10	11 or more
Tanzania	1991-92	9,001	3.15	5.2	12.5	20.0	4.16	35.2	5.6	53.4 ^a	2.4 ^b	3.4
Uganda	1988-89	4,727	3.40	3.4	9.6	20.4	3.67	34.5	17.0	35.8 ^a	7.5 ^b	5.3
Burundi	1987	3,943	3.00	2.3	4.2	15.9	1.37	74.2	7.2	13.4	3.7	1.6
Mali	1987	3,188	3.83	2.0	5.1	41.9	1.22	80.5	4.0	8.0	5.9	1.7
Niger	1992	5,854	3.78	4.6	8.8	38.8	1.04	83.1	2.3	8.1	5.3	1.1
Nigeria	1990	8,734	3.20	5.2	12.1	40.2	3.72	51.7	4.2	19.9	10.5	13.7
Kenya	1993	7,490	3.17	24.7	43.5	15.3	5.91	17.3	7.2	42.4 ^a	20.6 ^b	12.6
Ghana	1993	4,562	2.91	9.3	29.5	37.7	5.34	35.4	5.9	11.6	40.0	7.2
Togo	1989	3,351	3.21	3.4	10.7	35.2	2.31	58.8	10.1	19.1	10.4	1.6
Zambia	1992	7,004	3.13	6.7	22.1	47.6	5.37	18.4	11.3	48.4 ^a	16.4 ^b	5.4
Zimbabwe	1988-89	4,179	2.96	27.2	48.4	33.3	6.04	13.6	10.5	45.4 ^a	16.6 ^b	13.9
Senegal	1992-93	6,322	3.31	4.5	6.2	41.7	1.80	73.4	3.3	13.7	6.6	3.1
Cameroon	1991	3,862	3.00	5.4	19.9	56.6	5.07	33.4	6.5	22.9 ^c	24.5 ^c	12.7
Botswana	1988	4,356	2.44	31.8	56.8	51.7	5.85	20.8	7.0	43.3 ^a	21.6 ^b	7.3

Note: Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2). Statistics are for the unweighted working samples used in the analysis. See appendix table A-1 for sampling strategies in each country.

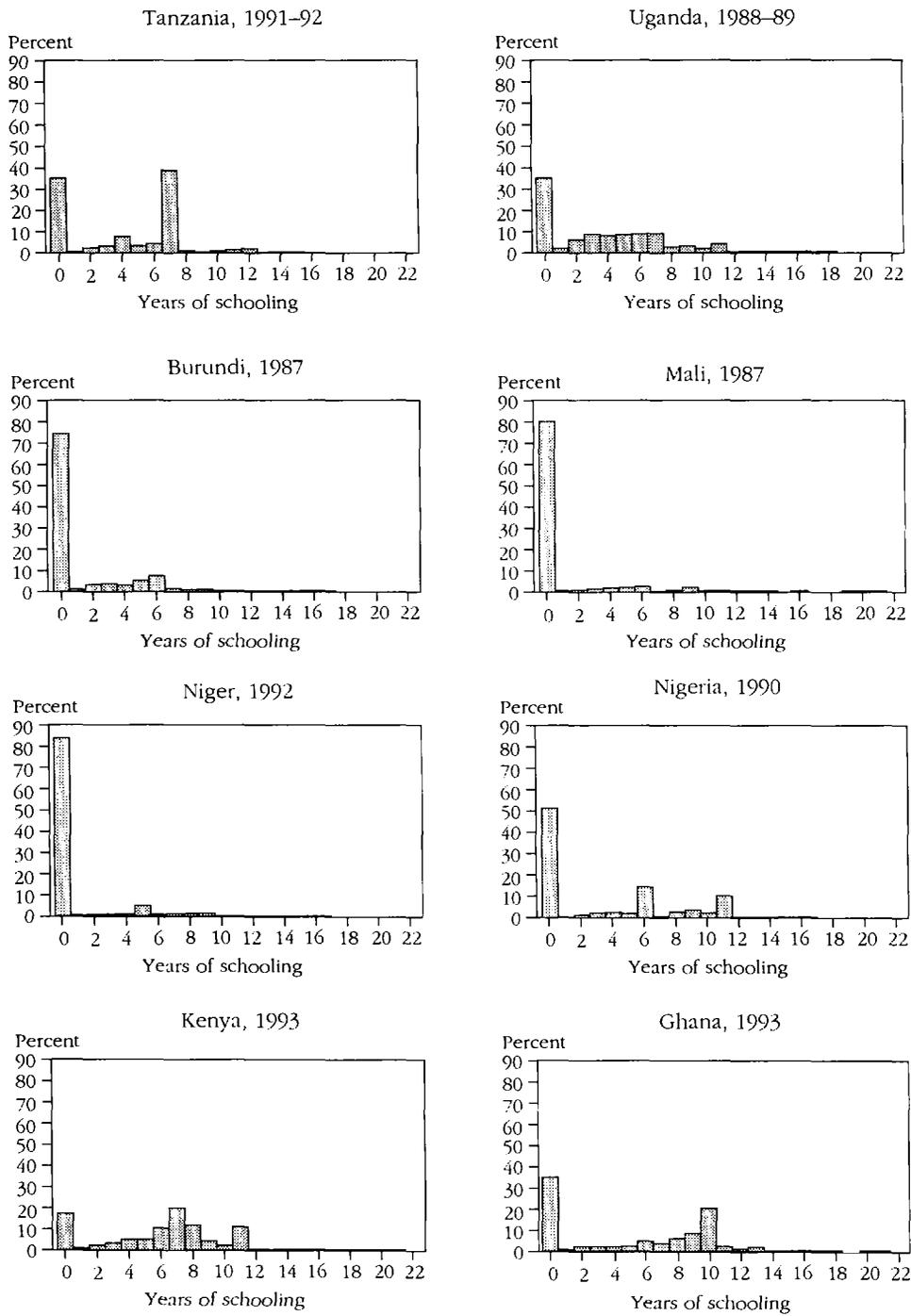
a. Includes four to seven years of primary schooling.

b. Includes eight to ten years of schooling.

c. In Cameroon, part of the country adheres to a six-year primary school cycle, and another part adheres to a seven-year cycle. The four-to-six category includes those who attended four to seven years in the seven-year cycle, and the secondary category represents seven to ten years or eight to ten years of schooling, depending on which system the woman attended.

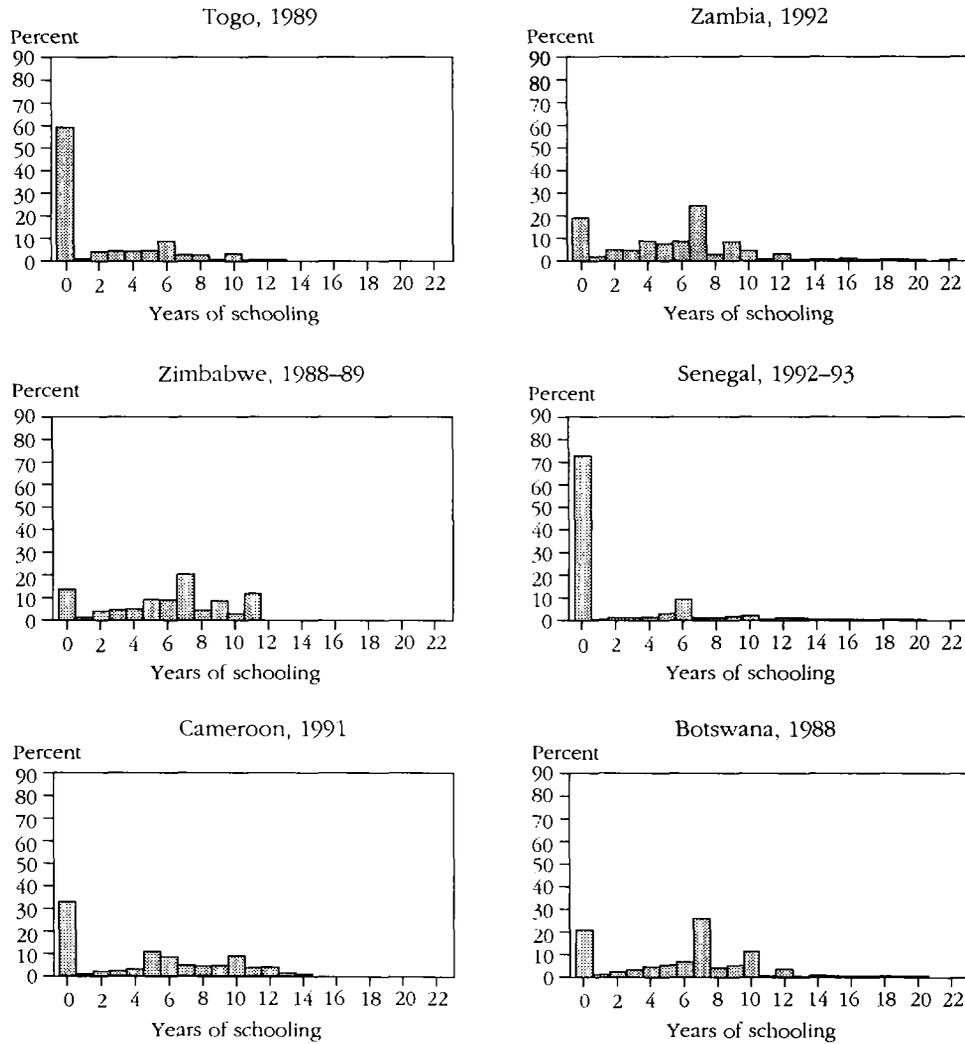
Source: DHS data.

Figure 1. *Distribution of Women 15–49 by Years of Completed Schooling*



(Figure continues on the following page.)

Figure 1. (continued)



Note: Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.
 Source: DHS data.

and Sahelian countries have by far the lowest schooling of women of reproductive age. But even in Ghana and Nigeria, thought to have strong educational policies in the past, 35 and 50 percent of all women in these samples, respectively, have had no schooling. In Tanzania, once thought to have achieved universal primary education, about 35 percent of women never attended school. Of course, figure 1 groups together women of many different birth cohorts. When the distribution of schooling is compared across cohorts, substantial progress has been made in raising female schooling over time in Botswana, Cameroon, Ghana, Kenya, Tanzania, Zimbabwe, and Zambia. However, in Burundi, Mali, Niger, and Senegal there has been little or no change in the level of female education over time.⁷

The distribution of schooling among educated women is often uneven. In Ghana, for example, about 35 percent of women had no schooling, and about 25 percent had exactly ten years. In Botswana, Kenya, Nigeria, and Zimbabwe, “spikes” are observed in the distribution at seven years of schooling. The lumpiness of the distribution of schooling in some of these data sets—including the relative scarcity of observations with less than complete primary schooling—is important to consider in interpreting the regression results. While the mean level of schooling may be two to three years, very few women are commonly found with exactly that number.

IV. WOMEN’S SCHOOLING AND FERTILITY

The OLS regression results for three of the four specifications in the fourteen countries are pictured in figure 2. On the basis of the regression coefficients, predicted children ever born is plotted against women’s years of schooling, while controlling for age, age squared, area of residence, ethnicity, religion, ownership of durable goods, and quality of housing. The straight line in each graph represents the linear specification of female schooling, in which the slope is constrained to be constant. In all of the countries, the linear specification is sloped downward, showing that increased schooling is generally associated with lower fertility.

However, the descriptive statistics suggest that the relation between female schooling and fertility is nonlinear. The broken lines in figure 2 represent the predictions from a quadratic specification of female schooling (schooling and schooling squared), and the small circles represent the prediction of a specification allowing a dummy variable for each individual year of schooling. These two specifications show that at low levels of schooling the relation between female schooling and fertility is weak or nonexistent, but that with the completion of primary schooling the relation is clearly negative. This makes sense, since it is difficult to believe that less-than-full primary schooling could result in basic

7. For the distribution of schooling in urban and rural areas and by cohort, refer to annex 2 of Ainsworth, Beegle, and Nyamete (1995).

Figure 2. Predicted Cumulative Fertility by Female Schooling Using Three Specifications

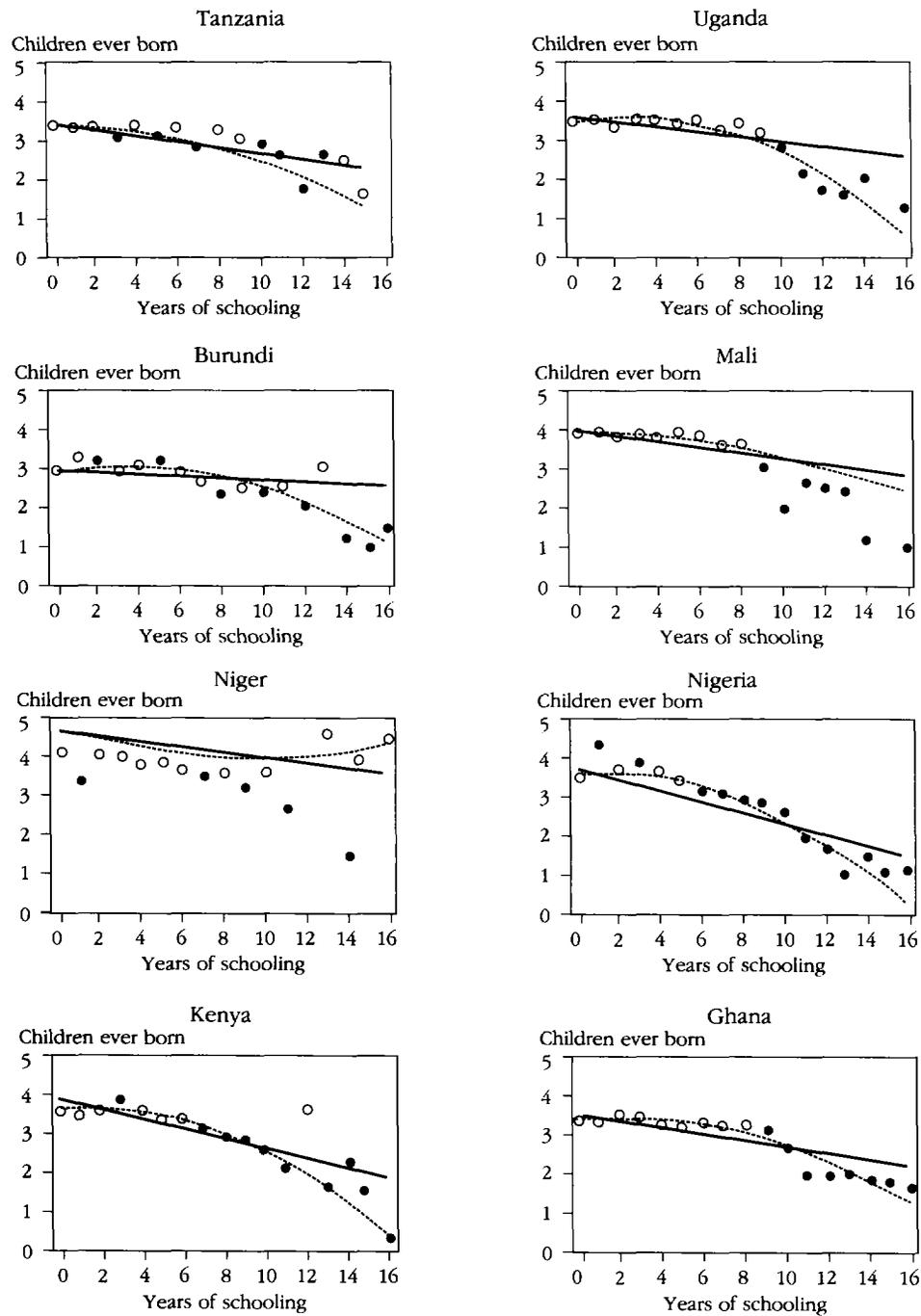
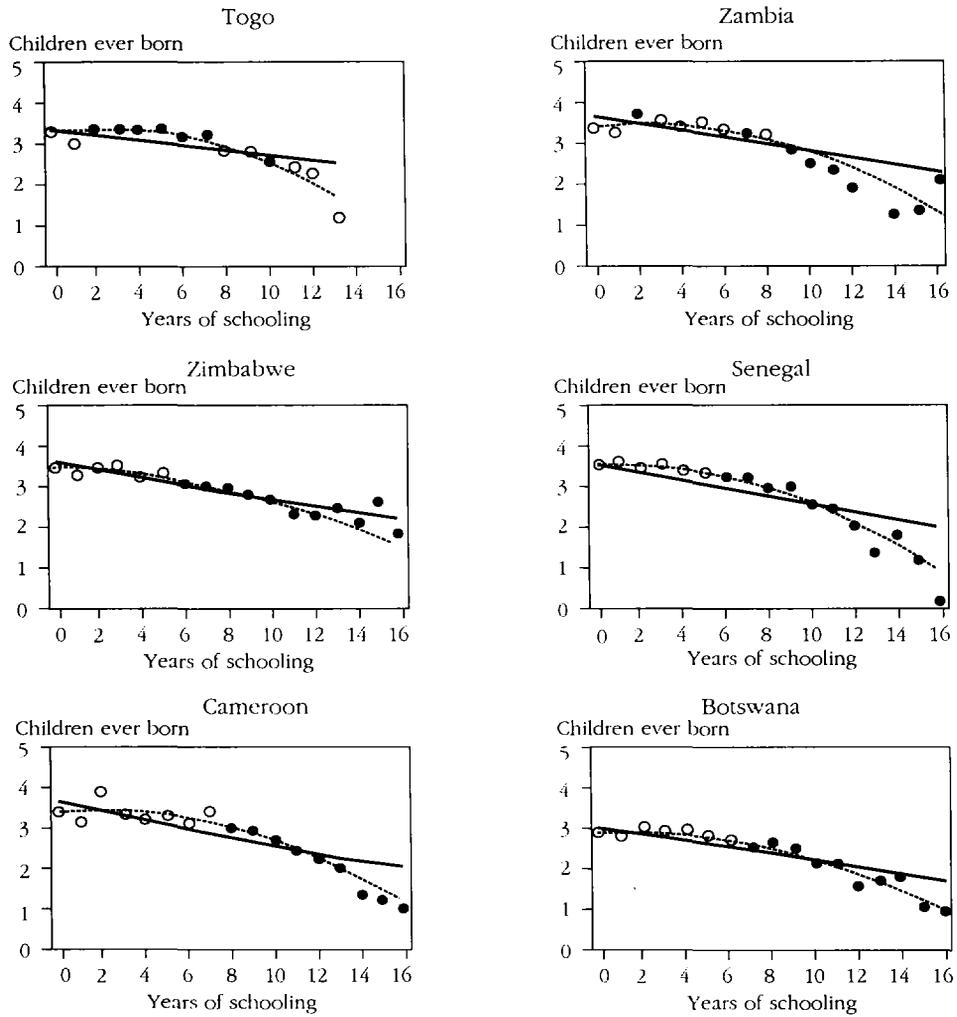


Figure 2. (continued)



Note: The graphs show predicted number of children ever born from ordinary least squares regressions using three different specifications of female schooling: the straight line in each graph represents a linear specification; the broken line represents the predictions from a quadratic specification (schooling and schooling squared); and the circles represent the prediction of a specification that allows a dummy variable for each individual year of schooling. In the latter, solid circles represent statistically significant coefficients (at the 5 percent level or less). Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.

Source: Authors' calculations from DHS data.

Table 4. *The Impact of Women's Schooling on the Number of Children Ever Born, Fourteen Sub-Saharan African Countries*

Country	Years of schooling	Level of schooling (years)			
		1-3	4-6	7-10	11 or more
Tanzania	-0.075**	-0.124	-0.324**	-0.255*	-1.201**
Uganda	-0.060**	-0.027	-0.022	-0.271*	-1.419**
Burundi	-0.024	0.182	0.141	-0.366**	-0.823**
Mali	-0.069**	-0.009	-0.027	-0.516**	-1.483**
Niger	-0.060**	-0.269	-0.280*	-0.736**	-0.178
Nigeria	-0.134**	0.319**	-0.298**	-0.722**	-1.626**
Kenya	-0.126**	0.173	-0.257**	-0.671**	-1.464**
Ghana	-0.079**	0.094	-0.104	-0.447**	-1.431**
Togo	-0.061**	-0.005	-0.055	-0.483**	-1.209**
Zambia	-0.092**	0.207*	-0.045	-0.546**	-1.520**
Zimbabwe	-0.102**	-0.022	-0.365**	-0.646**	-1.184**
Senegal	-0.102**	-0.002	-0.283**	-0.667**	-1.816**
Cameroon	-0.116**	-0.005	-0.174	-0.465**	-1.412**
Botswana	-0.086**	0.068	-0.222**	-0.521**	-1.245**

* Significant at 5 percent level.

** Significant at 1 percent level.

Note: Coefficients were estimated using ordinary least squares (OLS). For years of schooling, the specification was linear; for level of schooling, the specification used dummy variables to estimate the effect on the number of children born of raising female schooling from zero years to each level. Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2).

Source: Authors' calculations, DHS data.

literacy and numeracy or could substantially alter the opportunity costs of women's time. Also recall that most women are in the "no schooling" category or in the complete primary schooling category. Thus, some of the dummy variables for individual years of schooling at both incomplete primary and secondary levels represent very few women and are not individually statistically significant. However, a few outliers can greatly distort the relationship, as in the case of Niger. In fact, given how few women obtained higher levels of schooling in the Sahelian countries, the curves for very high schooling levels must be viewed with skepticism.

Table 4 shows regression coefficients for the linear specification and for a specification not shown in figure 2, which used dummy variables representing four different levels of schooling—one to three years, four to six years, seven to ten years, and eleven or more years.⁸ The coefficients are interpreted as the effect on the number of children ever born of raising female schooling from zero to that level. All other explanatory variables (age, age squared, urban residence, region, ethnicity, religion, ownership of durable goods, and quality of housing) were also entered in the regressions when available.⁹

8. For countries with a seven-year primary cycle, the levels entered are one to three, four to seven, and eight to ten years.

9. The following data sets did not have the full set of independent variables: ethnic group was missing for Botswana, Burundi, Cameroon, Nigeria, Tanzania, Uganda, and Zambia; region was missing for Botswana; and religion was missing for Burundi and Senegal.

The number of years of female schooling is significant and negatively related to cumulative fertility in thirteen of the countries, despite their different levels of female schooling and economic characteristics. With the exception of Senegal, the largest linear female schooling coefficients occur in countries in which the samples have large shares of women with postprimary schooling (Cameroon, Kenya, Nigeria, and Zimbabwe; refer to table 3). However, Ghana has the largest share of sample women with postprimary education (47 percent; see the last two columns in table 3) and the linear relation there is relatively small.

The results for the levels-of-schooling specification in table 4 indicate that lower primary schooling (one to three years) is not related to cumulative fertility in twelve countries and has a positive relation in two (Nigeria and Zambia). In half of the countries, women with four to six years of primary schooling have 0.2 to 0.4 fewer children ever born, compared to women with no schooling, and in the other half there is no relationship. On average, controlling for covariates, women in the samples with seven to ten years of schooling had from 0.2 to 0.7 fewer children ever born, and women with eleven years of schooling or more had 0.8 to 1.8 fewer children ever born, compared with women with no schooling.

Much has been made in the literature of the sometimes-observed positive relation between a few years of schooling and fertility. This is often explained as inadvertent outcomes of changes in proximate determinants of fertility. A positive relation would imply that even one year of primary schooling is sufficient to induce a quite large change in behaviors and outlooks that indirectly affect fertility. The realities of primary schooling in most Sub-Saharan countries—in terms of poor infrastructure, extremely limited availability of reading and instructional materials, inadequate teacher training and salaries, and the resulting high absenteeism and dropout rates—cast doubt on this interpretation (Lockheed and Verspoor 1991). Literacy is certainly not achieved in a single year of schooling and, under the circumstances that prevail, may not even be achieved until completion of primary school. A more plausible explanation is that the (small group of) women who completed only a few years of schooling are those who became pregnant, whose families wanted them to get married, or who simply could not keep up and therefore stopped their schooling.

Another plausible explanation for the sometime nonrelation between primary schooling and fertility or a positive relationship is the exclusion of variables like household income from the regressions. If, as incomes rise, parents want more children, holding wages and other prices constant, then higher incomes should be associated with higher fertility. If there is a strong association between schooled women and higher incomes, and if income is not properly controlled for, then the schooling coefficients may be absorbing both the negative schooling and positive income effects, which cancel out. This would also imply that the coefficients on women's schooling are underestimates of the negative relation with fertility. This was found to be the case in Côte d'Ivoire, where omitting income from fertility regressions notably weakened the schooling coefficient in magni-

tude (Ainsworth 1989). The controls for household assets—durable goods and quality of housing—may not have completely alleviated this problem in this study.

By the later years of primary schooling, however, some degree of literacy should have been achieved, even for women who did not complete primary school. Thus, we expect a negative relation in these cases. However, the last years of primary schooling are associated with lower fertility in only half of the countries and have no association in the other half. Understanding why this relation exists in some countries and not others is important to policymaking. It might reflect differences in the quality of instruction or differences in labor market conditions across countries, for example. Part of the explanation may also lie with complementarity between schooling and the availability of family planning services; Botswana, Kenya, and Zimbabwe have the strongest family planning programs and also show negative relations between female primary schooling and fertility.

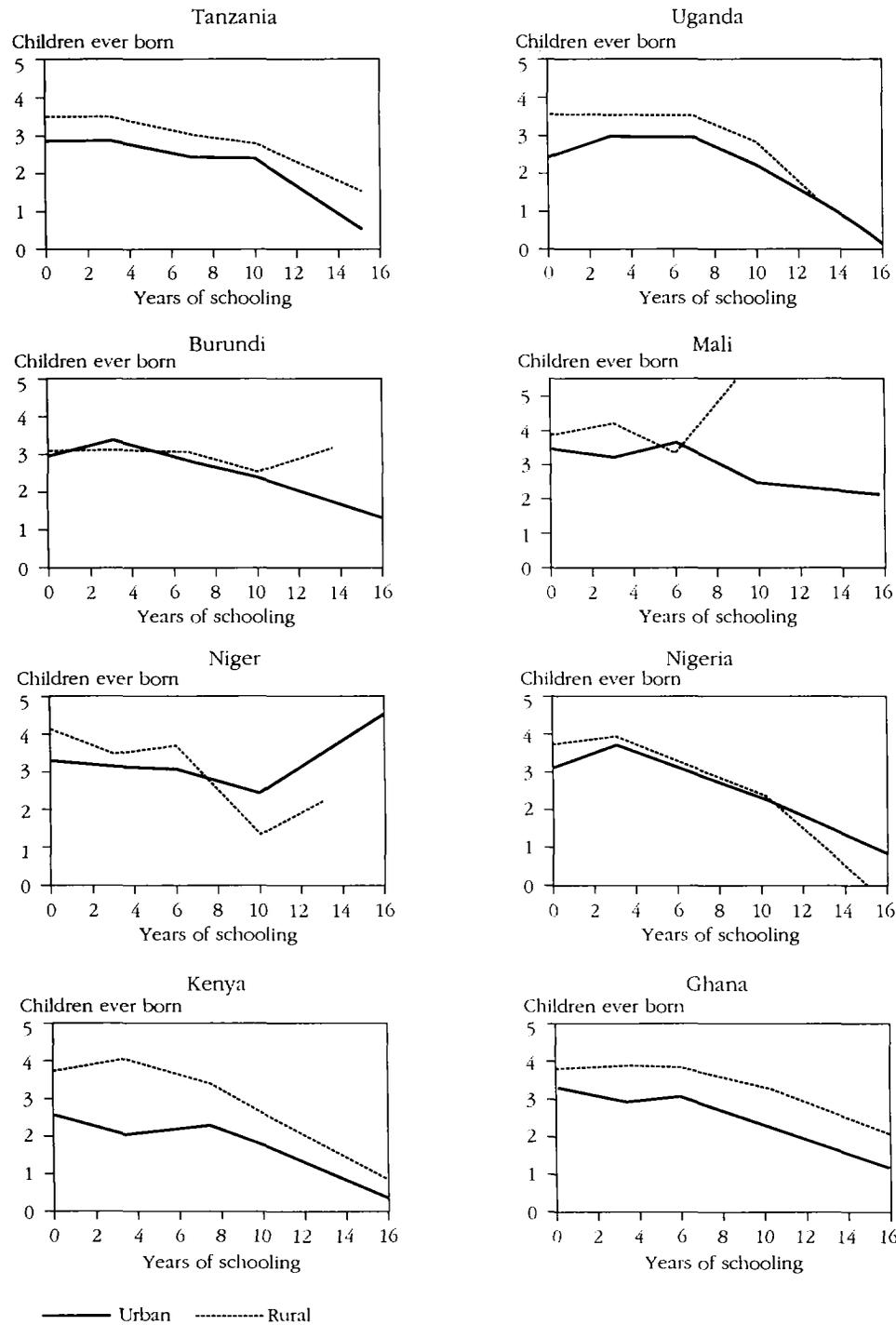
The strong negative association between women's higher secondary schooling and cumulative fertility evidenced in figure 2 and table 4 persists across all of the countries in the sample, regardless of their level of development, distribution of schooling, or intensity of family planning programs. (Niger is an exception; fewer than 0.1 percent of women had eleven or more years of schooling.) These results suggest that, with or without easy access to family planning, highly educated women do manage to lower their fertility. When supplies are scarce, highly educated women have the greatest access to contraceptive services by virtue of their education and probable income levels. However, in three countries with more active family planning programs, even women with only primary instruction are able to lower their fertility.

There is no obvious relation between the size of the linear schooling coefficients in table 4 and GNP per capita. This is not surprising, because cumulative fertility is likely to reflect past levels of income. Nigeria's income levels, for example, are vastly lower now than they were during the oil boom of the 1970s. In addition, GNP per capita hides differences in the distribution of income that may account for differential effects of schooling. Within countries, the regression results for ownership of assets revealed a negative relation between income and fertility in Botswana, Ghana, Tanzania, and Togo, but a positive relation in Nigeria. Results for other countries were ambiguous (see Ainsworth, Beegle, and Nyamete 1995).

Urban and Rural Samples

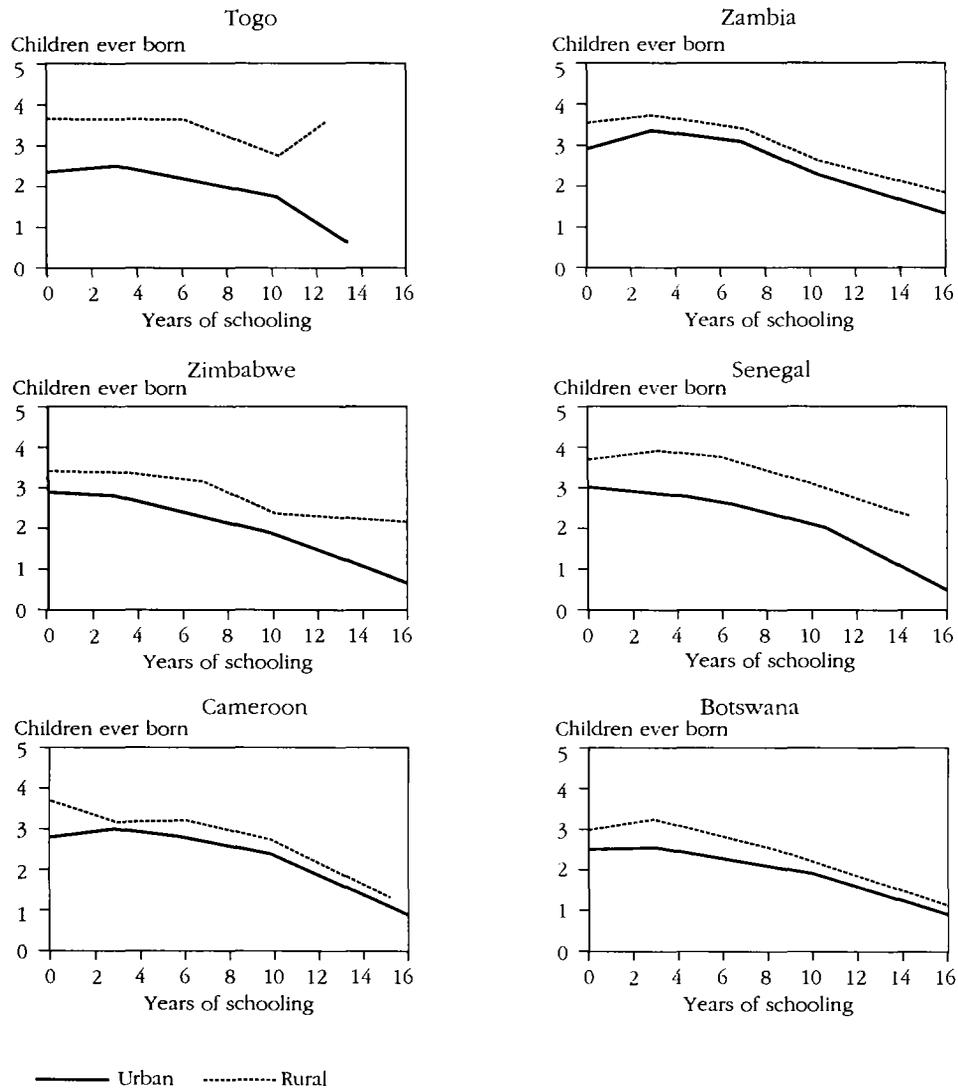
In the Botswana, Cameroon, Mali, Nigeria, Senegal, and Zambia data sets, 40 percent or more of women were living in urban areas. The least urbanized samples are in Burundi, Kenya, Tanzania, and Uganda, with 20 percent or fewer women in urban areas. Figure 3 shows predicted cumulative fertility using a linear spline specification of female schooling at zero to three, four to six, seven to ten, and eleven or more years of schooling, in urban and rural areas (Greene 1993). The

Figure 3. Predicted Cumulative Fertility by Female Schooling in Urban and Rural Areas



(Figure continues on the following page.)

Figure 3. (continued)



Note: The graphs show predicted cumulative fertility using a linear spline specification of female schooling with segments for 0-3, 4-6, 7-10, and 11 or more years of schooling. Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.
 Source: Authors' calculations from DHS data.

linear spline specification is jointly significant for all countries in urban and rural areas, with the exception of urban areas in Niger and rural areas in Burundi. However, specific segments of many of these curves are not statistically significant. The coefficients underlying figure 3 can be obtained from the authors.

In interpreting the results, it is important to keep in mind that 90 percent or more of rural women in Mali, Niger, and Senegal, and 64 percent of urban women in Mali and Niger, had no schooling. Thus, the results for higher-order splines are based on very few cases and the results are highly sensitive to outliers. With these caveats in mind, differences between urban and rural women within and across countries are nevertheless interesting. Fertility declines with increases in female schooling in both urban and rural areas, particularly after primary schooling. The early years of primary schooling are associated with higher fertility in urban Nigeria and Uganda, but are otherwise insignificant. In most of the countries, family planning services are not easily available in rural areas, yet very educated rural women (there are few of them) nevertheless have lower fertility. In fact, the differential between women with eleven or more years of schooling and those with no schooling is often greater in rural than urban areas (Cameroon, Kenya, Niger, Nigeria, Uganda, and Zambia) (see figure 3).

In general, at every level of schooling urban women have lower fertility than rural women. This may be due to a variety of factors, including more labor market opportunities, higher costs of children, and more readily available health and family planning services in urban areas. Nigeria is an important exception—at the highest levels of schooling, fertility declines more rapidly in rural areas and is in fact lower than in urban areas. Fertility in urban and rural areas also converges at higher levels of female schooling in Botswana, Kenya, and Uganda. When controlling for female schooling, differentials between urban and rural fertility are quite small in Botswana, Cameroon, Nigeria, and Zambia, but remain large in Ghana, Senegal, and Togo.

Results by Cohort

The relation between women's schooling and fertility may change over time. As female enrollment rates rise, a greater percentage of each successive cohort has had schooling. The level of schooling of the woman relative to the schooling of her cohort may alter the returns to schooling and thus the relation between schooling and fertility. Even if enrollment rates were to remain constant, changes in the quality and content of schooling over time might result in changes in the effectiveness of women's schooling in altering fertility behavior. Finally, over time other variables in the environment may also change, enhancing or detracting from the relationship. For example, making family planning more available might alter the effect of schooling on cumulative fertility by substituting for the schooling of poor women (lowering fertility even for women with no schooling) or by availing more educated women of the means to keep their fertility low.

Regressions run by cohort (ages fifteen to twenty-four, twenty-five to thirty-four, and thirty-five to forty-nine) reveal that the overall relation between

women's schooling and cumulative fertility is negative in the youngest and middle-age cohorts in all of the countries and in the oldest cohort in more than half of the countries (results are available from the authors). The negative relation between schooling and cumulative fertility is almost always larger in the middle cohort than in the youngest cohort. The results suggest that the effect of women's schooling on fertility increases with the woman's age, and middle-aged educated women are not "catching up" with the fertility of others in their cohort to compensate for lower fertility while young. The association of partial or completed primary schooling with lower cumulative fertility is observed to a greater extent among the youngest cohort. However, Botswana, Ghana, and Zambia, which have relatively high levels of schooling, show no significant effect of primary schooling in any of the cohorts. The higher levels of schooling are associated with significantly lower fertility in all cohorts, even in countries with low levels of schooling in the older cohort.

Women's Schooling Compared with Men's

An issue of policy interest is the relative impact of men's and women's schooling on cumulative fertility. Because child rearing is not generally intensive in the time of the father in these countries, we do not expect higher education and earning capacity of husbands to raise the "price" of children, as does women's education. More often, husband's education is used as a proxy for household income, and it may be a better proxy for income than the ownership of durable goods, which are already controlled for. Inclusion of an income proxy may alter the size of the woman's schooling coefficients to the extent that they are correlated with income or husband's education. However, to examine these issues we must restrict ourselves to the sample of ever-married women in each data set. Depending on the country, the sample of ever-married women may be as small as 45 percent of the total sample (Botswana) or as large as 86 percent (Mali). The restricted sample, conditioned on marital status, can be expected to show a smaller schooling effect for ever-married women than for all women, because the influence of schooling on delayed age at first birth of the unmarried women in the sample will not be included. Table 5 presents the OLS regression results of children ever born on the linear specification of woman's schooling, with and without the husband's schooling.

The woman's schooling coefficients for the sample of ever-married women in table 5 (second column) are generally smaller than for the sample of all women in table 4, and in Uganda and Zimbabwe the difference is considerable. This result confirms the point made earlier that studies restricted to samples of ever-married women may understate the relation between female schooling and fertility.

In table 5, controlling for husband's education generally acts to reduce slightly the woman's education coefficient (column three). In four countries (Cameroon, Kenya, Nigeria, and Uganda) only the woman's schooling is associated with lower fertility; the coefficients on husband's schooling (column four) are not significant. When statistically significant, increases in the husband's schooling are associated

Table 5. *The Impact of Women's and Their Husbands' Schooling on Cumulative Fertility, Fourteen Sub-Saharan African Countries*

Country	Sample size	Regression without husband's education	Regression with husband's education		Percentage with no schooling	
		Coefficient on woman's years of schooling	Coefficient on woman's years of schooling	Coefficient on husband's years of schooling	Ever-married women	Husbands
Tanzania	6,593	-0.069**	-0.063**	-0.017*	42.5	27.7
Uganda	3,657	-0.034**	-0.031*	-0.006	40.1	18.0
Burundi	2,541	-0.015	-0.019	0.011	77.3	57.7
Mali	2,750	-0.062**	-0.045**	-0.026*	83.0	84.3
Niger	4,953	-0.007	0.012	-0.058**	87.6	89.2
Nigeria	6,912	-0.112**	-0.114**	0.002	62.5	53.4
Kenya	5,003	-0.106**	-0.098**	-0.015	23.1	13.0
Ghana	3,417	-0.078**	-0.063**	-0.047**	41.6	31.9
Togo	2,318	-0.054**	-0.042**	-0.022*	68.0	49.7
Zambia	5,115	-0.088**	-0.076**	-0.022**	21.2	11.1
Zimbabwe	2,755	-0.079**	-0.062**	-0.038**	16.3	12.4
Senegal	4,354	-0.096**	-0.073**	-0.034**	85.2	84.2
Cameroon	2,878	-0.111**	-0.100**	-0.014	41.3	36.3
Botswana	1,954	-0.094**	-0.070**	-0.044**	27.9	35.4

* Significant at the 5 percent level.

** Significant at the 1 percent level.

Note: The samples include only women who have ever been married. Coefficients were estimated using ordinary least squares (OLS) and a linear specification of the years of female and male schooling. Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2).

Source: Authors' calculations based on DHS data.

with lower fertility, but the negative association between women's schooling and fertility is stronger than the men's in all but one of the remaining countries. Only in Niger is the husband's education alone associated with lower fertility. Investments in women's schooling, therefore, are likely to have a greater impact on fertility than investments in men's schooling—and the effects of women's schooling are even greater in the sample of all women than in the sample of ever-married women.

V. WOMEN'S SCHOOLING AND CONTRACEPTIVE USE

Contraceptive use is related directly to the demand for children. Therefore, all of the factors leading educated women to have fewer children should result in a positive relation between education and contraceptive use. In addition, educated women may be more likely to use contraception because information about the availability, correct use, side effects, costs, and so forth may be less difficult and costly for educated women to assimilate, and may make them more effective and satisfied users. Levels of current use of modern contraception in the DHS samples of all women used in the regressions are presented in table 6, for urban and rural women and for different levels of schooling. Both in our data and in virtually all tabulated results to date, urban women and women with more schooling (even those with primary schooling) have higher rates of contraceptive use

Table 6. *Women Currently Using a Modern Method of Contraception, by Woman's Residence and Education*
(percent)

Country	Year	Woman's residence			Woman's education (years)			
		All	Urban	Rural	0	1-6	7-10	11 or more
Tanzania ^a	1991-92	5.2	10.8	3.8	2.1	6.1	10.7	16.7
Uganda ^a	1988-89	3.4	10.7	1.5	1.0	2.8	9.6	15.6
Burundi	1987	2.3	11.5	0.5	0.8	4.9	9.7	19.4
Mali	1987	2.0	4.8	0.1	0.7	3.9	12.2	17.0
Niger	1992	4.6	10.9	0.7	3.3	10.0	13.5	15.2
Nigeria	1990	5.2	9.9	2.1	1.8	6.4	7.5	14.3
Kenya ^a	1993	24.7	32.2	23.3	17.0	23.1	24.4	42.1
Ghana	1993	9.3	12.5	7.3	3.8	9.8	11.8	20.7
Togo	1988	3.4	6.2	1.9	1.8	4.4	8.3	14.8
Zambia ^a	1992	6.7	10.9	3.0	2.7	4.8	11.4	28.2
Zimbabwe ^a	1988	27.2	33.6	24.0	23.5	27.8	23.3	33.0
Senegal	1992-93	4.5	9.0	1.3	2.2	8.4	13.6	18.8
Cameroon	1991	5.4	7.8	2.3	1.7	4.6	7.3	13.0
Botswana ^a	1988	31.8	38.1	25.0	18.7	30.4	39.9	54.3

Note: Unfortunately, these differentials are only produced in the DHS country reports for ever-married women. Thus these differentials in contraceptive prevalence rates have been calculated from the data used for analysis and are not weighted to compensate for oversampling. Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2).

a. Primary schooling is one to seven years, and the next highest level is eight to ten years for these countries.

Source: Authors' calculations based on DHS data.

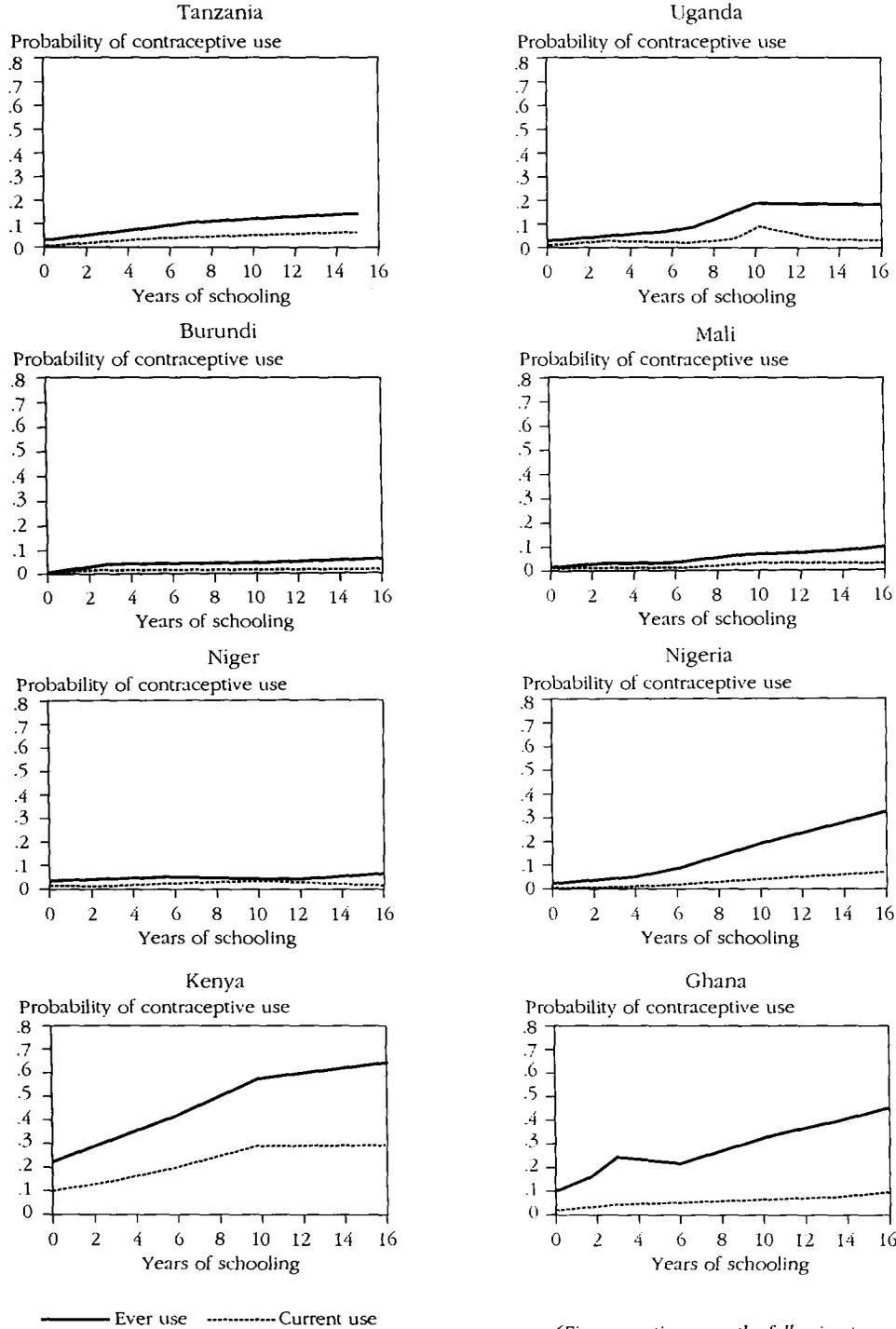
than rural and less-educated women (Castro Martin 1995; Jejeeboy 1992; National Research Council 1993).

Figure 4 shows the predicted relation between years of women's schooling and contraceptive use in the sample of all women, using a spline specification and holding the value of all other variables in the regressions at their means. These predictions are based on the results of logit regressions of current or ever use of contraception on the same set of independent regressors as in the fertility work: age; age squared; urban residence; female schooling; dummy variables for ownership of a bicycle, a radio, or a television; dummy variable for the quality of flooring; religion; region; and ethnic group. In order to maintain cross-country comparability, controls for the availability of family planning are not included here. Availability of family planning was collected in four of the DHS data sets (Kenya, Nigeria, Tanzania, and Zimbabwe) and has been analyzed by Beegle (1995) for Tanzania, Feyisetan and Ainsworth (1994) for Nigeria, and Thomas and Maluccio (1995) for Zimbabwe. Using Living Standards Survey data, Oliver (1995) has analyzed the impact of the availability of family planning in Ghana.

In all countries an increase in female education is significantly associated with an increase in current contraceptive use.¹⁰ However, in many countries—

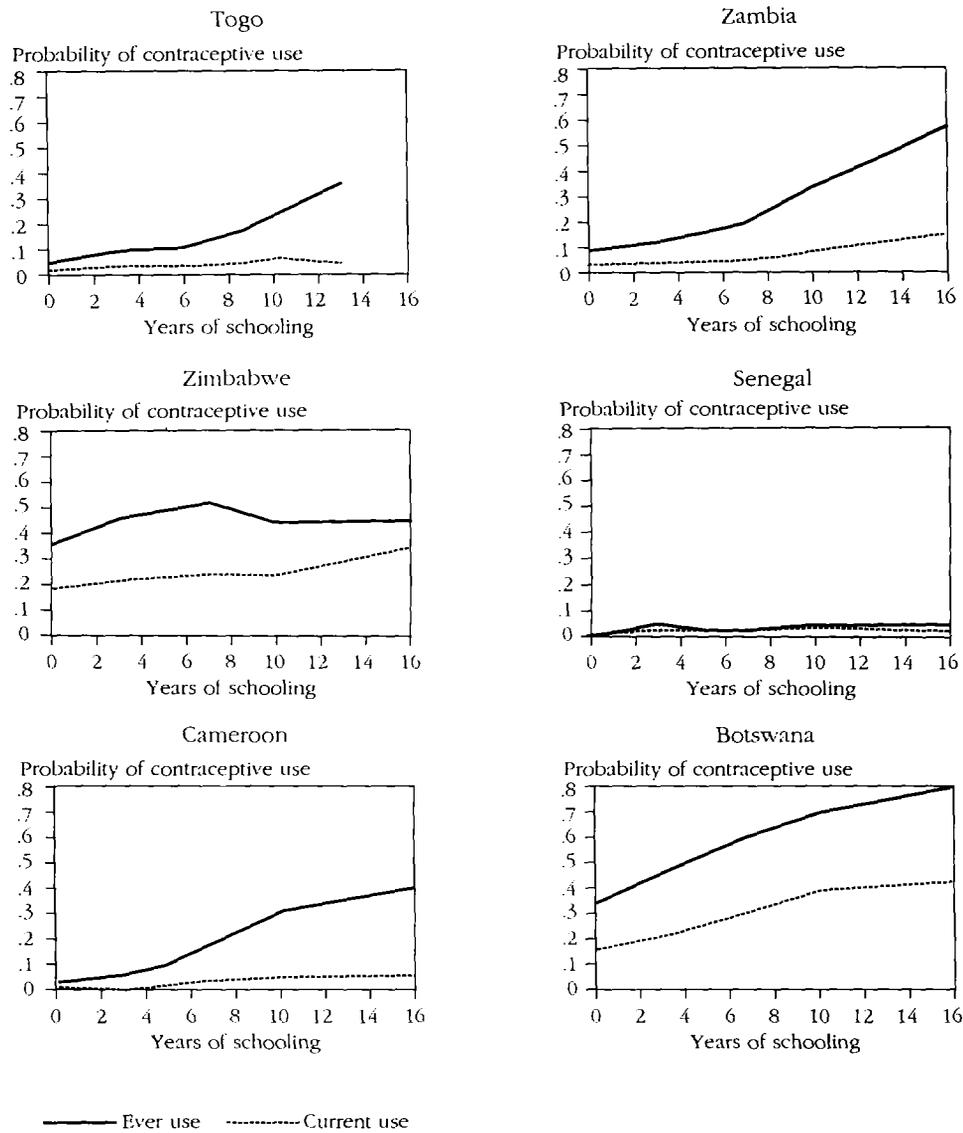
10. In Niger and Zimbabwe, the splines are jointly significant for current use at $p \leq 0.05$, even though none of the individual coefficients were significant. However, the splines in the ever-use regression were not significant for Niger.

Figure 4. Predicted Current Use and Ever Use of Modern Contraception by Female Schooling



(Figure continues on the following page.)

Figure 4. (continued)



Note: The predictions are based on logit regressions of current use and ever use of contraceptives, using a spline specification (0-3, 4-6, 7-10, and 11 or more years of schooling) and holding the values of all other variables in the regressions at their means. Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.

Source: Authors' calculations from DHS data.

most with very low levels of female schooling and limited availability of family planning—both current and ever use are low, even among women with high levels of schooling. The major increase in current contraceptive use in Burundi, Ghana, Niger, Senegal, and Tanzania occurs at the early years of female schooling, and there is very little increase in contraceptive use with additional schooling beyond primary. In fact, even in countries where higher levels of female schooling show positive gradients (Botswana, Cameroon, Kenya, and Zambia), the slope of the relationship at earlier years of schooling is steeper. Only in Zimbabwe does the relationship between female schooling and current contraceptive use seem to steepen with increased schooling levels. However, it is important to remember that there are very few women with high levels of schooling in the majority of these countries. Thus, this last segment of the spline may be very sensitive to outliers and responsible for seemingly weaker (or contrary) results for higher levels of schooling in some of the countries. The education-contraceptive use gradient is steeper for ever use of contraception as education rises, with the exception of Niger (where there is no significant relation for ever use) and Senegal and Zimbabwe (where the relationship is basically flat for all but the early levels of schooling). The relationship between female schooling and contraceptive use does not seem to have any relation to the level of GNP per capita. For example, Senegal and Zimbabwe have the same GNP per capita, but the relationship is quite different in the two countries. Within countries, ownership of assets was associated with higher contraceptive use, particularly in Kenya, Nigeria, Tanzania, Zambia, and Zimbabwe (Ainsworth, Beegle, and Nyamete 1995).

These results represent the relationship between female schooling and contraceptive use at the time of the surveys, holding all other factors constant. However, they do not represent an immutable relationship or law unique and unchanging for every country. As the average level and quality of female schooling and the returns to education rise in countries like Burundi, Mali, and Niger, if the experience of other countries is a guide, their curves will very likely shift upward. Likewise, the steepness and height of the relationship should also be related to the availability of contraception. In Zimbabwe, for example, the slope of the curve is fairly flat. It may be that the greater availability of contraception mutes differentials in contraceptive use by education in Zimbabwe relative to Kenya, which shows sharp curvature upward. Figures for Zimbabwe and Botswana thirty years ago would have looked quite different than they do now, following major investments in female schooling and better contraceptive services.

Urban and Rural Samples

The effect of schooling on contraceptive use is generally greater in urban than in rural areas (not shown). At the mean level of female schooling in the samples, an additional year of schooling is associated with 0.4 to 2.6 percentage points increase in current contraceptive use in urban areas and 0.1 to 1.8 percentage points increase in rural areas. In urban areas the early years of primary school-

ing are associated with higher contraceptive use only in Mali. However, in nine of the countries the later years of primary schooling have an impact; among those for which this is not the case are countries with relatively high average schooling levels—Cameroon, Ghana, Zambia, and Zimbabwe. The only country for which higher levels of schooling do not significantly affect contraceptive use in urban areas is Zimbabwe. Possibly the relatively wider availability of contraceptives in urban areas of that country mutes differentials in contraceptive use by female schooling. Contraceptive use is so low in rural areas that regressions could be run on rural data from only eight countries. The early years of primary schooling are more likely to be associated with increased contraceptive use in rural areas than in urban areas.

Women's Schooling Compared with Men's

Table 7 classifies countries according to the relative strength of the relationship between the woman's and husband's schooling and current contraceptive use, among the sample of ever-married women. In half the countries, only the woman's schooling is a statistically significant determinant of current contraceptive use. This group includes countries with both the highest and lowest average levels of female schooling, income, and availability of contraceptives (for example, Botswana and Zimbabwe, as well as Mali and Niger). In six countries, both the woman's and husband's schooling are significant. However, in all of these countries the coefficient on the woman's schooling is greater in absolute value than the husband's schooling coefficient.

What can explain the unusual grouping of seemingly different countries? The countries for which only female schooling is a statistically significant determinant of contraceptive use are those for which husbands and wives have roughly equal probabilities of having received instruction. In Mali and Niger, for example, from table 5, the percentage of wives and husbands without any schooling is high and roughly equal, while in Cameroon and Zimbabwe the percentage is lower but still similar between husbands and wives. In Botswana, fewer husbands than wives have any schooling. The most important exception is Uganda, which has a spread of 22 percentage points between wives and husbands in the percent with any schooling. In the countries where both husband's and wife's schooling are significant determinants of contraceptive use, the differential between the percentage of husbands and wives with any schooling is generally greater. An important exception is Burundi, where the differential between the percentage of husbands and wives with no schooling is great, but neither is significant. Another important exception is Senegal, where there is basically no difference between the percentage of husbands and wives with no schooling, but both the wife's and husband's schooling coefficients are significant.

The observation that women and their husbands have similar schooling levels in countries where only the woman's schooling is a significant determinant of contraceptive use would be consistent with a bargaining power explanation. That is, when husbands and wives have both been schooled or

Table 7. *Classification of Countries According to the Marginal Effects of a One-Year Increase in Female and Male Schooling on Current Use of Contraception and Female-Male Schooling Differentials*

Woman's schooling	Husband's schooling			
	Significant		Not significant	
Significant	Kenya	[10.2]	Botswana	[-7.5]
	Nigeria	[9.2]	Cameroon	[5.1]
	Senegal	[1.0]	Ghana	[9.7]
	Tanzania	[14.8]	Mali	[-1.3]
	Togo	[18.3]	Niger	[-1.6]
	Zambia	[10.1]	Uganda	[22.1]
			Zimbabwe	[3.9]
Not significant			Burundi	[19.6]

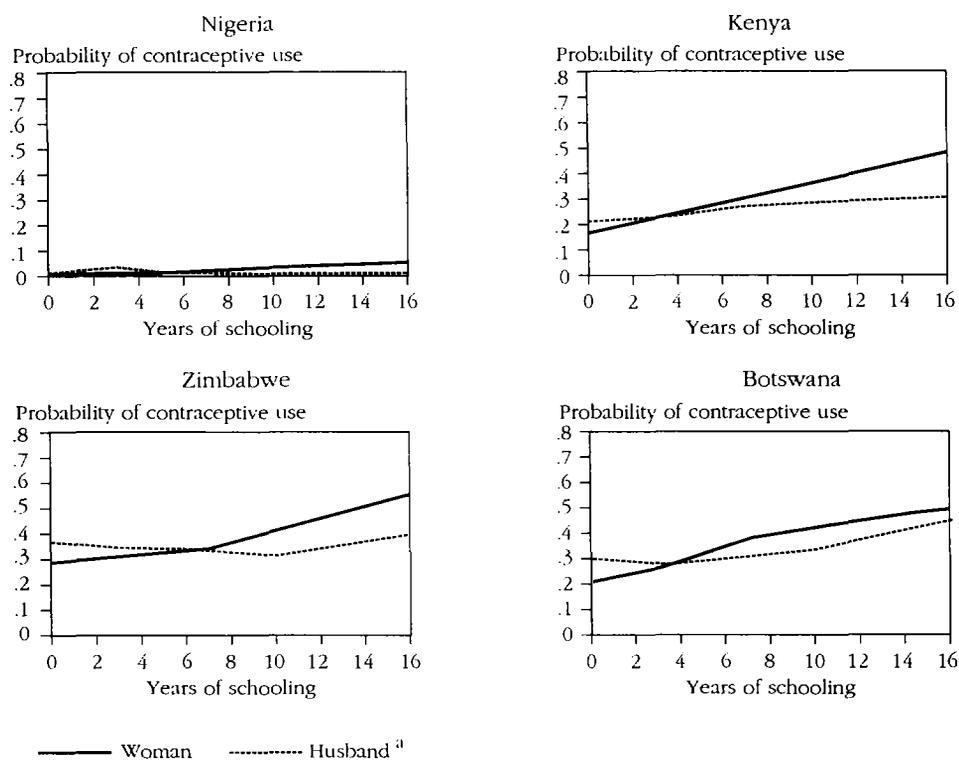
Note: Countries are classified on the basis of marginal effects of woman's and husband's schooling from a logit regression on the current use of contraception, using a linear specification of schooling. The samples include only women who have ever been married. Values in brackets are the difference in the percent of ever-married women and men with no schooling.

Source: Authors' calculations based on DHS data.

only the wife has schooling, then only the wife's schooling makes a difference for contraceptive use; when the husband is more likely to be schooled than the wife, both the husband's and the woman's schooling matters. However, in the latter instances, it is still the wife's schooling that has a larger impact on contraceptive use. This hypothesis and others deserve additional research at the micro level. However, it would not explain as well the differences in the impact of the husband's compared with the woman's education on fertility, presented earlier. Botswana, Ghana, and Zimbabwe all have a very high proportion of female-headed households (45 percent in Botswana, 37 percent in Ghana, and 33 percent in Zimbabwe), which might explain why husband's schooling is not significant (Ayad and others 1994; Ghana Statistical Service 1994). However, this is also true in Kenya (33 percent of households are female-headed), where husband's schooling still affects contraceptive use (Kenya Central Bureau of Statistics 1994).

The results for four countries are graphed in figure 5. The results for the countries not shown generally resemble those for Nigeria. In some countries the relative importance of female compared with male schooling in determining contraceptive use among ever-married women switches according to the level of schooling. The husband's schooling has a larger predicted impact at low levels of male and female schooling, but the wife's schooling has a stronger relation at higher levels of schooling. In Kenya this crossing point seems to be at about three years of schooling, but in Botswana and Zimbabwe it seems to be at about five years and six years, respectively, although husband's schooling is not statistically significant in the latter two countries. At higher levels of female schooling in Kenya and Zimbabwe, the slope of the relationship becomes quite steep for female schooling, but is flat for the husband's.

Figure 5. *Predicted Relation between Current Use of Contraception and Woman's and Husband's Schooling, Sample of Ever-married Women*



Note: The graphs show predicted contraceptive use for the sample of ever-married women in four countries, presented in order of 1991 GNP per capita, from lowest to highest (see table 2). Results for other countries generally resemble those for Nigeria.

a. Husband's schooling is not statistically significant in Botswana or Zimbabwe.

Source: Authors' calculations from DHS data.

VI. CONCLUSIONS

In this article we have analyzed the relations between female schooling and fertility and between female schooling and use of modern contraception in fourteen Sub-Saharan African countries where Demographic and Health Surveys have been conducted. Total fertility rates are high in these countries—ranging from a low of 5.0 in Botswana to as much as 7.4 in Niger. Modern contraceptive use is below 10 percent in all but Botswana, Kenya, and Zimbabwe. Despite rising female enrollments in many countries, the level of completed schooling among women of reproductive age is extremely low. In six of the countries, half or more of all women have never been to school. Average schooling is highest in Zimbabwe (six years); in four countries the average is less than two years.

We find strong support for the negative correlation between female schooling and cumulative fertility in virtually all of the countries, in both urban and rural areas. However, the relationship is nonlinear. The first three years of primary schooling have no relation with fertility in twelve of the fourteen countries. Children are unlikely to become literate in the first three years, and given the state of schooling systems on the continent, it is unlikely that a single year or two of schooling would be enough to radically transform a child's world outlook. Thus, we interpret the two instances of a significant positive effect of early primary schooling on fertility as evidence of some type of selectivity operating among those who dropped out with only a year or two of schooling, rather than as a schooling effect. The last years of primary schooling have a negative relation with fertility in about half of the countries and no relation in the remainder. Secondary schooling is universally associated with lower fertility, even in countries with less-vigorous family planning programs.

Jejeeboy (1992:3), reviewing the evidence on education and fertility primarily from the World Fertility Survey, characterized the evidence for "a uniformly inverse relationship" in the poorest countries as "shaky": "a little education appears to lead to higher fertility and we are likely to observe a curvilinear or reversed U-shaped relationship." In fact, she points to an inverted-U shape in ten of twelve African countries, implying that at low levels of schooling fertility rises. In this article, we use different and more recent data sets, control for many more factors simultaneously (including wealth), and use microanalysis of actual fertility (as opposed to the TFR). We find very limited evidence of a positive relation between female schooling and fertility in these countries, and at such low levels of schooling that we question the line of causation.

The most intriguing difference among the results for women's schooling and fertility is that for half of the countries upper primary schooling has a negative relation with fertility, and it has no effect in others. Could this reflect differences in the quality of instruction (with a time lag), differences in the labor markets that affect the returns to upper primary schooling, or perhaps differences in the availability of family planning? Unfortunately, exogenous measures of these explanatory variables are not among those available in the individual data sets. Internationally comparable data at the national level are hard to come by and are of varying quality. In additional country-level regressions (with a sample size of fourteen), the infant mortality rate, GNP per capita, percentage of female-headed households, and various representations of the distribution or average levels of female schooling were not statistically significant predictors of those countries in which four to six years of primary schooling has a negative relation with fertility. Additional research to explain these differences would be very useful to schooling and population policies.

Female schooling has also been found to greatly raise the likelihood of contraceptive use, even among women with primary schooling only. However, as with fertility, the relation is nonlinear. While women with higher levels of schooling are increasingly more likely to use contraceptives, an important finding is

that often the marginal relation between an additional year of female schooling and contraceptive use is greatest at the primary schooling level. Again, understanding why this is observed in some countries and not others, and the relation of these results to the availability of contraception, could lead to new policy insights.

Another important difference to be explained across countries is the relative impact of male and female schooling on fertility and contraceptive use, among the sample of ever-married women. Husband's schooling has no significant relation with fertility in about one-third of the countries. In countries where both women's and men's schooling matter, women's schooling exerts a much larger negative effect on fertility than does men's schooling. The analysis also confirmed that female schooling effects are lower when the samples are restricted to ever-married women. This means that studies that are based on married women understate the effects of schooling on fertility and contraceptive use. Husband's schooling is associated with higher contraceptive use in only half of the fourteen countries. In cases where men's schooling is statistically significant, it generally exerts a smaller influence than female schooling. These results are additional evidence of the importance of investing in female education to lower fertility and raise contraceptive use. However, attempts to explain why only female schooling matters in some countries but both male and female schooling matter in others were not successful, either for fertility or contraceptive use.¹¹

This study used multivariate analysis of cross-sectional data to examine marginal relationships—such as the relation in the cross-section of altering schooling by a small amount. However, the levels of female schooling in these countries are so low that more than just marginal increases in female schooling will be necessary. The multivariate regression results do not help us to infer the likely impact of large changes in female schooling—such as ensuring that the 40 percent of women with no schooling complete seven years of primary education. Further, other factors held constant in these regressions—like income—might also change as a result of large increases in schooling. The experience of Botswana, Kenya, and Zimbabwe—where major investments in schooling and family planning have been made in the past decade—may be better indicators of the likely effect of similar policies in other countries. These investments will improve the quality of life for women and children and enhance their future contribution to development, in addition to lowering fertility.

11. Regressors included GNP per capita, the infant mortality rate, the difference between the percentage of males and females with no education, the percentage of female-headed households, and various measures of the level and distribution of female schooling. Unfortunately, there are no good measures of exogenous availability of family planning services across countries that do not somehow incorporate actual levels of contraceptive use.

Table A-1. *Notes on the Sampling and Coverage of Data Sets from the Demographic and Health Surveys for Fourteen Sub-Saharan African Countries*

<i>Country</i>	<i>Description of oversampling and weighting</i>	<i>Coverage</i>
Botswana	Oversampling of urban areas by a factor of two. Self-weighted sample within urban and rural areas.	National
Burundi	Oversampling of urban areas by a factor of five. Self-weighted within urban and rural areas.	National
Cameroon	Yaoundé/Douala oversampled by a factor of two. Other urban areas are also oversampled. Self-weighted sample within each urban and rural stratum.	National
Ghana	No oversampling. Self-weighted.	National
Kenya	Oversampled rural areas in fifteen districts.	Excludes North Eastern province and four northern districts accounting for less than 4 percent of the national population.
Mali	Oversampled urban areas. Self-weighted within urban and rural strata.	100 percent coverage of urban areas; 90 to 95 percent coverage of rural areas. Nomadic rural population of Timbuktu and Gao excluded.
Niger	Oversampled Niamey by a factor of four and other urban areas by a factor of three, relative to rural areas.	All departments except pastoral areas of northern desert (zone of Arlit in the Agadez department, arrondissement of Bilma). Excluded population is less than 1 percent of national population.
Nigeria	Oversampled urban areas by a factor of two. Self-weighted sample within urban and rural strata.	National
Senegal	No oversampling. Self-weighted.	National
Tanzania	Stratified by urban or rural area and by region; different weights apply to each region and urban or rural areas.	National (Mainland and Zanzibar)
Togo	No oversampling. Self-weighted.	National
Uganda	Urban areas oversampled by a factor of three. Self-weighted within urban areas. South West Region and Luwero Triangle in Central Region oversampled in rural areas.	Excludes nine of thirty-four districts, with 20 percent of the national population.
Zambia	Oversampling of Luapula, North-Western, and Western provinces.	National
Zimbabwe	No oversampling. Self-weighted.	National

Source: DHS country reports.

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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.

Kofi Benefo is with the Department of Sociology at Brown University, and T. Paul Schultz is with the Department of Economics at Yale University. This article was written as background for the research project on "The Economic and Policy Determinants of Fertility in Sub-Saharan Africa," financed by the World Bank Research Committee (RPO 67691) and sponsored by the Africa Technical Department and the Policy Research Department of the World Bank. The authors acknowledge helpful comments by the participants at a World Bank workshop; comments by Ann Judd, Mark Montgomery, Raylynn Oliver, and the anonymous referees; and the encouragement and comments by Martha Ainsworth.

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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);

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

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 informa-

tion 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:

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

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 in-

strumental 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 pur-

poses 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.

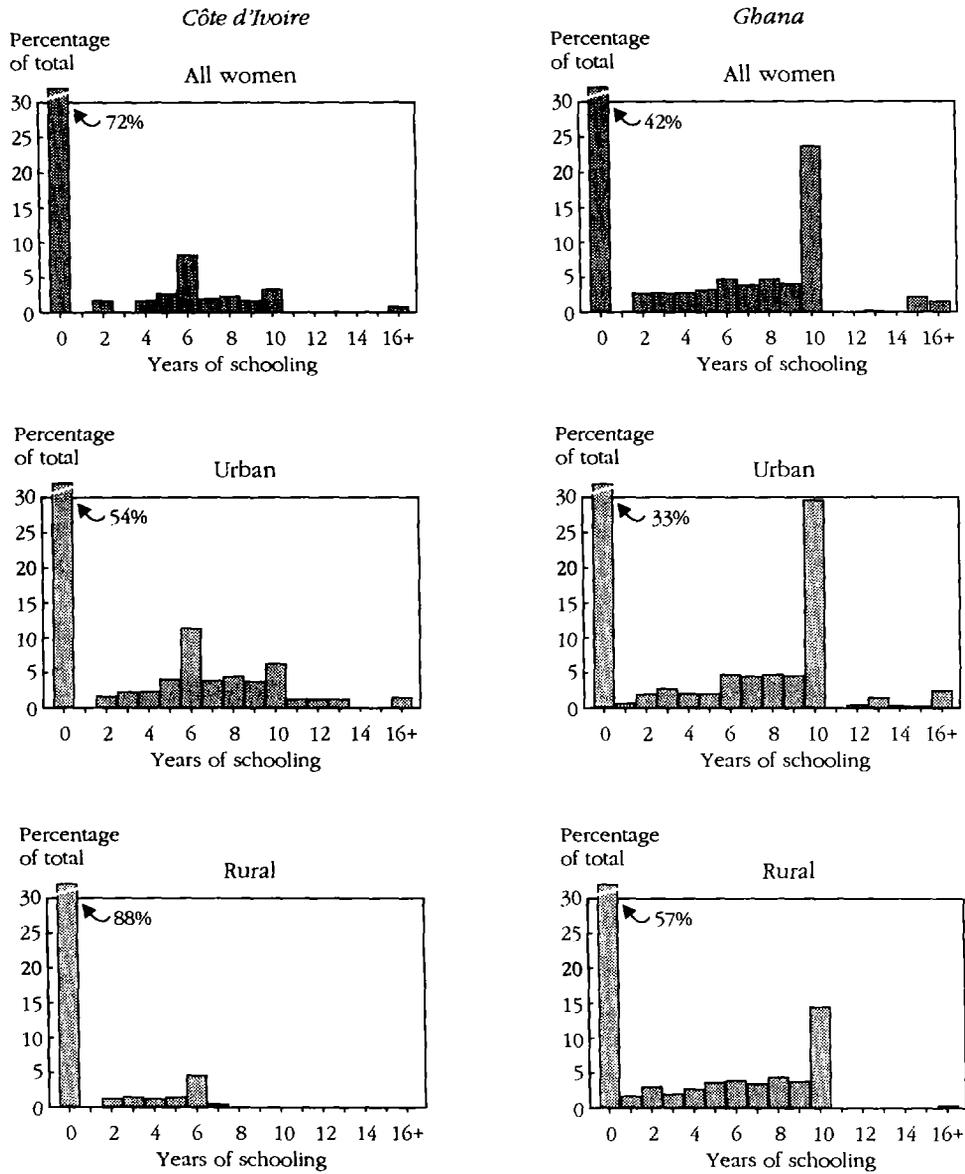
Major differences in the timing and extent of social development of the two countries are reflected in their educational systems. In Côte d'Ivoire, the colonial and postcolonial governments kept close control over schools. This resulted in a schooling system modeled quite closely after that in metropolitan 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 GISS 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

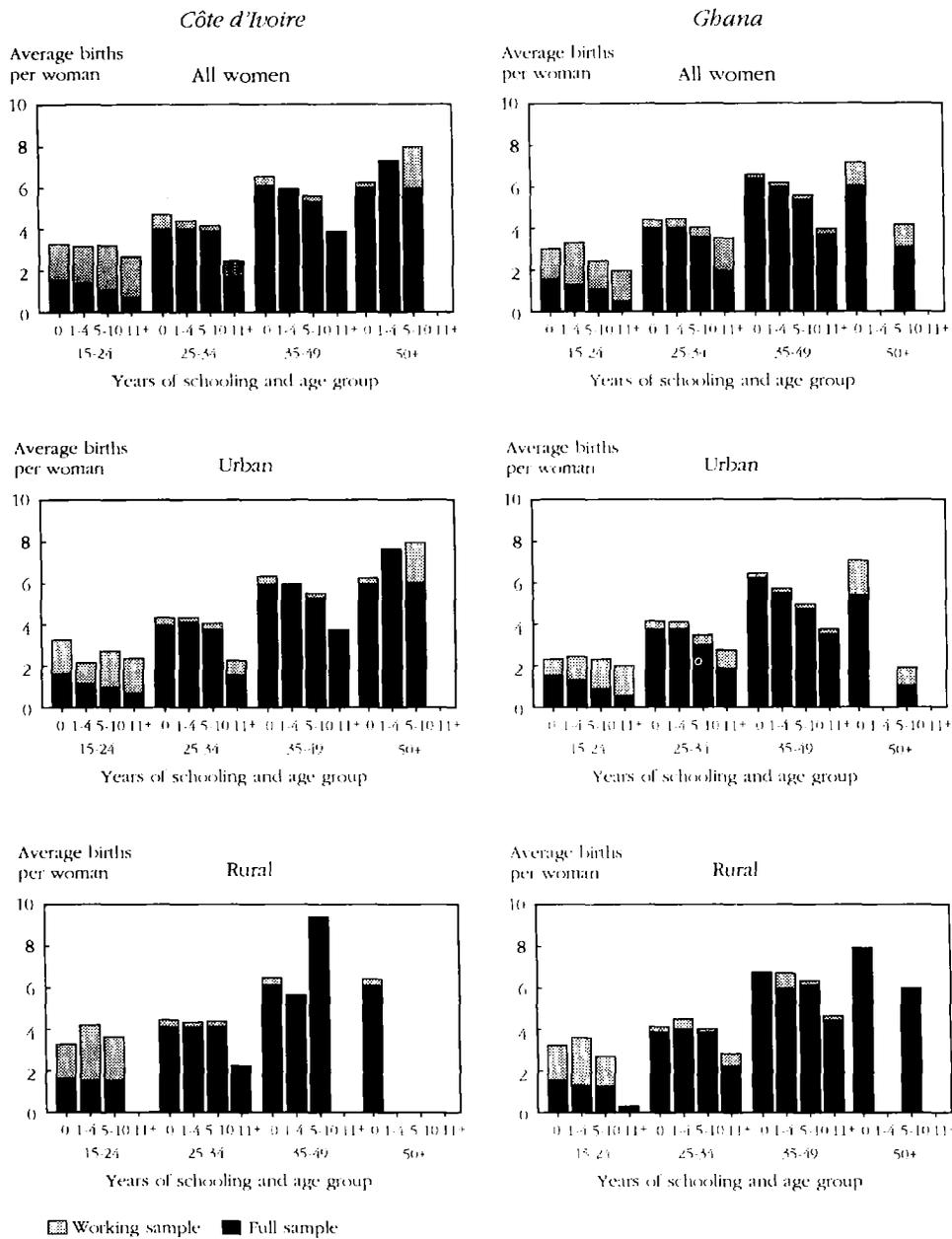


Table 1. *Fertility and Child Mortality, by Women's Schooling and Region, Côte d'Ivoire, 1985-87, and Ghana, 1987-89*

Country and indicator	Women's schooling (years)				All women
	None	1-4	5-10	11 or more	
<i>Ghana</i>					
<i>Fertility rate^a</i>					
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
<i>Child mortality rate^b</i>					
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
<i>Côte d'Ivoire</i>					
<i>Fertility rate^a</i>					
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
<i>Child mortality rate^b</i>					
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		Ghana	
	Regression 1	Regression 2	Regression 1	Regression 2
<i>Individual variables</i>				
Woman's schooling (years)				
Primary (1–6)	–0.0035 (1.01)	–0.0022 (0.62)	–0.0015 (0.47)	–0.0014 (0.42)
Middle (1–4)	–0.0006 (0.07)	–0.0000 (0.00)	–0.0092 (1.80)	–0.0089 (1.73)
Secondary and higher education (1–3 or more)	–0.0109 (1.18)	–0.0115 (1.21)	–0.0053 (1.24)	0.0058 (1.34)
Woman's height (ln meters)	–0.111 (0.78)	–0.101 (0.70)	–0.330 (2.43)	–0.352 (2.58)
Household assets (local currency) ^a	0.0182 (0.62)	0.0190 (0.64)	–0.0227 (1.46)	–0.0239 (1.54)
Woman's age ^b				
25–29	0.0001 (0.01)	0.0008 (0.04)	0.0038 (0.18)	0.0088 (0.40)
30–34	0.0108 (0.51)	0.0109 (0.49)	0.0080 (0.38)	0.0143 (0.62)
35–39	0.0192 (0.86)	0.0183 (0.75)	–0.0103 (0.46)	–0.0021 (0.08)
40–49	0.0280 (1.36)	0.0273 (1.17)	–0.0166 (0.76)	–0.0119 (0.48)
50 or more	0.0671 (3.24)	0.0656 (2.73)	–0.0258 (0.69)	–0.0243 (0.62)
<i>Household composition and husband characteristics^c</i>				
No husband present (dummy)		0.0114 (0.10)		0.154 (1.17)
Woman head of household (dummy)		0.0013 (0.06)		–0.0233 (1.07)
Husband's schooling (years)				
Primary (1–6)		0.000 (0.02)		–0.0013 (0.26)
Middle (1–4)		–0.0095 (1.30)		–0.0021 (0.29)
Secondary and higher education (1–3 or more)		0.0029 (0.41)		–0.0025 (0.75)
Husband's height (ln meters)		0.0937 (0.62)		0.418 (2.47)
Husband's age (years)		–0.0014 (0.40)		0.0037 (0.95)
Husband's age squared (x10 ⁻²)		0.0014 (0.45)		0.0043 (1.05)
<i>Woman's current residence (dummy variables)^{d,e}</i>				
Other urban/urban coast	0.024 (1.00)	0.024 (1.01)	0.064 (2.51)	0.061 (2.39)
East forest/rural coast	0.043 (1.47)	0.043 (1.42)	0.058 (1.66)	0.052 (1.50)

(Table continues on the following page.)

Table 2. (continued)

Variable	Côte d'Ivoire		Ghana	
	Regression 1	Regression 2	Regression 1	Regression 2
West forest/urban forest	0.092 (2.60)	0.091 (2.53)	0.030 (0.90)	0.026 (0.77)
Savannah/rural forest	0.027 (0.79)	0.026 (0.77)	0.073 (2.00)	0.070 (1.92)
n.a./urban savannah			0.059 (1.62)	0.070 (1.92)
n.a./rural savannah			0.062 (1.58)	0.052 (1.41)
<i>Woman's ethnicity or language (dummy variables)^{d,i}</i>				
Other/Ewe	0.018 (0.97)	0.0116 (0.61)	-0.070 (4.24)	-0.072 (4.33)
Krou/Ga-Adangbe	-0.049 (2.23)	-0.050 (2.22)	-0.079 (3.45)	-0.084 (3.61)
Mande-North/Dagbani	-0.013 (0.60)	-0.017 (0.78)	0.022 (0.63)	0.015 (0.43)
Mande-South/Hausa	0.017 (0.84)	0.016 (0.79)	-0.032 (0.82)	-0.038 (0.97)
Voltaic/Nzema	-0.024 (0.99)	-0.028 (1.16)	-0.000 (0.01)	0.002 (0.03)
Other language			-0.022 (1.21)	-0.027 (1.45)
<i>Woman's religion (dummy variables)^k</i>				
Muslim			-0.0033 (0.11)	-0.0048 (0.16)
Christian			-0.0596 (2.45)	-0.0567 (2.32)
Traditional and other			0.0032 (0.12)	0.0003 (0.01)
<i>Community variables</i>				
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)
<i>One of the two most serious community health problems (dummy variables)</i>				
Malaria	0.042 (2.20)	0.042 (2.17)	-0.0083 (0.46)	-0.0079 (0.44)
Diarrhea	0.021 (1.26)	0.021 (1.27)	0.0336 (2.00)	0.0333 (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)

Variable	Côte d'Ivoire		Ghana	
	Regression 1	Regression 2	Regression 1	Regression 2
Child immunization campaign in last five years (dummy)			-0.0084 (0.45)	-0.0077 (0.40)
Public health expenditures per person in the province (x10 ³ , 1988 cedis)			-0.361 (0.48)	-0.303 (0.40)
Rainfall (centimeters per year) ^h	-0.0006 (1.27)	-0.0005 (1.18)	-0.0011 (1.40)	-0.0010 (1.29)
Share of tree crops ⁱ	-0.0208 (0.84)	-0.0232 (0.93)	-0.0623 (2.04)	-0.0635 (2.08)
Prices in the community ^{d,i}				
Manioc/cassava	0.0224 (0.15)	0.0240 (0.16)	0.0030 (2.29)	0.0029 (2.20)
Bananas/maize	-0.0599 (0.41)	-0.0641 (0.43)	0.0023 (2.98)	0.0023 (2.97)
Fish/fish	-0.0756 (2.11)	-0.0744 (2.07)	-0.0000 (0.54)	-0.0000 (0.64)
Beef/eggs	-0.118 (1.85)	-0.120 (1.87)	-0.0074 (3.52)	-0.0075 (3.56)
Palm oil/antibiotics	-0.0330 (1.82)	-0.0321 (1.77)	0.0214 (1.88)	0.0218 (1.92)
Peanut butter/sugar	-0.0723 (1.82)	-0.0706 (1.77)	0.0012 (3.52)	0.0011 (3.46)
Round 2 (dummy)	0.004 (0.21)	0.0004 (0.02)	-0.001 (0.11)	-0.001 (0.08)
Round 3 (dummy)	-0.017 (0.78)	-0.021 (0.96)		
Intercept	0.396 (3.64)	0.379 (2.56)	0.135 (0.94)	0.0119 (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			Ghana		
	Regression 1	Regression 2	Regression 3	Regression 1	Regression 2	Regression 3
<i>Individual variables</i>						
<i>Woman's schooling (years)</i>						
Primary (1–6)	0.0133 (0.35)	0.0131 (0.34)	0.0364 (0.91)	-0.021 (0.85)	-0.024 (0.95)	-0.011 (0.45)
Middle (1–4)	-0.164 (1.84)	-0.164 (1.83)	-0.125 (1.35)	-0.169 (4.31)	-0.185 (4.51)	-0.169 (4.13)
Secondary and higher education (1–3 or more)	-0.231 (2.30)	-0.232 (2.25)	-0.218 (2.09)	-0.133 (4.06)	-0.122 (3.66)	-0.106 (3.16)
Woman's height (ln meters)	3.40 (2.20)	3.39 (2.16)	2.66 (1.72)	-0.064 (0.06)	-0.532 (0.48)	-0.552 (0.51)
Child mortality rate ^a	1.07 (4.30)	1.01 (0.51)	1.31 (0.68)	0.480 (2.95)	-1.10 (0.93)	-1.14 (0.98)
Household assets (local currency) ^b	0.538 (1.68)	0.539 (1.67)	0.393 (1.24)	-0.0473 (0.40)	-0.0797 (0.65)	-0.106 (0.88)
<i>Woman's age^c</i>						
25–29	0.902 (4.03)	0.903 (4.01)	0.692 (3.11)	0.878 (5.32)	0.886 (5.36)	0.749 (4.51)
30–34	1.91 (8.30)	1.92 (8.21)	1.51 (6.36)	1.97 (12.0)	1.99 (12.0)	1.71 (9.84)
35–39	3.21 (13.2)	3.21 (12.9)	2.75 (10.5)	2.85 (16.3)	2.83 (16.1)	2.47 (13.0)
40–49	3.59 (16.0)	3.59 (15.3)	3.06 (11.9)	4.33 (26.0)	4.31 (25.6)	3.99 (21.2)
50 or more	3.41 (15.1)	3.41 (13.0)	3.27 (11.3)	4.32 (15.1)	4.28 (14.8)	4.08 (13.7)
<i>Household composition and husband characteristics^d</i>						
No husband present (dummy)			1.16 (0.95)			2.15 (2.18)
Woman head of household (dummy)			-0.066 (0.27)			0.050 (0.30)
<i>Husband's schooling (years)</i>						
Primary (1–6)			0.082 (2.28)			0.017 (0.45)
Middle (1–4)			-0.030 (0.39)			-0.071 (1.31)
Secondary and higher education (1–3 or more)			-0.036 (0.49)			-0.001 (0.02)
Husband's height (ln meters)			-4.49 (2.80)			-1.16 (0.91)
Husband's age (years)			0.174 (4.84)			0.146 (4.88)
Husband's age squared ($\times 10^{-2}$)			-0.158 (4.68)			-0.138 (4.46)

(Table continues on the following page.)

Table 3. (continued)

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

Table 3. (continued)

Variable	Côte d'Ivoire			Ghana		
	Regression 1	Regression 2	Regression 3	Regression 1	Regression 2	Regression 3
Round 3 (dummy)	-0.49 (0.21)	-0.049 (0.21)	-0.085 (0.38)			
Intercept	1.64 (1.74)	1.65 (1.61)	0.0060 (0.00)	2.04 (3.61)	2.66 (3.63)	0.220 (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*

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

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

creases 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

Variable	Côte d'Ivoire		Ghana	
	Mean	Standard deviation	Mean	Standard deviation
<i>Dependent variables</i>				
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
<i>Explanatory variables at individual household level</i>				
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	
<i>Household composition and husband characteristics^d</i>				
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		Ghana	
	Mean	Standard deviation	Mean	Standard deviation
<i>Other variables averaged for sample cluster</i>				
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
<i>Prices in the community^{f,g}</i>				
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
<i>Woman's religion (dummy variables)</i>				
Muslim	—		0.135	
Christian	—		0.633	
Traditional religions	—		0.179	
<i>Woman's ethnicity or language (dummy variables)</i>				
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		Ghana	
	Mean	Standard deviation	Mean	Standard deviation
Mande-North	0.090		n.a.	
Mande-South	0.137		n.a.	
Voltaic	0.097		n.a.	
Alien	0.135		n.a.	
<i>Woman's current residence (dummy variables)^{a, b}</i>				
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.

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Contraceptive Use and the Quality, Price, and Availability of Family Planning in Nigeria

Bamikale J. Feyisetan and Martha Ainsworth

Nigeria has experienced high fertility and rapid population growth for at least the past thirty years. Only recently have public authorities launched efforts to promote contraceptive use. In this article, individual women are linked to the characteristics of the nearest health facility, pharmacy, and source of family planning to assess the relative importance of women's socioeconomic background and the characteristics of nearby services on contraceptive use. The results suggest that the limited levels of female schooling (and probably other factors affecting women's opportunity cost of time) are constraining contraceptive use, especially in rural areas. Another major constraint to increased contraceptive use is the low availability of family planning services in Nigeria. Broader availability of the pill and other methods in pharmacies and of injectables and intrauterine devices (IUDs) in health facilities is likely to raise contraceptive use. Outpatient or consultation fees at nearby health facilities do not appear to be constraining demand for modern contraceptive methods.

With a total population of nearly 100 million inhabitants, Nigeria is home to about one in every five Sub-Saharan Africans (World Bank 1992). Although there are indications of a fertility decline in southwest Nigeria (Caldwell, Orubuloye, and Caldwell 1992), the country as a whole has experienced high fertility and rapid population growth for at least the past thirty years. Only relatively recently have public authorities become interested in affecting these trends and promoted contraceptive use. Among those involved in the delivery of family planning services, there is a broadly held conviction that improved availability of contraceptives and higher quality of services will result in greater contraceptive use. At the same time, even the most recent surveys indicate that Nigerians often prefer large families. In the 1990 Nigeria Demographic and Health Survey (NDHS), for example, the mean desired family size among the 40

Bamikale J. Feyisetan is with the Department of Demography and Social Statistics at Obafemi Awolowo University, Ile-Ife, Nigeria; Martha Ainsworth is with the Policy Research Department at the World Bank. This article was written as background for the research project on "The Economic and Policy Determinants of Fertility in Sub-Saharan Africa," financed by the World Bank Research Committee (RPO 67691) and sponsored by the Africa Technical Department and the Policy Research Department of the World Bank. The authors gratefully acknowledge the late Esther Boohene, Trevor Croft of the Demographic and Health Surveys, and Kathleen Beegle and Susmita Ghosh. The authors appreciate comments from John Caldwell, Susan Cochrane, J. A. Ebigbola, Andrew Foster, Elizabeth Frankenberg, S. K. Kwafu, Samson Lamle, Paulina Makinwa-Adebusoye, Lewis Ndhlovu, David Radel, Fred Sai, and Baba Traoré.

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percent of women who gave numerical answers was 5.8 children (Federal Office of Statistics and IRD/Macro International 1992). About 60 percent of the respondents replied that their family size was “up to God,” indicating that they have no preferences, they are reluctant to state their preferences, or they would like as many children as possible.

The success of efforts to lower fertility and promote greater contraceptive use will depend on an understanding of the importance of factors affecting the demand for children and the demand for contraception—including individual characteristics and the availability, price, and quality of services. Public policy potentially can influence outcomes through all of these channels. However, up to now, an assessment of the impact of the availability, price, and quality of services on the demand for contraception in Nigeria has been hampered by the unavailability of adequate data. Demographic surveys have concentrated on the collection of data on household and individual characteristics that are hypothesized to influence fertility or family planning decisions. Community data, where collected, are often not linked with individual data because they are usually collected by different agencies or researchers for different purposes. The Service Availability Module attached to the 1990 NDHS has now made such an analysis possible.

In this article, we link individual women with the characteristics of the nearest pharmacy, health facility, and source of family planning to assess the relative importance of socioeconomic background and service characteristics on contraceptive use in Nigeria. Section I presents background information on Nigeria’s fertility trends, population policy, and economy. Section II describes the model that motivates the choice of variables in the empirical analysis. Section III describes the women and facilities in our sample. Empirical results for contraceptive use are presented in section IV. Section V summarizes salient findings and offers tentative conclusions.

I. BACKGROUND

Nigeria has been characterized by high, yet stable, birth rates. The 1965/66 National Rural Demographic Sample Survey gave a crude birth rate of 50 per 1,000 persons and an average completed family size of 5.6 children (Federal Office of Statistics 1968). United Nations’ estimates put the total fertility rate (TFR) at close to 7 and the crude birth rate at 50 between 1960 and 1980, and did not indicate significant fertility declines over that period (United Nations 1985).¹ More recently, the 1981/82 Nigeria Fertility Survey (NFS) found a TFR for Nigeria of 5.94 in 1980–82 and the 1990 NDHS put the TFR at 6.01 in the period 1988–90 (National Population Bureau (Nigeria) and World Fertility Survey 1984; Federal Office of Statistics and IRD/Macro International 1992).

1. These are estimates from the “medium variant” projection. Other scattered surveys, which vary in scope and content, also indicate average completed family size of between five and six and crude birth rates around fifty (for more details, see Arowolo 1984).

Regional variations in fertility, especially between the southern and northern regions, have become more pronounced since 1980. The NFS found total fertility to be highest in the northwest (6.38) and southwest (6.25), lower in the northeast (5.95), and lowest in the southeast (5.72). By 1988–90, the TFRs in the southeast and southwest (5.46 and 5.57, respectively) were both lower by about one child than those in the northeast and northwest (6.53 and 6.64, respectively). There is evidence, therefore, of significant decline in fertility in southwestern Nigeria in the 1980s. As Caldwell, Orubuloye, and Caldwell (1992) point out, this decline is important on a continental scale because the southwestern region of Nigeria is more populous than all but three Sub-Saharan countries. Note also that the difference between the lowest and highest TFRs has increased from 0.66 to 1.18 during the 1980s. Fertility differentials were also found by levels of education, place of residence (urban or rural), marital status, employment status, and use of contraception, among others. With respect to education, the NDHS found that total fertility was lower among women who had completed secondary schooling (4.2) than among those who had completed primary schooling (5.6) or those with no schooling (6.5). Women with incomplete primary schooling had the highest total fertility (7.2).

The relatively stable high birth rates in Nigeria have been accompanied by steady declines in death rates. The crude death rate was estimated to decline from 25 in 1960 to 17 in 1983; during the same period, the infant mortality rate declined from 195 to 115 and the under-five mortality rate from about 325 to 190 per 1,000 live births (UNICEF 1985). The 1990 NDHS estimated an even lower infant mortality rate of 91; the highest rate was in the northwest (110), while infant mortality in the other three regions ranged from 83 to 88 (Federal Office of Statistics and IRD/Macro International 1992). The balance between the stable high birth rates and the steadily declining death rates (in the absence of a major contribution by net migration) has led to an annual population growth rate in excess of 3 percent.

Economy

Before the 1970s, Nigeria depended mainly on agriculture for its domestic and foreign earnings. Five major cash crops were exported—cocoa, rubber, cotton, groundnuts, and palm products. However, oil was discovered in the late 1960s and went into large-scale production in the early 1970s. It became the major revenue earner and contributed immensely to the growth of Nigeria's economy during the early 1970s, as the country benefited from the high price of oil in the world market. This brought about a rapid increase in the number of educational institutions and health facilities and in the provision of roads, electricity, and piped water. In addition, wages increased in the nonagricultural sector.

By the early 1980s, dwindling oil revenues provoked a downturn in the economy (National Research Council 1993). Living standards worsened, as goods became unaffordable. The quality of health and education services deteriorated

and essential facilities became scarce. Primary enrollment rates peaked at 98 percent in 1980 and declined thereafter to only 72 percent in 1990 (Scribner 1995). The situation eventually led to the adoption of a structural adjustment program in 1986. By that time it had become very apparent that unchecked rapid population growth is undesirable, no matter the level of economic growth. With the assistance of several international agencies, the federal government set in motion a course of action to slow down the rate of population growth.

Population Policy

During the oil boom of the 1970s, rapid population growth was not perceived as an obstacle to economic growth. The Third National Population Policy reads: "Although Nigeria has (by world standards) a large and rapidly growing population, these demographic factors do not appear as yet to constitute a significant or serious obstacle to economic progress. The country is fortunate in possessing a large land area endowed with natural resources, which if carefully exploited should provide a basis for building a viable economy which would ensure a steadily rising standard of living for the population within the foreseeable future especially during the current phase of the country's demographic transition which is characterized by rapid growth . . ." (Federal Republic of Nigeria 1975: 293–94). There was, however, a plan to continue with the integration of the family planning information and services into an overall health and social welfare system for the country through the National Population Council of Nigeria.

As living standards worsened in the 1980s, official population policy changed. The period 1983–89 marked the beginning of a government-sponsored, national family planning program. The 1988 National Policy for Development, Unity, Progress and Self-Reliance acknowledged that the *laissez-faire* approach to population issues was not effective in lowering population growth and had adverse consequences on the welfare of the citizens and the socioeconomic development of the country. The new policy adopted specific demographic objectives and advocated extending coverage of family planning services to half of all women of childbearing age by 1995, and to 80 percent by 2000 (Federal Republic of Nigeria 1988).

Since 1983, organized family planning services have received great encouragement from two related developments. First, the recognition of family planning as part of the state public health system led to the establishment, in 1987, of a family planning coordinator in each state. Second, a major effort by the Federal Ministry of Health with the technical and financial assistance of the United States Agency for International Development (USAID), the World Bank, and the United Nations Population Fund (UNFPA) resulted in the distribution of contraceptives such as pills, injectables, IUDs, vaginal foaming tablets, and condoms to health facilities. Hospitals, health clinics, maternity centers or maternity homes, family planning clinics, pharmacies, and patent medicine stores became involved in the distribution of these commodities. In addition to the organized stationary delivery points, the Planned Parenthood Federation of

Nigeria has, in recent years, recruited individuals to distribute nonclinical contraceptives in rural communities.

By 1990, 7.5 percent of all women of reproductive age were current users of contraception and use of modern methods was only 3.8 percent. Modern methods include sterilization, IUD, injectables, pills, condoms, spermicides, and diaphragm. The rate of use of any contraceptive among married women (6 percent) was only half that of unmarried women (13 percent) (Federal Office of Statistics and IRD/Macro International 1992). The probability of use of modern contraception rose with female education, from only 1.3 percent of women with no schooling, to 3.9 and 6.4 percent of women with incomplete and complete primary schooling, respectively, to 16.7 percent of women who have completed secondary schooling. Caldwell, Orubuloye, and Caldwell (1992) point out that contraceptive use has particularly expanded among younger single women: the NDHS results found that 38 percent of use was among single women, and in their 1990 study of urban women in Ekiti (Ondo State), contraceptive use rates were three to five times higher among unmarried than among married women aged fifteen to twenty-four. The other main demand for modern contraceptives comes from married women who want to replace traditional methods of birth spacing.

II. THE MODEL

The demand for family planning is conditional on the demand for children. The “demand for children” broadly includes decisions on the number of children desired and the timing of births.² Economic models of fertility highlight several key factors affecting the demand for children (Becker 1960, 1981; Rosenzweig and Schultz 1985):

- The value of women’s time, because childrearing is intensive in the use of women’s time.
- The price of other child inputs, such as food, clothing, schooling, and health care.
- The value of children’s time in home production now and as an economic asset in the future.
- Household income.

These are in addition to more subjective factors, often referred to as inherent “tastes” for children. The implication of these models is that as the costs of children rise, holding other factors constant, the number of children desired will decline. Alternatively, as the economic benefits of children rise, holding costs constant, fertility can be expected to rise. The effect of household (nonlabor) income is ambiguous, because higher income means that couples can afford more children or can decide to invest more per child for any given number.

2. For a more formal exposition of the model, see annex 1 of Feyisetan and Ainsworth (1994).

The demand for family planning services arises from their role as an input into producing and achieving a desired number of children. Therefore, family planning demand will depend on the price and quality of services, conditioned on the target number of children. The cost of family planning services includes the cost of the contraceptives, the cost of transport to the facility providing family planning services, the value of the time it takes to reach the facility, and the registration (or outpatient) fee. The quality of services can be proxied by such variables as the number and composition of staff, the number and types of services available, and the regularity of supplies of contraceptives. Other ways of preventing births—such as periodic abstinence, rhythm, and withdrawal—rely to an even greater extent than modern methods on behavior modification, and thus also entail costs to the user. The costs of different methods will determine users' choices. When the cost of modern methods rises, we expect a shift from modern to traditional methods or, if traditional methods are also too costly to practice, to no contraception and possibly a higher family size.

The empirical model estimated in this article expresses the use of modern contraception as a function of factors affecting both the demand for children and the costs of fertility regulation:

$$(1) \quad FP = FP(P_{fp}, Q, w, P_c, I)$$

where FP is use of modern contraception, P_{fp} is the price of family planning services, Q is the quality of services, w is the opportunity cost of women's time, P_c is the price of other child inputs, and I is household nonlabor income.

In the empirical work, we have employed variables that proxy the arguments in equation 1. We expect variables that measure the value of women's time, such as education, urban residence, and region of residence, to lead to lower demand for children and higher contraceptive use. Variables that reflect the price of family planning, such as the distance to a family planning source, the price of commodities, and registration, consultation, or outpatient fees, should lower the use of contraception. We expect that indicators of the quality of family planning services will raise contraceptive use. Examples of variables that might be perceived as reflecting quality include the type of family planning source (pharmacy, hospital, health clinic or maternity center, and health center), the number and composition of staff at the family planning source, the types of family planning services available, and the number and types of family planning methods available. We have no a priori expectations about the relation between contraceptive use and nonlabor income because it depends largely on the relation between income and the demand for children. If, as incomes rise, women want more children, then we would expect a negative relation between income and the use of contraception. In economic terms, this is the case if children are "normal" goods. By contrast if, as incomes rise, women want fewer children (perhaps of higher "quality"), then we would expect contraceptive use to rise with rising income.

The left-hand side of equation 1 is measured by current use of a modern contraceptive. The dependent variable is dichotomous, taking a value of one or zero depending on whether the woman possesses the attribute under consideration. Estimating the coefficients of equation 1 using ordinary least squares (OLS) will produce biased estimates. Thus, maximum likelihood logit has been used to estimate the parameters of the equation.

In order to interpret results of the relation between service characteristics and contraceptive use as an "impact" of services, we must assume that these services are randomly placed. However, if individuals selectively migrate to areas in response to program characteristics or if the placement of services is based on the characteristics of the population, then program placement would not be exogenous and the estimates of the effect of program characteristics may be biased (Pitt, Rosenzweig, and Gibbons 1993; Rosenzweig and Wolpin 1988). For example, if public family planning services are selectively placed in areas with high fertility and low contraceptive use, one might observe a negative correlation between the availability and use of family planning. On the other hand, if services are targeted to women in areas of high demand for contraception, then estimates of the positive relation between availability and contraceptive use may be overstated. Unfortunately, with only a single cross-section of data to work with, we are unable to correct for the potential endogeneity of service placement. Family planning services are not widely available in Nigeria, however, so we suspect that services have not been targeted to areas with low demand.

III. DATA AND VARIABLE DEFINITIONS

This study uses data from the 1990 NDHS. Data were collected from 8,781 women on their socioeconomic characteristics, fertility histories, and use of contraception, among others. (The sample design is described in detail in Federal Office of Statistics and IRD/Macro International 1992.) In addition, information on family planning services was collected from two sources: groups of four or five knowledgeable informants in the selected community, and staff at facilities visited by the interviewers. Informants for the community questionnaire were asked to identify the hospital, maternity clinic, health center, family planning clinic, and pharmacy nearest to each cluster of households interviewed for the NDHS. All named facilities (one of each type per cluster) were then visited for the service module if they were within six hours on foot from the cluster. At each facility, information was collected about the availability and costs of drugs and family planning methods, the types and number of health personnel, registration or outpatient fees, and the types of maternal and child health services that were available. By linking the exogenous facility data to the individual data, we were afforded an opportunity to examine the impact of the availability, price, and quality of certain services on women's demand for modern contraception.

The facility data have some limitations. First, the service availability survey was conducted in only 185 of the 299 survey clusters, of which almost

all (165) were in rural areas. The criteria for including 20 urban clusters in the service survey were not documented, but roughly 10 to 15 percent of urban women from each of the four regions could be linked to the service survey. Because two-thirds of the women using contraceptives were living in clusters not surveyed by the facility module, we were not able to include them in our assessment of the impact of the quality of services on the demand for contraception. Second, the identification of health facilities and the estimation of distances were left entirely in the hands of the community informants. In situations where people want more from the government, there is the possibility of underestimating the number of health facilities in a locality. Respondents may also have identified facilities more distant than the nearest ones. Many clusters of women could not be linked to facilities because the respondents could not name a facility, not because one was not available. Third, even when a facility was named by community respondents, it was not always interviewed. As a result, although 8,781 women were successfully interviewed, only 5,714 were located in clusters covered by the community-facility survey and, of these, only 4,681 (81.9 percent) could be linked to the nearest health facility. Our main sample for analysis is the 4,589 women who could be linked to the nearest health facility and for whom all explanatory variables at the individual and health-facility level were present.

Characteristics of the Women

Of the 4,589 women in the working sample, 32 percent reside in the northeast, 23 percent in the northwest, 29 percent in the southeast, and 16 percent in the southwest. Eighty-nine percent reside in rural areas. The average age of the women is 28.6 years; for ever-married women, the average age is 30.4 years. Approximately 84 percent have been married. Over half of the women (56 percent) are Muslim, 26 percent are Protestant, and 13 percent are Catholic. The average number of children ever born is 3.48. Approximately 23 percent of the women have no children, and 34 percent have 5 or more.

The level of literacy of these mostly rural women is generally low. Only 38 percent have ever attended school, and the average woman in the sample has completed only 2.6 years of schooling. Among those who have ever attended school, the average years of schooling is 7. Among women who have husbands or partners, the male partners have on average 1 year more of schooling than the women (2.7 compared with 1.7 years). Slightly more than a third of the male partners had some schooling (35 percent) compared with only about a quarter of the women who had ever been married (28 percent).

With respect to contraceptive use, 5.6 percent of the women in the working sample were currently using a traditional or modern method of contraception, and 2.9 percent were currently using a modern method. Of those currently using a modern method, 39 percent were using the pill, 22 percent IUD, and 14 percent injection (see table 1). The main sources of contraceptives were hospitals (41 percent) and pharmacies (25 percent).

Table 1. *Distribution of the Sample of Women Using Modern Contraception by Method and Source*

<i>Method and source</i>	<i>Percent</i>
<i>Method</i>	
Pill	38.9
IUD	22.3
Injection	13.7
Condom	11.5
Sterilization	9.4
Spermicide, diaphragm	4.3
Total	100.0
<i>Source</i>	
Hospital	41.0
Pharmacy or patent medicine store	25.2
Health center, maternity center, or health clinic	13.7
Private clinic	7.2
Planned Parenthood clinic	2.9
Friends or relatives	2.9
Market	1.4
Private doctor	1.4
Husband's place of work	0.7
Unknown	3.6
Total	100.0

Note: The sample size is 139 women. Totals may not add to 100 because of rounding.
Source: 1990 NDHS data.

Health Facilities

Community data were collected from 185 clusters of households (165 rural and 20 urban). The nearest of four types of stationary health facilities are identified on the community questionnaire: hospital; health clinic, maternity center, or family planning clinic (including the few family planning clinics that were identified, this group is henceforth referred to as health clinic); health center; and pharmacy (see table 2). At least one type of health facility was identified in 184 clusters: all four different types were identified in 32 clusters, three types in 71 clusters, two types in 64 clusters, and one type in 17 clusters. The number of clusters identifying a facility is highest for the pharmacy (144), followed by the hospital (134), the health clinic (108), and the health center (102). The community informants reported that 52 percent of all the named facilities provide family planning services. The percentage providing family planning services varies among the different types of health facilities: hospital (81 percent), health clinic (55 percent), health center (45 percent), and pharmacy (28 percent). However, comparison of these responses with what was reported by the health facilities reveals that the community informants were often incorrect. Thus, in the analysis below we use measures of family planning availability collected directly from the facilities.

The mean distance from the cluster to the nearest health facility varies by type of health facility and by availability of family planning services in the health

Table 2. *Distance and Time from Communities to the Nearest Health Facilities*

Community-level variable	Facility			
	Hospital	Health clinic maternity center, or family planning clinic	Health center	Pharmacy
<i>Nearest facility</i>				
Number of communities that named a facility	134	108	102	144
Percentage of all 185 clusters	72.4	58.4	55.1	77.8
Mean distance to the nearest facility (miles)	15.5	6.7	8.0	4.9
Mean travel time by the most common means of transport (minutes)	92.8	68.4	89.9	67.2
<i>Nearest facility with family planning</i>				
Number of facilities named with family planning	109	59	46	40
Percentage of all named facilities	81.3	54.6	45.1	27.8
Mean distance to the nearest named facility (miles)	14.9	7.6	7.6	5.4
Mean travel time by the most common means of transport (minutes)	92.8	87.9	84.7	235.2

Note: The community data are from 185 clusters of households.

Source: 1990 NDIHS Service Availability Survey, community informants.

facility. The mean distance is highest for the hospital (16 miles) and lowest for the pharmacy (5 miles). Hospitals and health centers with family planning services are slightly closer to the community than those without family planning, and health clinics and pharmacies with family planning clinics are slightly farther from the communities than those without family planning services. The average time it takes to reach the nearest facility by the commonest means of transportation is generally greater than one hour. It takes roughly an hour and a half to reach hospitals and health centers. This is not surprising because most of the sample is in rural areas.

To be eligible for an interview, a facility had to be within six hours' walking distance from the community. A health facility of each type was visited if it met the eligibility requirement. Ninety-three hospitals, 91 health clinics, 88 health centers, and 127 pharmacies were thus visited (see table 3). In 165 clusters (approximately 90 percent of the 185 clusters with community modules) at least 1 health facility was visited. Ninety-three percent of hospitals, 58 percent of health clinics, 61 percent of health centers, and 32 percent of pharmacies that were visited had family planning services. The private sector controls between 3 percent (health centers) and 40 percent (health clinics) of the facilities. The hospitals have been in existence for a longer period than the other types of facilities, and although higher proportions of hospitals charge a registration or outpatient fee, the fees are highest in the health clinics.

Variations in the quantity and quality of medical personnel and inpatient services across types of health facilities reflect the level of complexity of the tasks each type of facility performs. Hospitals generally perform the most complex tasks, followed by health clinics. Although almost all of the hospitals have

Table 3. *Description of the Nearest Health Facilities*

Facility-level variable	Facility			
	Hospital	Health clinic maternity center, or family planning clinic	Health center	Pharmacy
Number of facilities visited	93	91	88	127
<i>Ownership (percent)</i>				
Public	75.3	58.7	94.3	—
Private	18.3	40.2	3.4	—
Other	6.5	1.1	2.3	—
Mean years in operation	22.8	13.3	12.0	5.7
<i>Prices</i>				
Percentage of facilities that charge an outpatient fee	87.1	82.4	70.5	—
Mean registration fee (naira) among facilities that charge ^a	2.55	4.00	1.71	—
<i>Medical staff</i>				
Percent with at least one doctor	95.7	52.2	27.3	—
Mean number of doctors	11.6	1.1	0.5	—
Mean number of nurses	40.6	3.3	3.4	—
Mean number of midwives	27.0	3.3	3.7	—
<i>Infrastructure</i>				
Mean number of beds	147.8	9.5	11.2	—
Equipment (percent of facilities)				
Examination table	96.8	79.4	65.9	—
Electricity	87.1	64.1	53.4	52.8
Refrigerator	92.5	44.0	53.4	26.0
Running water	85.0	53.3	52.3	38.6
<i>Services (percent of facilities)</i>				
Family planning	92.5	58.2	61.4	32.3
Postnatal care	95.7	89.0	72.7	—
Antenatal care	94.6	75.8	63.8	—
Delivery services	95.7	86.8	60.2	—
Antimalarial drugs	89.3	76.9	64.8	96.9
Antibiotics	76.3	51.7	47.7	60.6
Any vaccine	81.7	50.6	73.9	—

— Not available. This information was not included in the questionnaire for pharmacies.

a. The average 1990 market exchange rate was 12.8 naira per U.S. dollar.

Source: 1990 NDHS Service Availability Survey, facility respondents.

at least one doctor, only 52 percent of health clinics and 27 percent of health centers have one. On average, each hospital has about twelve doctors, health clinics one, and health centers zero. Similarly, the average number of nurses varies from three (health clinics and health centers) to forty-one (hospitals) and the number of midwives from three (health centers) to twenty-seven (hospitals) (table 3).

With respect to infrastructure, the results show that examination tables, electricity, running water, and refrigerators are more likely to be found in hospitals than in any other type of facility. The number of beds in each facility reflects the amount of inpatient service it provides. The hospitals have, on average, 148 beds; the average numbers for the health clinics and the health centers are about 10 and 11, respectively.

Information was also collected on the types of maternal and child health services that were available in each facility. Four types of services are identified here: antenatal, delivery, postnatal, and immunization. Hospitals are more likely to provide these services than any other type of facility. With respect to the supply of drugs, the pharmacies and the hospitals are the most likely to supply antimalarial drugs and antibiotics, respectively. It is not surprising that almost all the pharmacies had antimalarial drugs at the time of the survey. In Nigeria the patient (or the patient's relative) finds it more convenient to visit a pharmacy for antimalarial drugs than to visit a hospital; hospitals are usually consulted for complicated cases.

The Health Facilities with Family Planning Services

Table 4 describes health facilities that offer family planning services with respect to the family planning methods offered, the average price of such commodities, and the regularity of their supply. The number of facilities with at least one doctor or nurse capable of inserting the IUD exceeded the number with an IUD insertion kit at the time of the survey. This suggests that nonavailability of trained personnel is not the binding constraint for expanding availability of IUDs. The results also show that the likelihood of having sterilization performed is highest in the hospitals: 58 percent of hospitals with family planning services have at least one doctor trained in female sterilization. This figure contrasts with 32 percent for health clinics and 7 percent for health centers.

With respect to the availability of methods, the pill is the most available, followed by the condom; female sterilization is least available. No method was available in all the facilities at the time of the survey. While the probability of obtaining the pill is highest in the health clinics, the probability of obtaining an IUD, condoms, or spermicides is highest in the hospitals. The health center is the second-best place where all methods, except female sterilization, can be found. The price of obtaining a method is generally higher in the health clinics and pharmacies, which are preponderantly privately owned. Not all facilities that had a method at the time of the survey always had the method. For example, although 87 percent of hospitals with family planning services had the pill at the

Table 4. Description of the Nearest Health Facilities with Family Planning

Facility-level variable	Facility			
	Hospital	Health clinic, maternity center, or family planning clinic	Health center	Pharmacy
Number of facilities visited that offered family planning	86	53	54	41
<i>Family planning methods offered (percent of facilities)</i>				
Pills	87.2	94.3	92.6	68.3
Injection (e.g., Depo Provera)	64.0	7.7	68.5	31.7
IUD	86.1	64.2	68.5	—
Condom	86.1	73.6	85.2	82.9
Foaming tablets (spermicide)	68.6	50.9	63.0	41.5
Female sterilization	46.5	17.0	3.7	—
<i>Mean price of methods (naira)^a</i>				
Pill	1.25	2.94	0.77	6.25
Injection (e.g., Depo Provera)	6.66	11.41	3.12	13.19
IUD	5.13	27.94	4.06	—
Condom	0.75	1.59	0.53	1.85
Foaming tablets (spermicide)	2.68	4.02	5.84	6.91
Female sterilization	25.94	86.22	3.70	—
<i>Percent of facilities that ran out of stock within the six months preceding the survey</i>				
Pill	38.7	16.6	36.0	35.7
Injection (e.g., Depo Provera)	21.8	22.2	37.8	46.2
IUD	17.6	3.1	18.9	—
Condoms	16.2	16.2	23.9	23.5
Foaming tablets (spermicide)	11.9	16.0	11.8	11.8
Percent with someone trained to insert IUD	88.4	77.4	75.9	—
Percent with an IUD insertion kit in stock	86.1	75.5	57.4	—
Percent with a doctor trained to perform sterilizations	58.1	32.1	7.4	—

—Not available. This information was not included in the questionnaire for pharmacies.

a. The average 1990 market exchange rate was 12.8 naira per U.S. dollar. Mean prices include zeros.

Source: 1990 NDHS Service Availability Survey, facility respondents.

time of the survey, only 61 percent had the pill in stock during the six months preceding the survey.

Definitions of Variables

The dependent variable is current use of any modern method of contraception.³ The explanatory variables include characteristics of the women and char-

3. For results for determinants of ever use of contraception, see Feyisetan and Ainsworth (1994).

acteristics of the pharmacies, health facilities, and sources of family planning that are nearest to the women surveyed. The explanatory variables can be organized into three groups: the individual woman's characteristics, variables reflecting access to a health facility or the price of services, and those reflecting the quality of the nearest health facility.

The individual woman's characteristics include age, education, place of residence, and religion. The choice of individual variables is based on their theoretical as well as practical relevance. Women's education is also interacted with urban residence and region of the country to see in which areas education has a greater effect. In the absence of a direct measure of wealth, the type of floor in the dwelling is adopted as an index on the assumption that women who live in dwellings with polished wood, vinyl, ceramic, or cement floors are likely to have higher income than those in dwellings with animal dung or earth-sand floors.

Access or price variables include the distance to the nearest health facility, the availability of family planning services, and, conditional on the facility offering family planning, the availability and price of individual methods. The quality of the nearest health facility is measured by whether it is privately owned, whether the facility has at least one doctor, and the number of contraceptive methods offered.

IV. EMPIRICAL RESULTS

The determinants of contraceptive use are estimated as a function of three types of facilities—the nearest health facility, the nearest pharmacy, and the nearest health facility offering family planning. Results are presented in tables 5, 6, and 7. Descriptive statistics for the variables in the regressions are in appendix table A-1.

Logit estimation results for the determinants of current contraceptive use as a function of the characteristics of the nearest health facility or nearest facility with family planning are presented in table 5. The nearest facility is defined as the hospital, health clinic-maternity center, or health center that is closest to a community. The first three specifications are for the sample of 4,589 women who could be linked to the nearest health facility and for whom there were no missing values on independent variables. The first specification shows the results for individual characteristics and characteristics of the nearest health facility that reflect the quality, availability, and price of contraceptive methods. In the second specification, we add the characteristics of the nearest pharmacy. In the third specification, we replace the characteristics of the nearest health facility by the characteristics of the nearest source of family planning. The fourth specification is the same as the third, but includes the entire national sample of 8,761 women.⁴ Note, however, that although using the full sample adds obser-

4. The total sample was 8,781 women, but values on the independent variables were missing for 20 women.

vations to the variables measured at the individual level, the number of observations on service characteristics is unchanged from the third specification and still reflects only the primarily rural areas where this information was collected. Thus, the fourth specification is shown primarily for purposes of comparing the results on women's characteristics with the earlier specifications.

For ease of interpretation, the logit coefficients have been transformed into the marginal effects of a change in the explanatory variables on the probability of contraceptive use, evaluated at the mean of each variable and multiplied by 100. Thus, the coefficients can be interpreted as the increase (or decrease) in current contraceptive use (in percentage points) associated with a one-unit change in the variable, evaluated at its mean value.

Women's Characteristics

In the first three specifications (table 5), current contraceptive use increases with age but at a decreasing rate. This is expected: as women age, the longer is their potential exposure to pregnancy and their fertility will approach desired family size. However, they also become less fecund and thus are less likely to need contraception to limit births. The two measures of the opportunity cost of women's time—education and urban residence—exert great positive impact on contraceptive use. Education and urban residence increase the opportunity cost of women's time by enabling women to hold higher-paying jobs, making childrearing more costly. This leads to a decline in the demand for children and an increase in the demand for contraception. The negative marginal effect of the interaction between schooling and urban residence indicates that the positive relation between female education and contraceptive use is weaker in urban than in rural areas. For ease of interpretation of the relation between education and contraceptive use by region, table 6 combines the schooling coefficients interacted with regional and urban dummy variables using the first specification in table 5. The positive relation between female schooling and contraceptive use is greatest in the rural north and rural southwest.

Although the interaction between female schooling and the regions is jointly significant, the dummy variables for regions are not individually or jointly significant in the first specification of table 5. However, when characteristics of the nearest pharmacy and nearest source of family planning are included (as in the second and third specifications), they become weakly jointly significant and women in the northwest appear to have lower contraceptive use than in other regions. In the first three specifications (table 5), women in Protestant households are more likely to be current users of contraception.

Most of the sample in the first three specifications is from rural Nigeria, where the most distinguishing feature of wealth is the type of housing a family has. As such, women who reside in dwellings with polished wood, ceramic, or cement floors no doubt have access to higher income. The positive marginal effect on type of floor, therefore, indicates an increase in the demand for contraception as income rises. This result might seem to imply that income would

Table 5. *The Marginal Effect of the Characteristics of Women and the Nearest Health Facility, Pharmacy, or Family Planning Source on Contraceptive Use*

Explanatory variable	Specification			
	1	2	3	4
<i>Individual woman</i>				
Age (years)	0.277 (3.19)	0.231 (3.45)	0.242 (3.48)	0.509 (5.84)
Age squared	-0.003 (-2.21)	-0.003 (-2.41)	-0.003 (-2.46)	-0.006 (-4.42)
Urban residence ^a	1.252 (2.14)	1.276 (2.79)	1.421 (3.12)	2.298 (4.21)
Years of schooling	0.132 (3.17)	0.127 (4.00)	0.138 (4.27)	0.346 (5.47)
Interaction: urban x schooling	-0.094 (-1.81)	-0.093 (-2.40)	-0.118 (-2.72)	-0.133 (-2.03)
Northeast residence ^a	-0.196 (-0.41)	-0.120 (-0.36)	-0.352 (-1.06)	-0.971 (-1.44)
Northwest residence ^a	-0.780 (-1.38)	-0.743 (-1.61)	-0.999 (-2.23)	-2.213 (-2.82)
Southwest residence ^a	-0.177 (-0.32)	-0.117 (-0.23)	-0.330 (-0.74)	-0.721 (-1.20)
<i>Interaction variables</i>				
Northeast x schooling	0.104 (1.37)	0.060 (0.93)	0.060 (0.83)	0.019 (0.15)
Northwest x schooling	0.107 (1.61)	0.067 (1.33)	0.094 (1.83)	0.198 (2.20)
Southwest x schooling	0.088 (1.46)	0.072 (1.55)	0.083 (1.69)	0.034 (0.45)
Type of floor ^b	0.754 (2.19)	0.511 (1.95)	0.618 (2.37)	0.498 (2.04)
Protestant ^a	0.585 (2.12)	0.519 (2.45)	0.546 (2.41)	0.375 (1.29)
Muslim ^a	0.154 (0.39)	0.152 (0.51)	0.147 (0.48)	-0.105 (-0.30)
<i>Nearest health facility</i>				
Distance (miles)	-0.088 (-2.74)	-0.074 (-2.65)	-0.036 (-1.65)	-0.081 (-1.42)
Outpatient registration fee ^c	-0.038 (-1.17)	-0.017 (-0.62)	0.026 (0.84)	0.041 (0.54)
Family planning offered ^a	-1.132 (-1.73)	-1.212 (-2.62)		
Injection offered ^a	0.998 (2.29)	0.896 (3.10)	0.967 (3.69)	1.464 (2.68)
Injection price ^{c,d}	-0.027 (-0.56)	-0.049 (-1.92)	-0.063 (-3.38)	-0.072 (-1.91)
IUD offered ^a	0.830 (1.69)	0.414 (1.57)		
IUD price ^{c,d}	-1.41x10 ⁻⁴ (-0.01)	0.015 (1.84)		
Pill offered ^a	0.105 (0.17)	0.578 (1.63)	-0.408 (-1.04)	-1.057 (-1.17)

Table 5. (continued)

Explanatory variable	Specification			
	1	2	3	4
Pill price ^{c,d}	0.028 (0.47)	0.054 (0.97)	0.154 (3.24)	0.251 (2.45)
Condom offered ^a	0.045 (0.12)	-0.057 (-0.22)	0.422 (1.46)	0.794 (1.14)
Condom price ^{c,d}	0.065 (0.85)	0.102 (2.03)	0.140 (3.36)	0.247 (2.42)
At least one doctor ^a	-0.645 (-1.89)	-0.743 (-2.83)	-0.621 (-2.42)	-1.421 (-2.23)
Hospital ^a	0.694 (1.92)	0.910 (3.24)	0.575 (2.29)	1.767 (2.67)
Health clinic ^a	0.222 (0.62)	0.124 (0.45)	0.014 (0.04)	0.497 (0.70)
Privately owned facility ^a	0.639 (1.66)	0.516 (1.64)	0.233 (0.87)	0.168 (0.25)
Health facility with family planning linked to the cluster ^a			-0.130 (-0.58)	0.094 (0.17)
<i>Nearest pharmacy</i>				
Pharmacy interviewed ^a		-1.446 (-3.64)	-1.325 (-2.97)	-2.087 (-1.88)
Distance (miles)		0.011 (0.37)	-0.026 (-0.78)	-0.109 (-1.16)
Number of hours open per week		0.014 (3.62)	0.016 (3.61)	0.022 (1.88)
Family planning offered ^a		0.333 (0.66)	-0.184 (-0.46)	-0.314 (-0.30)
Number of family planning methods available		0.541 (1.68)	0.666 (2.81)	1.703 (3.12)
Injection offered ^a		-0.319 (-0.81)	-0.137 (-0.44)	-0.785 (-0.90)
Injection price ^{c,d}		-0.034 (-3.08)	-0.024 (-2.84)	-0.063 (-2.78)
Pill offered ^a		1.041 (1.86)	1.588 (2.83)	3.325 (2.51)
Pill price ^{c,d}		-0.254 (-2.05)	-0.321 (-5.09)	-0.698 (-3.66)
Condom offered ^a		-0.630 (-1.09)	-0.530 (-0.97)	-1.537 (-1.08)
Condom price ^{c,d}		-0.382 (-1.65)	-0.417 (-1.81)	-1.074 (-1.77)
Constant	-10.037 (-7.73)	-10.441 (-7.77)	-10.944 (-8.48)	-9.265 (-13.17)
Likelihood	-486.75	-472.56	-475.36	-1465.45
Pseudo R ²	0.1962	0.2196	0.2150	0.1821
Sample size	4,589	4,589	4,589	8,761

(Table continues on the following page.)

Table 5. (continued)

Explanatory variable	Specification			
	1	2	3	4
<i>Joint tests^c</i>				
Schooling: regions x schooling	35.94 [0.000]	41.54 [0.000]	54.43 [0.000]	73.34 [0.000]
Method availability (health facility)	15.50 [0.009]	16.94 [0.005]	16.44 [0.003]	8.03 [0.090]
Method availability (pharmacy)		29.53 [0.000]	38.55 [0.000]	19.06 [0.002]

Note: Values represent the marginal change in current contraceptive use (percent) for a one-unit change in the explanatory variable. *t*-statistics are in parentheses and are from the original logit regressions. Logit coefficients have been transformed into marginal changes using the formula $dp/dx_k = \beta_k \cdot \exp(x'\beta) / [1 + \exp(x'\beta)]^2$, and the result has been multiplied by 100. Standard errors have been estimated using Huber's technique, which is robust to heteroskedasticity and cluster effects.

a. Dummy variable: the value is 1 if the condition is true; 0 otherwise.

b. Dummy variable: the value is 1 if the floor is parquet, vinyl, ceramic, or cement; 0 otherwise.

c. Fees and prices are in naira. The average 1990 market exchange rate was 12.8 naira per U.S. dollar.

d. The variable is availability of the method (1 or 0) times the price.

e. The value reported is the χ^2 statistic for the joint test; *p*-values are in brackets.

Source: 1990 NDHS data.

exert a negative effect on fertility. However, this seems not to be the case in Nigeria (see Ainsworth, Beegle, and Nyamete 1995).

The results for individual variables in the fourth specification reveal that the relationship between contraceptive use and female schooling, area, and region of residence is stronger in the sample of all Nigerian women than in the sample of women for which the characteristics of health facilities were available. The marginal effect of an additional year of female schooling, for example, increases from roughly 0.13 in the first three specifications to 0.35 in the fourth (table 5). The relation with urban residence also increases dramatically from about 1.3 in the first three specifications to 2.3 in the fourth. These "stronger" results arise from the fact that the marginal effects are computed at the mean of the independent variable, and the mean levels of schooling and urban residence are higher for the sample of all Nigerian women. For example, the mean years of female schooling for the first three regressions is 2.6 years, while for all women it is 3.7 years. Eleven percent of the women in the first three regressions lived in urban areas, compared with 40 percent of those Nigeria-wide (see table A-1).

Nearest Health Facility and Nearest Facility with Family Planning

With respect to the characteristics of the nearest health facility, both the first and second specifications in table 5 show that greater distance is associated with a lower probability of contraceptive use, irrespective of whether family planning is actually offered at the facility. When in the third specification we consider the distance to the nearest health facility with family planning, the relation is also negative, but only half as strong and very weakly statistically significant.

Table 6. *The Marginal Effect of a One-Year Increase in Female Schooling on Current Contraceptive Use*

<i>Region</i>	<i>Urban</i>	<i>Rural</i>
Southeast	0.04	0.13
Southwest	0.13	0.22
Northeast	0.14	0.24
Northwest	0.15	0.24

Note: The data show the marginal change in current contraceptive use for a one-unit change in the explanatory variable. Logit coefficients have been transformed into marginal changes using the formula $dp/dx_k = \beta_k \cdot \exp(x'\beta)/(1 + \exp(x'\beta))^2$, and the result has been multiplied by 100.

Source: 1990 NDHS data.

In none of the specifications is current use of contraception related to the level of outpatient or registration fees.

Conditional on the availability of any method of family planning, women with access to injections and the IUD at the nearest health facility are more likely to be current users (the first specification).⁵ The coefficients on availability of other specific methods are not individually significant, but are jointly significant in determining current contraceptive use. The results for prices of specific methods are generally insignificant, but are sensitive to inclusion of the characteristics of the nearest pharmacy in the second and third specifications. In the latter case, strong positive price effects on contraceptive use appear for the IUD, pill, and condom, while the relation with injection prices is always negative (table 5).

Controlling for the other characteristics of health facilities, women for whom the nearest health facility or source of family planning is a hospital are more likely to be current users of contraception, compared with those for whom the nearest facility is a health clinic or dispensary. This may have to do with the quality of the services provided at a hospital, which we have been unable to completely control for, or may reflect some characteristic of women who live near hospitals. Women for whom the nearest health facility is private are also more likely to be using modern contraception, although whether or not the nearest facility with family planning is private is not related to contraceptive use. Curiously, the presence of a medical doctor at the nearest facility is associated with *lower* contraceptive use and almost exactly offsets the positive coefficient on hospital. A similar result has been found in Zimbabwe (see Thomas and Maluccio 1995). One plausible explanation is that most Nigerian doctors are men; women may prefer to receive contraceptive services from female providers. In other specifications, the distance to a primary school and the number of years that the facility had been operating were not significant determinants of current use.

5. When the availability of various individual methods and their prices are included in the regression, the coefficient on the availability of any family planning is negative (see table 5). However, this coefficient must be used in combination with those on specific methods. When only the availability of family planning is entered (without dummy variables for specific methods and their prices), the coefficient is positive, although of borderline significance (see Feyisetan and Ainsworth 1994, table 6A, specification 2).

Nearest Pharmacy

Because of the recency in the integration of family planning programs into the primary health care scheme, the pharmacy has, for a long time, been the major distributor of nonsurgical contraceptives in Nigeria. It is not uncommon in some areas to find pharmacies stocked with contraceptives that are lacking in the hospitals, especially in government-owned hospitals. But because pharmacies do not perform several of the functions of the three other health facilities (hospitals, health clinics, and health centers), we present the results for pharmacy characteristics in addition to whichever of the three other stationary facilities is closest to the community.

In the second and third specifications in table 5, we add to the regressions the characteristics of the nearest pharmacy. The nearest pharmacy was not interviewed for 27 percent of the women for whom the characteristics of the nearest health facility were obtained. A dummy variable for whether a pharmacy was interviewed has thus been introduced. The distance to the nearest health facility (and, marginally, the nearest source of family planning) remains a significant determinant of contraceptive use, but the distance to the pharmacy is not significant. However, the results for other characteristics of the nearest pharmacy are more highly and consistently significant than those for the nearest health facility or nearest facility with family planning. Increased hours of operation at the nearest pharmacy are associated with higher contraceptive use, as is the number of methods offered. Among specific methods, availability of the pill at the nearest pharmacy is associated with significantly higher contraceptive use, but the prices of injections, the pill, and condoms are associated with lower contraceptive use. Recall that only 3 percent of women overall were current users of a modern method. Only 22 percent of the women who could be linked to a pharmacy lived nearest to a pharmacy that supplies the pill. This suggests that increased availability of the pill at private pharmacies may have an important impact on raising contraceptive use in Nigeria.

In the fourth column of table 5 the full set of methods and quality characteristics is entered for the nearest family planning source and pharmacy for all women in the NDHS, irrespective of whether the women could be linked to these facilities. The major difference between the results of the third model and those of the fourth is that the levels of significance of some of the characteristics of the nearest family planning source and pharmacy decrease in the fourth model, while the size of the marginal effects increases. Note that the pseudo R^2 declines for the full sample of women as well; this is not surprising in light of the fact that 70 percent of them had no values for the characteristics of the nearest source of family planning and 56 percent had no pharmacy characteristics.

Regional Differences

A chi-squared test confirmed that there are structural differences in the determinants of contraceptive use by region. The sixth and seventh specifications in table 7

show the relationship between the characteristics of the nearest health facility and current use of contraception among women in the sample living in the north and south. Because the models were estimated separately for the two regions, the interactions between urban residence, women's education, and regions have been dropped. The results of the fifth specification, on the pooled women and without these regional and schooling interactions, are provided for comparison.

A strong relation between urban residence and contraceptive use is observed among northern women, but not among women in the south. The marginal effect of a one-year increase in women's schooling is also much larger in the north (.402) than in the south (.016). In the north, women's schooling has a positive relation with contraceptive use in both urban and rural areas, but in the south it shows a net positive relation in rural areas only. The proxy for income is insignificant among women in both regions, but it is significant for the entire sample in the fifth specification. Protestant women in the north are more likely to use modern contraception than women from other religious groups; both the significance of the coefficient and the size of the marginal effect of religion are smaller in the south.

There are important differences among northern and southern women with respect to the relation between characteristics of services and contraceptive use as well. Among northern women, the distance to the nearest health facility, the price of outpatient consultations, and the presence of a medical doctor are significantly associated with lower use of modern contraceptives. In addition, contraceptive use is higher among women for whom the nearest facility is a hospital. None of the variables measuring the availability or price of specific methods are statistically significant.

In contrast, among southern women contraceptive use does not significantly vary by distance, the presence of a doctor, or the type of facility, and higher outpatient fees are associated with *higher* contraceptive use. The results for distance and presence of a doctor reinforce the suspicion that the negative relation between doctor and contraceptive use may be caused by the gender of the doctors, because the majority of northern women are Muslim. The positive relation between outpatient fee and contraceptive use among southern women may be capturing some other aspect of service quality that could not be controlled for but that is associated with higher fees. Finally, the availability of the pill is very strongly correlated with higher contraceptive use among women in the south, and private ownership of the nearest health facility is associated with lower use. All of the contraceptive methods are jointly significant for the southern sample, but only at marginal levels for the northern sample. The independent variables explain a much higher proportion of the variation in contraceptive use among southern women than among northern women (the pseudo R^2 is 0.2718 and 0.1457 for southern and northern women, respectively).

Partner's Characteristics

In the first seven specifications, we have included all women in the regressions, regardless of their marital status. There are several reasons for this. First,

Table 7. *The Marginal Effect of the Characteristics of Women and the Nearest Health Services on Current Contraceptive Use, by Region and Marital Status*

<i>Explanatory variable</i>	<i>All women</i> 5	<i>Women in the north</i> 6	<i>Women in the south</i> 7	<i>Women who have a partner</i> 8
<i>Individual woman</i>				
Age (years)	0.281 (3.16)	1.013 (4.07)	-1.03x10 ⁻⁴ (-0.01)	0.281 (3.00)
Age squared	-0.003 (-2.18)	-0.013 (-3.38)	1.04x10 ⁻⁴ (2.46)	-0.003 (-2.07)
Urban residence ^a	1.057 (1.98)	2.853 (2.27)	0.033 (0.32)	0.503 (1.29)
Years of schooling	0.187 (5.43)	0.402 (5.45)	0.016 (2.24)	0.120 (3.01)
Interaction: urban x schooling	-0.075 (-1.66)	-0.119 (-1.00)	-0.016 (-2.66)	
Northeast residence ^a	0.278 (0.66)			0.355 (0.83)
Northwest residence ^a	-0.214 (-0.47)			-0.133 (-0.29)
Southwest residence ^a	0.380 (1.03)			0.376 (1.01)
Type of floor ^b	0.745 (2.10)	1.126 (1.23)	0.059 (1.30)	0.748 (2.03)
Protestant ^d	0.607 (2.18)	1.294 (1.82)	0.115 (1.56)	0.585 (2.06)
Muslim ^a	0.095 (0.24)	1.000 (0.90)	0.049 (0.61)	0.086 (0.22)
Partner or husband ^a				-0.707 (-1.58)
Partner's years of schooling				0.074 (2.32)
<i>Nearest health facility</i>				
Distance (miles)	-0.102 (-2.98)	-0.139 (-1.72)	-0.008 (-1.52)	-0.105 (-3.08)
Outpatient registration fee ^c	-0.036 (-1.01)	-0.237 (-2.30)	0.028 (3.08)	-0.043 (-1.18)
Family planning offered ^a	-1.178 (-1.74)	-2.550 (-1.07)	-1.169 (-11.95)	-1.058 (-1.55)
Injection offered ^a	0.968 (2.24)	1.095 (0.78)	0.063 (0.94)	0.830 (2.07)
Injection price ^{c,d}	-0.021 (-0.41)	0.017 (0.11)	0.015 (1.01)	-0.015 (-0.33)
IUD offered ^a	0.880 (1.74)	2.190 (1.48)	0.011 (0.13)	0.816 (1.69)
IUD price ^{c,d}	-8.22x10 ⁻⁴	-0.015	0.003	-0.004

<i>Explanatory variable</i>	<i>All women</i> 5	<i>Women in the north</i> 6	<i>Women in the south</i> 7	<i>Women who have a partner</i> 8
	(-0.04)	(-0.27)	(0.27)	(-0.20)
Pill offered ^a	0.238 (0.37)	0.717 (0.29)	1.239 (14.19)	0.302 (0.47)
Pill price ^{c,d}	0.015 (0.25)	0.141 (0.97)	-0.004 (-0.17)	0.008 (0.15)
Condom offered ^a	0.060 (0.16)	-0.197 (-0.19)	-0.116 (-1.64)	-0.007 (-0.02)
Condom price ^{c,d}	0.044 (0.58)	0.096 (0.44)	-0.018 (-0.83)	0.041 (0.58)
At least one doctor ^a	-0.697 (-1.97)	-2.107 (-2.04)	-0.047 (-0.61)	-0.676 (-1.97)
Hospital ^a	0.111 (1.85)	2.704 (2.19)	0.013 (0.17)	0.772 (2.05)
Health clinic ^a	0.241 (0.66)	1.361 (1.41)	-0.050 (-0.98)	0.249 (0.70)
Privately owned facility ^a	0.731 (1.88)	0.987 (1.02)	-0.407 (-1.78)	0.753 (1.93)
Constant	-10.304 (-7.99)	-11.839 (-7.57)	-7.747 (-3.57)	-9.726 (-7.23)
Likelihood	-488.58	-339.70	-134.28	-486.57
Pseudo R ²	0.1931	0.1457	0.2718	0.1965
Sample size	4,589	2,071	2,518	4,589
<i>Joint tests^e</i>				
Regions	2.63 [0.452]			2.59 [0.459]
Method availability (health facility)	16.63 [0.005]	9.26 [0.099]	269.87 [0.000]	13.53 [0.019]
Woman's schooling, partner, partner's schooling				41.40 [0.000]

Note: Values represent the marginal change in current contraceptive use (percent) for a one-unit change in the explanatory variable. *t*-statistics are in parentheses and are from the original logit regressions. Logit coefficients have been transformed into marginal changes using the formula $dp/dx_k = \beta_k \cdot \exp(x\beta) / [1 + \exp(x\beta)]^2$, and the result has been multiplied by 100. Standard errors have been estimated using Huber's technique, which is robust to heteroskedasticity and cluster effects.

a. Dummy variable: the value is 1 if the condition is true; 0 otherwise.

b. Dummy variable: the value is 1 if the floor is parquet, vinyl, ceramic, or cement; 0 otherwise.

c. Fees and prices are in naira. The average 1990 market exchange rate was 12.8 naira per U.S. dollar.

d. The variable is availability of the method (1 or 0) times the price.

e. The value reported is the χ^2 statistic for the joint test; *p*-values are in brackets.

Source: 1990 NDHS data.

as Caldwell, Orubuloye, and Caldwell (1992) have pointed out, the demand for contraception appears to be higher among unmarried women than among married women. Dropping the unmarried women would therefore eliminate a major share of users. Second, the decision to marry is related to the decision to have children, and thus marital status is jointly endogenous with fertility and contraceptive use. Third, to the extent that more-educated women delay marriage and therefore have higher contraceptive use before marriage, excluding unmarried women will distort the relation between education and contraceptive use. However, one advantage of conditioning on marital status is the ability to compare the relative effects of male and female schooling on women's contraceptive use. Thus, in the last column of table 7, we control for whether the woman has ever had a husband or partner and for the education of the current or most recent partner.

Having a partner is associated with lower contraceptive use, but the relation is not statistically significant at conventional levels. When the partner's or husband's variables are included, the marginal effect of female schooling declines (from 0.19 in the fifth specification to 0.12 in the eighth specification), but is still significant and substantially greater than the marginal effect of male schooling (0.07) (see table 7). Husband's schooling is often included as a proxy for income, but its inclusion in the eighth specification does not detract from the proxy for wealth (type of flooring), which remains positive and significant. The results for other characteristics of health facilities are substantially the same as in the fifth specification.

V. SUMMARY AND CONCLUSIONS

This article has examined the impact of individual characteristics and the availability, price, and quality of services at the nearest pharmacy and health facility on current use of contraception in Nigeria. Only 3 percent of the women in this study were currently using a modern method of contraception. Among the background characteristics that had the strongest relation with contraceptive use are factors thought to raise the opportunity cost of women's time—women's schooling and urban residence. Women's schooling in particular had a consistently strong positive relation with contraceptive use in every specification; in rural areas, the relation between schooling and contraceptive use is more pronounced. In the sample of women analyzed, overall levels of schooling were extremely low. Of all women aged fifteen to forty-nine in our sample, 62 percent had received no formal schooling whatsoever; in rural areas, this figure is 67 percent, and in urban areas about a quarter of the women had no schooling. Our analysis strongly suggests that policies to raise female schooling will result in greater contraceptive use, holding constant the characteristics of services. The relation between our proxy for income and contraception was also consistently positive, indicating that higher incomes will contribute to greater contraceptive use.

The low availability of family planning services in Nigeria is a constraint to increased contraceptive use. Increased distance to the nearest health facility was associated with lower contraceptive use, but distance to the nearest facility with family planning was not. This suggests that women who seek health care are more likely to consider using contraception, even if methods are not available at the nearest facility. Women in the sample were generally closer to a pharmacy (4.3 miles) than to the nearest health facility (5.1 miles) or to the nearest facility with family planning (6.9 miles), making the pharmacy the least costly source in at least one sense. However, pharmacies in this predominantly rural sample were also less likely to stock contraceptives than were health facilities: 32 percent of the nearest pharmacies offered family planning, but 55 percent of the nearest health facilities did so. Longer hours of operation at the nearest pharmacy were associated with higher use. Conditional on the availability of any family planning method at the nearest health facility, the availability of injections and sometimes the IUD is often significantly associated with higher current use of contraception. At pharmacies, the total number of methods and the availability of the pill are associated with higher contraceptive use, and the price of all methods is associated with lower use. Outpatient or consultation fees at nearby facilities do not appear to be constraining demand for modern methods.

The results of this study suggest that the limited levels of female schooling (and probably other factors affecting women's opportunity costs of time) are constraining contraceptive use in both urban and rural areas, but more so in rural areas and in the north. Broader availability of the pill through pharmacy outlets and of the injection and IUD in stationary health facilities is likely to raise contraceptive use as well. Pharmacies are a particularly good outlet for nonsurgical methods, as pharmacies are generally more accessible to rural women and unmarried men and women than are health facilities that offer family planning. Furthermore, they may require less waiting time for the client and may be less conspicuous.

The results for the effect of service quality variables are not strong. Of course, the facility questionnaires are not able to capture all of the quality aspects of a service. Interviews with clients and potential clients and observation of service delivery may yield more subjective insights. The Population Council recently conducted an in-depth situation analysis of 147 family planning service delivery points in six states of Nigeria, which included observation of client-provider interactions and interviews with staff and clients (Mensch and others 1994). Multivariate analysis of the number of new family planning clients per 1,000 women resident in the area found no statistically significant effect of the quality of provider services. However, the study was not able to control for the socioeconomic characteristics of the female clients or for the availability of services, as the present article has done. The final report for the situation analysis noted that queuing is not common at health facilities and method stockouts are not "a major problem" (Adewuyi and others n.d.). Despite improvements that could be made in sanitation, counseling, and availability of basic equipment, client

satisfaction was very high. However, insistence on spousal consent may be limiting access to services in many facilities. In a country such as Nigeria, where availability of services and female schooling are both very low, it is difficult to believe that improved service quality (and the implied higher unit costs) of providing it will be the most cost-effective means of raising contraceptive use. Some of the most measurable aspects of quality and availability that public authorities can monitor are measured in the NDHS.

Although this study has shown some statistically significant marginal effects of both individual and service factors on contraceptive use, it would be incorrect to infer that these marginal effects reflect the probable outcomes of large increases in the share of women who are educated or in the availability of contraception. The experience of countries such as Zimbabwe shows that substantially raising the schooling of large numbers of women and their access to family planning services (as was done during the 1980s) can have a much greater impact than these marginal effects would imply. Furthermore, we would expect that as contraceptive services become more available in Nigeria, distance will cease to be a binding constraint to increased contraceptive use.

We have had to assume that the placement of health facilities and pharmacies and the availability of family planning within them is independent of the women's fertility desires or their demand for contraception. Since Nigeria is a country where family planning services are not widely available, this may not be a good assumption. Certainly in the case of private pharmacies, it is likely that the probability of family planning being offered will be influenced by perceptions of the demand environment. We have no way of correcting for the potential endogeneity of the supply of family planning within the existing data set. More accurate estimates of the potential impact of improved availability or quality of contraceptive services could be obtained through a study in which facilities were randomly assigned family planning services and contraceptive use could be observed over time. Since one objective of the population program in Nigeria is to improve the availability of methods, it seems to us that careful data collection from women and facilities, as they are sequentially provided these services, would yield even greater insight on the impact of availability and quality of services on contraceptive use.

Table A-1. Variable Means for Characteristics of Women, the Nearest Health Facilities, and the Nearest Pharmacies by Various Specifications

Variable	Specification ^a				
	1, 2, 5, 8	3	4	6	7
Dependent variable					
Current use of contraception	0.029	0.029	0.052	0.014	0.048
Independent variable					
<i>Individual woman</i>					
Age (years)	28.6	28.6	28.2	28.6	28.6
Age squared	906	906	876	902	910
Urban residence ^b	0.107	0.107	0.402	0.038	0.191
Years of schooling	2.63	2.63	3.72	0.904	4.72
Interaction: urban x schooling	0.788	0.788	2.43	0.104	1.35
Northeast residence ^b	0.317	0.317	0.233		
Northwest residence ^b	0.232	0.232	0.193		
Southwest residence ^b	0.162	0.162	0.310		
<i>Interaction variable</i>					
Northeast x schooling	0.278	0.278	0.234		
Northwest x schooling	0.218	0.218	0.245		
Southwest x schooling	0.886	0.886	2.08		
Type of floor ^c	0.529	0.529	0.583	0.398	0.688
Protestant ^b	0.263	0.263	0.335	0.089	0.475
Muslim ^b	0.559	0.559	0.487	0.887	0.161
Partner or husband ^b	0.837				
Partner's years of schooling	2.27				
<i>Nearest facility^d</i>					
Distance (miles)	5.14	5.73	3.18	7.05	2.83
Outpatient registration fee ^c	2.33	1.80	0.993	1.39	3.46
Family planning offered ^b	0.643			0.747	0.518
Injection offered ^b	0.419	0.526	0.298	0.482	0.342
Injection price ^{e,f}	2.72	3.15	1.68	2.63	2.82
IUD offered ^b	0.463			0.519	0.394
IUD price ^{e,f}	3.04			2.69	3.46
Pill offered ^b	0.588	0.735	0.411	0.663	0.496
Pill price ^{e,f}	1.03	0.787	0.447	0.826	1.29
Condom offered ^b	0.546	0.682	0.381	0.701	0.358
Condom price ^{e,f}	0.488	0.611	0.323	0.577	0.380
At least one doctor ^b	0.559	0.573	0.316	0.521	0.606
Hospital ^b	0.337	0.413	0.229	0.401	0.258
Health clinic ^b	0.379	0.224	0.127	0.266	0.517
Privately owned facility ^b	0.212	0.143	0.080	0.075	0.379
Health facility with family planning linked to the cluster ^b		0.581	0.304		
<i>Nearest pharmacy</i>					
Pharmacy interviewed ^b	0.733	0.733	0.437		
Distance (miles)	3.03	3.03	1.87		
Number of hours open per week	57.4	57.4	34.3		
Family planning offered	0.227	0.227	0.133		

(Table continues on the following page.)

Table A-1. (continued)

Variable	Specification ^a				
	1, 2, 5, 8	3	4	6	7
Number of family planning methods offered	0.707	0.707	0.294		
Injection offered ^b	0.061	0.061	0.040		
Injection price ^{c,f}	0.833	0.833	0.506		
Pill offered ^b	0.159	0.159	0.091		
Pill price ^{c,f}	1.12	1.12	0.616		
Condoms offered ^b	0.194	0.194	0.108		
Condom price ^{c,f}	0.360	0.360	0.198		
Sample size	4,589	4,589	8,761	2,071	2,518

a. The specifications correspond to those in tables 5 and 7.

b. Dummy variable: the value is 1 if the condition is true; 0 otherwise.

c. Dummy variable: the value is 1 if the floor is parquet, vinyl, ceramic, or cement; 0 otherwise.

d. For specifications 3 and 4, this is the nearest source of family planning; for all of the other six specifications, it is the nearest health facility.

e. Fees and prices are in naira. The average 1990 market exchange rate was 12.8 naira per U.S. dollar.

f. The variable is availability of the method (1 or 0) times the price.

Source: 1990 NDHS data.

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Fertility, Contraceptive Choice, and Public Policy in Zimbabwe

Duncan Thomas and John Maluccio

Zimbabwe has invested massively in public infrastructure since independence in 1980. The impact of these investments on demographic outcomes is examined using household survey data matched with two community level surveys. A woman's education is a powerful predictor of both fertility and contraceptive use. These relationships are far from linear and have changed shape in recent years. After controlling for household resources, both the availability and quality of health and family planning services have an important impact on the adoption of modern contraceptives. In particular, outreach programs such as mobile family planning clinics and community-based distributors (CBDs) have been especially successful. However, not all women are equally served by this infrastructure. For example, CBDs have a bigger impact on younger, better educated women, while mobile family planning clinics appear to have more success with older, less educated women.

Since independence in 1980 the government of Zimbabwe has invested massively in infrastructure and a large share of the public budget has been allocated to the provision of social services, particularly health and education. For example, between 1980 and 1986, enrollment ratios rose by 40 percent among primary school age children and almost sixfold (from 8 to 46 percent) among those of secondary school age. Today the vast majority of the population has access to primary education. The family planning program, which has been integrated into the public health system since the mid-1980s, has expanded dramatically since independence (Boohene and Dow 1987), and there has been considerable effort to provide services to the poorest Zimbabweans.

Duncan Thomas is with the Labor and Population Program at RAND and the Economics Department at UCLA, and John Maluccio is in the Economics Department at Yale University. This article was written as background for the research project on "The Economic and Policy Determinants of Fertility in Sub-Saharan Africa," financed by the World Bank Research Committee (RPO 67691) and sponsored by the Africa Technical Department and the Policy Research Department of the World Bank. The authors gratefully acknowledge financial support from the DHS Small Grants Program funded by the Andrew Mellon Foundation, a National Science Foundation Graduate Research Fellowship, the World Bank, and Yale University Center for International Area Studies. The authors thank the Institute for Resource Development (IRD)/Macro International, the Central Statistical Office in Harare, Zimbabwe, the World Bank, and the Zimbabwe National Family Planning Council for making data available. The authors appreciate the comments of Martha Ainsworth, Susan Cochrane, Elizabeth Frankenberg, Charlie Griffin, Pelad Namfua, and two anonymous referees, and the guidance of Ityai Muvandi.

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What have these investments bought in terms of demographic outcomes? Among Sub-Saharan African countries, Zimbabwe, along with Botswana and South Africa, leads the pack in terms of adoption of modern contraceptive methods. According to the 1988 Zimbabwe Demographic and Health Survey (ZDHS), 27 percent of women age 15 to 49 were using a modern method at that time, almost 50 percent had used a method, and knowledge of modern methods was virtually universal (CSO and IRD/Macro International 1989). Prevalence rates are roughly similar in Botswana (where per capita gross national product (GNP) is about 50 percent higher than in Zimbabwe) and these rates are about twice those reported in Kenya. Prevalence rates in the rest of continental Africa (apart from South Africa) are typically below 10 percent (National Research Council 1993a). Yet, in spite of the apparent success of family planning in Zimbabwe, fertility remains high: the total fertility rate (TFR) was estimated to be about 5.5 in 1988 (CSO and IRD/Macro International 1989).

Critics have charged that the family planning program is not effective. Mauldin and Ross (1991), for example, rank the strength of the program as "moderate" and well behind that of Botswana. Some studies have suggested that a majority of women use contraceptives for birth spacing rather than stopping (Way, Cross, and Kumar 1987); others have suggested that contraceptives are used inefficiently (Adamchak and Mbizvo 1990); and the family planning program has been criticized for relying too heavily on only one modern method, the pill.

There has not, however, been any systematic evaluation of the impact of the public investments in health and education infrastructure in Zimbabwe over the last decade. Because the effects of these investments are likely to be greatest on the most recent age cohorts, it will be decades before it is possible to provide a complete and definitive answer to the question of what the investments have bought. But policy decisions cannot wait decades and some aspects of the question can be addressed. This article attempts to do just that.

Using microlevel data, we begin with an examination of the determinants of fertility outcomes in Zimbabwe, focusing on the role of the household and its resources, in particular education and measures of income. To assess the impact on fertility of public investments in health and family planning services, historical data on those services are needed because fertility reflects the cumulation of choices, attitudes, and service availability over a woman's entire childbearing life. This is true even of current fertility (such as births in the last five years). Although the surveys we use are rich, they do not contain historical information that would allow us to directly examine the link between infrastructure and fertility. We turn, therefore, to a choice related to fertility outcomes, the decision to use modern contraceptives. In addition to examining the influence of household resources, we place the spotlight on the role of the availability and quality of community health and family planning services. We pay special attention to the distributional impact of investments in health programs by examining differences in the effects of the programs across educational groups and different cohorts of women.

Consistent with much of the rest of the literature, we find that education is a powerful predictor of both fertility and contraceptive usage. Moreover, these relationships are far from linear and have changed shape in recent years in Zimbabwe. For example, among women age thirty-five and above, there is no significant relationship between education and the number of children ever born; among younger women, however, the relationship is negative and significant, and even women with relatively little education have fewer children than their less educated peers. Turning to community characteristics, the results indicate that health and family planning services do have a positive impact on adoption of modern methods, after controlling for household resources. In particular, outreach programs such as mobile family planning clinics and community-based distributors (CBDs) have been especially successful. Not all women are equally served by this infrastructure. For example, CBDs have a bigger impact on younger, better educated women and mobile family planning clinics appear to have more success with older, less educated women.

The next section outlines the conceptual model guiding the empirical analysis. Section II describes the data. The results are presented in section III, and a conclusion follows.

I. MODEL

Following the economic model of household production (Becker 1981) applied to fertility and contraception (Rosenzweig and Schultz 1985), we assume that households choose to allocate resources in order to maximize utility, which depends on consumption of market and nonmarket goods. Consumption includes the leisure of all household members as well as, among others, the quantity and quality of children. Household choices are made based on a budget constraint and the technology underlying home production, including the production of child quantity and quality.

On the one hand children are valued in and of themselves, and may also be viewed as productive assets, providing labor while young and yielding returns in terms of income support to parents later in life. On the other hand children impose a time and money cost on the household. A desire to lower fertility below its natural (or unregulated) level will depend on the pecuniary costs of raising children as well as on the imputed value of time costs and thus the value of parents' time. Hence, desired fertility will be lower among couples who earn higher wages and who are better educated (conditional on income). If women bear the brunt of childrearing, then the impact of maternal education is likely to be larger than that of husbands. But even if husbands spend no time raising children, as long as male and female leisure times are complementary, the husband's education, like the wife's, will be negatively associated with fertility.

Income effects are ambiguous. If children are normal goods, higher income will be associated with more children. But if demand for child quality rises with

income, this relation will operate in the opposite direction and confound the income effect. Moreover, if our income measures do not adequately measure long-run household resources, then they may be proxied by husband's education, which muddies the interpretation of that covariate.

Focusing on these indicators of household resources, we first estimate the reduced form demand for children, N :

$$(1) \quad N = N(\mu_h, \omega_h)$$

which depends on household characteristics, μ_h , and unobserved household-level heterogeneity ω_h , representing, for example, differences in fecundity and tastes for children, which are assumed to be random and uncorrelated with household characteristics.

If the costs of children outweigh their benefits, couples may choose to limit the number of pregnancies and thereby control the quantity of children. One method of limitation is the adoption of contraceptives. Since there is evidence that short birth intervals are associated with poorer maternal and child health outcomes, contraception may also be used for birth spacing. Of course, wider birth intervals for any woman will also be associated with completed fertility (of women forty-five and older) being below its natural level.

The decision to use contraceptives will depend on their perceived costs and benefits. Costs will depend on the efficacy of the contraceptive, its price, and the difficulty of obtaining and using it. Thus contraceptive usage is likely to be affected by supply-side factors. For many women, a large element of the full price will be captured by the availability of contraceptives. A key aim of this article is to examine the influence of a broad array of community level indicators of the availability of services on contraceptive use. We pay special attention to service quality and are particularly interested in the impact of the community-based distribution mechanism that has been in operation in Zimbabwe since independence in 1980.

The benefits of contraceptive usage will be associated with the fecundability of the couple and also their desire to reduce fertility below its natural level. The benefits will vary with age, and this relationship is likely to be nonmonotonic. Very young women may adopt contraceptive methods to delay childbearing. As they move into a childbearing period, usage will decline only to rise again when they decide it is time to stop bearing children. Things are a bit more complicated if contraceptives are used for birth spacing, because women in their twenties and thirties are also likely to be contraceptive adopters. Finally, since fecundability tends to be lower among older women, the benefits of contraception will not be as great and so usage is likely to be lower among these women.

If, as argued earlier, fertility is lower among higher wage and thus better educated women, contraceptive usage will tend to rise with maternal education. Of course, education is likely to play many roles, over and above its influence on the value of time, including improved information processing and possibly efficiency in usage of contraceptives. In addition to its impact through fertility,

income may affect adoption of contraceptives if they involve resources, in which case the poorest may be less willing (or able) to buy contraceptives than the better off.

Our second empirical model is a contraceptive usage, π , function:

$$(2) \quad \pi = \pi(\mu_b, \mu_c, \varepsilon_b)$$

where μ_c are community level characteristics. Unobserved household-specific heterogeneity, such as fecundity and efficacy of use, is captured in ε_b which is assumed to be random and uncorrelated with either μ_b or μ_c .

We thus rule out migration of women or couples to places where services are better in order to obtain access to contraceptives; endogenous program placement is also ruled out (Rosenzweig and Wolpin 1982, 1986). In the case of Zimbabwe, these assumptions do not seem to be obviously foolish. There are no taboos associated with using contraceptives, which are relatively readily available. Migration, it seems, is likely to be motivated by more than a desire for contraceptives. Since 1980 many clinics and several hospitals have been opened as public health policy has been seeking to bring basic services to the majority of the population. Because increasing contraceptive usage has not been the highest priority in public health policy, the placement of these programs is likely to have more to do with health problems and inadequate health services in the vicinity than contraception per se. Some evidence is presented that *suggests* that endogeneity of program placement may not be critical in this context, at least for large-scale investments. Nevertheless, it is not possible to definitively test these assumptions with the data at hand, and thus the conclusions regarding the impact of community characteristics need to be interpreted with this caveat in mind. Some authors have suggested using first-difference estimates to control for the endogeneity of program placement (Pitt, Rosenzweig, and Gibbons 1993; Gertler and Molyneaux 1993; Frankenberg 1995). We explore a related strategy later in the article.

Another potentially serious issue is that community services tend not to be located in the poorest regions of the country. Failure to control for household, or at least community, income levels could thus lead to substantially incorrect inferences. For example, suppose that contraceptives are more likely to be used by higher-income women who tend to live in areas that have better health services. Without good controls for resources, an empirical correlation between service quality and contraceptive usage does not have an unambiguous interpretation: it may simply reflect the impact of the omitted covariate (income) or it may in fact be that service quality does affect usage.

The survey data, discussed more fully later, contain limited information on household resources. All regressions, but one, include controls for the household's possession of a range of assets. Income of men is not reported, and so the regressions include a good predictor of it, the husband's education. As discussed above, his education will thus capture both a value-of-time effect and an income effect. Because not all women are married, controls for marital status are also included

in the model. It could be argued that marital status should be treated as endogenous in a model of contraceptive choice. But, given that a key contribution of this article lies in the examination of how contraceptive choice is influenced by community services, we choose to ignore that potential problem in an effort to control for income to the fullest extent possible. Estimates that exclude marital status and husband's education are discussed in the text; these and other estimates not presented here are reported in Thomas and Maluccio (1995).

II. DATA AND METHODS

Data are drawn from three sources: a household survey and two specially conducted community level surveys, which we describe in that order.

The ZDHS, conducted in 1988 by the Central Statistical Office (CSO) in collaboration with the Institute for Resource Development (IRD)/Macro International, Inc., is a nationwide survey that interviewed over 4,200 women and their families in 166 clusters. The survey provides detailed information about the fertility history of these women, their contraceptive use and knowledge, their health, and that of their children. The survey respondents also provided limited information about the socioeconomic status of their households, including their own education, that of their husband, and household's ownership of any of a series of assets. The data are fully described in CSO and IRD/Macro International (1989); key summary statistics are presented in appendix tables A-1 and A-2.

The ZDHS is part of a worldwide program that has been operating since the mid-1980s and has successfully fielded surveys in a wide array of countries. These surveys have provided an extremely rich data source, which has led to substantial contributions to the understanding of demographic change in many countries around the world. For an excellent discussion focusing on Africa, see the series of volumes published as part of a National Academy of Sciences study (National Research Council 1993a, 1993b, and 1993c).

According to the ZDHS, the average Zimbabwean woman has given birth to nearly three children, and the number increases with age. Among women age thirty-five and older, the average is 6.2, and completed fertility (of women forty-five and older) is 6.8 children; it remains to be seen whether completed fertility among the current cohort of women in their twenties and thirties will be as high as the cohort of women in their late forties. Contraceptive knowledge is virtually universal, and 27 percent of the sample women report they are currently using a modern method. For over 87 percent of these women, that method is the pill; 6 percent are sterilized, 3 percent use condoms, and 3 percent (or twenty-nine women) use intrauterine devices (IUDs). Traditional methods are very uncommon, especially among younger and urban women: less than 5 percent of the sample women report they are currently using a traditional method. The overwhelming dominance of the pill reflects policies during both the pre-independence government (which tended to emphasize birth spacing) and the first post-independence government (which banned the injectable Depo Provera

in the early 1980s). In more recent years there has been a concerted attempt to expand the choices available to women. Because very few women in the survey use a modern method other than the pill, most of the analyses reported later do not try to distinguish among the methods.

About 14 percent of women in the survey report having no education and about half have completed primary school or more, although nearly half of those women exited at the end of primary school (seven years of schooling).¹ These averages mask substantial differences across cohorts, because the youngest have benefited from heavy investments in education since independence. For example, among women thirty-five and above, only 11 percent had gone beyond primary school, but among those who are less than thirty-five years old this proportion is almost 40 percent.

Although about two-thirds of the sample women are currently married, less than three-quarters of married women are living with their husbands; split households are common in Zimbabwe, and in the majority (but not all) of the cases the woman lives in the rural area while her husband works in a town.

These household level data have been matched with two community level data sources. First, in 1989–90 the CSO and IRD/Macro International resurveyed the same 166 clusters covered in the ZDHS and obtained extremely detailed information about general infrastructure, along with the availability and quality of health and family planning services in the community. Those data, recorded in the Zimbabwe Services Availability Survey (CSO and IRD/Macro International 1991; see also Wilkinson 1992) can be directly matched, at the cluster level, with the ZDHS.

Information about local services was gathered from “knowledgeable” community informants who were typically identified by the village head; the number of informants in each community ranged from two or three to twenty or more. In addition to describing services in the vicinity, the informants were asked about six types of facilities—general or district hospitals, rural hospitals, clinics or health centers, Zimbabwe National Family Planning Council (ZNFPC) clinics, pharmacies, and private doctors. They were asked to identify the nearest facility of each type and the distance to it. If the facility was within 30 kilometers of the community center, it was visited by an enumerator who collected information on the nature, quality, and prices of services offered.

The collection of community level data is far from trivial, and it is not obvious how best to identify local providers or, put another way, the appropriate catchment area for a particular provider. Unfortunately, it appears that informants in several communities were not very well informed. For example, infor-

1. Years of schooling is constructed from responses to questions about completed level and the grade within that level. For primary school, women were able to list up to five grades, so completion of Standard 5 (seven years of schooling) is treated as completion of primary school. For secondary school, completion of Form 2 is treated as equivalent to nine years of completed schooling, and Form 4, eleven years. The small fraction of women who have twelve or more years of schooling are grouped together (see appendix table A-1). Also, we note that twelve percent of the women in the survey have not yet completed schooling.

mants in 8 percent of the clusters failed to identify a general or district hospital.² Exactly why a hospital was not identified is unclear, and one may argue that if the informant could not identify it, this may reflect the general perception of people in the community that they do not have access to a hospital.

Along the same lines, but perhaps a bit more problematic, is that ZNFPC clinics were identified by informants in only 16 percent of the clusters. In part this reflects the fact that these clinics do not cover the entire country and are concentrated in towns and cities, so that rural informants may not even be aware of the clinics. But in Harare, for example, where there are seventeen clusters, the ZNFPC clinic was identified by informants in only one of those clusters. Since the ZNFPC clinic shares the same grounds as the Harare Hospital (but is a completely independent entity and located apart from the hospital), we can deduce the distance to the ZNFPC clinic using reported distances to Harare Hospital: in every case, it is less than 30 kilometers. This calls for caution in relying on information about only facilities identified as being within a 30 km radius of the community (and thus visited by the enumerators). For the purposes of family planning services, therefore, we will define the community as the district (there are fifty-two districts).

Because over the last decade public policy in Zimbabwe has shifted dramatically toward the provision of family planning services through CBDs, it is of considerable interest to look closely at CBDs' role in affecting women's choice to use modern methods. Information on CBDs being rather limited in the Services Availability Survey, we turn to a second special community survey, the Zimbabwe Situation Analysis Study.

The Situation Analysis Study was conducted in 1992 by the ZNFPC, the Population Council's Africa Operations Research and Technical Assistance project, and the Family Planning Service Expansion and Technical Support project (ZNFPC 1992). The objective of the Situation Analysis Study was to provide comprehensive information about the availability, functioning, and quality of family planning services in Zimbabwe. In addition to detailed information on individuals who are CBDs, the survey provides data on family planning services available from (public and private) clinics. Information was collected in structured interviews with providers and clients (including exit polls), as well as direct observation of clinic conditions and provider-client interactions. The sample design, which is described in detail in ZNFPC (1992), is essentially facility based. We have, therefore, matched the facilities with the household data at the district level. It should be noted that not all districts in Zimbabwe were included in the ZDHS and that for those which were included but do not have data in the Situation Analysis Study, we have matched data from a neighboring district. The Situation Analysis Study gathered information from 181 clinics and 140 CBDs.

2. One of these clusters is in the Jambesi area of the Hwange District, and the informants failed to identify Hwange Hospital; in the neighboring district to the south, Gwaai, Hwange was identified by the informants, but it was too far away (87 kilometers) to be selected for a visit.

Information about CBDs and clinics contained in the Services Availability Survey and Situation Analysis Study overlaps. It is thus possible to cross-check the two sources. Because the surveys were conducted two to three years apart, the data contained in them are unlikely to be identical. Good correspondence between them, however, would suggest that district level matching of the two community surveys is reasonable in the Zimbabwe context. Similarity may arise either because there is only one provider of a particular type in each district or because the intradistrict heterogeneity is considerably smaller than the interdistrict variation.

It turns out that the information contained in both surveys is remarkably close. In only 8 percent of districts in which the Situation Analysis Study recorded an interview with a CBD, the Services Availability Survey reported no CBDs in that district. In part, this discrepancy may reflect expansion of the CBD program during the three years between the fielding of the Services Availability Survey and Situation Analysis Study.³ There is also broad agreement about services available in clinics. For example, in only 6 percent of the districts was there disagreement about the presence of state-certified nurses, and in less than 5 percent of districts there were discrepancies in the availability of condoms and oral contraceptives. In general, we find that the intradistrict (and intersurvey) heterogeneity is tiny relative to the interdistrict variation in the data.

The results are quite reassuring. They suggest there have not been large changes in the provision of these services during the period between the two surveys. This is not too surprising in view of the fact that real public health expenditures grew little during the late 1980s and early 1990s. This is important because we are implicitly assuming that no shifts occurred in the relative distribution of availability and quality of services provided in Zimbabwe between 1988 (when the ZDHS was fielded) and 1992 (when the Situation Analysis Study was completed).

Appendix table A-2 summarizes some of the community level information. The first column is measured at the cluster level; the second to fourth columns reflect the proportion of women living in communities with the services. Of interest is the fact that about half the sample women live within the vicinity of a general hospital (and virtually all urban women are close to a facility of this sort). There is a clinic in every community, and almost half of them have been built since 1980. About two-thirds of the communities are visited by a health worker but only half of those are also served by a mobile family planning clinic. CBDs are operating in about two-thirds of the communities.

III. REGRESSION RESULTS

Using the microdata in the ZDHS, the analysis begins with an examination of the impact of household characteristics, and especially a woman's education, on

3. In 20 percent of the districts there was a discrepancy in the gender of the CBD; the Situation Analysis Study reported interviews with considerably more male CBDs. This is unlikely to reflect changes in the CBD program and suggests, perhaps, that local informants in the Services Availability Survey may have been misinformed.

fertility. We proceed to assess how the same characteristics affect the probability that she uses modern contraceptives. To discern the influence of a series of community service characteristics on this probability, we incorporate data collected in the Zimbabwe Services Availability Survey and the Zimbabwe Situation Analysis Study and estimate the reduced form, equation 2.

Fertility

Fertility in Zimbabwe is high. Table 1 presents evidence on the household factors that affect one measure of fertility, the number of children ever born. Age at first birth and birth spacing are also discussed briefly. The model is estimated by the method of least squares, which ignores the fact that the outcome is discrete. The results do not rely on this assumption: a Poisson model of children ever born provides essentially identical results. Each woman's own education is included in the regression with no parametric restrictions placed on the shape of the relation between it and fertility: each year of completed schooling is represented by a dummy variable (except for education of twelve years and above, which is equivalent to continuing beyond "O" levels and accounts for less than 2 percent of women in the sample; see footnote 1). The coefficients represent the difference in the number of children born to a woman with a given education level and to a woman with no education, holding other background characteristics constant.

In the first column of table 1, education of the woman is included along with her age (represented by dummies for each five-year age group), marital status, ethnicity, and sector of residence.⁴ Some authors, including Cochrane (1983) and Cochrane and Farid (1990), have noted that in many countries the impact of maternal education on fertility is not monotonic. For women with very little education, the number of children ever born tends to rise with education until some threshold level (typically somewhere between five and seven years of schooling) is reached; thereafter, fertility and education are negatively correlated. A similar pattern is observed in Zimbabwe. The first few years of primary schooling are unrelated to fertility and it is only when women are close to completing primary school (specifically, six years of education) that there is a significant negative association between education and fertility. This correlation is not constant but tends to increase with education, particularly at the top of the distribution.

To what extent can the effect of education be explained by income? We attempt to address this question in the second column of table 1, in which husband's education and a set of dummies for ownership of a range of household assets are added to the regression to control for permanent income and wealth. Income effects are small, and husband's education only matters among the better edu-

4. Dropping controls for marital status results in slightly lower education effects but only one of these differences is significant (eleven years of schooling). The χ^2 statistic for significance of all differences in education effects is 5.4 with a p -value of 0.94. Endogeneity of marital status seems to be of second-order importance in its effect on estimated education coefficients in these regressions. The same conclusion applies to the contraceptive use regressions discussed later.

Table 1. *Number of Children Ever Born: Role of Education and Income*

Variable	Woman's education and household income		By woman's age		By woman's residence	
	Woman's education only	household income	Less than 35	35 or older	Urban	Rural
<i>Woman's education (completed years)^{a, b}</i>						
1	-0.193 (0.88)	-0.191 (0.88)	-0.545 (2.85)	0.410 (0.78)	0.676 (1.41)	-0.369 (1.48)
2 (complete preschool)	0.005 (0.04)	0.028 (0.18)	-0.117 (0.85)	0.250 (0.73)	0.104 (0.33)	0.024 (0.14)
3	0.089 (0.63)	0.105 (0.74)	0.087 (0.66)	0.287 (0.89)	0.391 (1.37)	0.046 (0.28)
4	-0.191 (1.37)	-0.155 (1.11)	-0.395 (3.24)	0.253 (0.73)	0.067 (0.27)	-0.135 (0.80)
5	-0.157 (1.39)	-0.096 (0.83)	-0.333 (3.35)	0.349 (1.22)	-0.129 (0.56)	-0.062 (0.47)
6	-0.405 (3.50)	-0.307 (2.54)	-0.465 (4.72)	0.144 (0.42)	-0.314 (1.40)	-0.209 (1.46)
7 (complete primary)	-0.516 (5.32)	-0.365 (3.49)	-0.461 (5.38)	-0.061 (0.20)	-0.306 (1.66)	-0.266 (2.08)
8	-0.640 (4.26)	-0.417 (2.67)	-0.500 (4.30)	0.152 (0.20)	-0.459 (1.86)	-0.291 (1.47)
9 (complete Form 2)	-0.731 (5.91)	-0.456 (3.40)	-0.572 (5.49)	-0.346 (0.72)	-0.442 (2.15)	-0.383 (2.12)
10	-0.793 (4.51)	-0.528 (2.90)	-0.744 (5.60)	-0.308 (0.29)	-0.611 (2.40)	-0.477 (1.88)
11 (complete Form 4)	-1.051 (8.81)	-0.697 (5.18)	-0.959 (9.33)	-0.491 (0.75)	-0.736 (3.64)	-0.777 (4.04)
12 or more	-1.418 (6.39)	-0.974 (4.17)	-1.364 (7.78)	-0.611 (0.72)	-1.211 (4.55)	0.056 (0.10)
<i>Husband's education (completed years)^a</i>						
Complete preschool		0.112 (0.54)	0.268 (1.49)	-0.042 (0.08)	-0.814 (1.63)	0.203 (0.86)
Some primary school		0.168 (1.70)	0.384 (4.28)	-0.111 (0.49)	0.228 (1.19)	0.136 (1.18)
Complete primary school		-0.013 (0.15)	0.110 (1.32)	-0.051 (0.20)	-0.245 (1.40)	0.110 (0.92)
Complete Form 2		-0.199 (1.64)	-0.141 (1.45)	0.131 (0.37)	-0.147 (0.78)	-0.194 (1.23)
More than Form 2		-0.522 (4.33)	-0.246 (2.62)	-0.316 (0.74)	-0.467 (2.58)	-0.466 (2.78)

(Table continues on the following page.)

Table 1. (continued)

Variable	Woman's education only	Woman's education and household income	By woman's age		By woman's residence	
			Less than 35	35 or older	Urban	Rural
<i>Household assets^a</i>						
Motorcycle or bicycle		0.061 (0.98)	-0.011 (0.24)	0.240 (1.27)	0.096 (1.07)	0.047 (0.59)
Car		-0.288 (2.92)	-0.062 (0.85)	-1.320 (3.92)	-0.304 (2.95)	-0.240 (1.35)
Radio		-0.066 (1.06)	-0.032 (0.70)	-0.036 (0.18)	-0.068 (0.69)	-0.025 (0.33)
Television		0.076 (0.75)	0.028 (0.37)	0.058 (0.16)	0.201 (2.03)	-0.263 (1.04)
Cattle		-0.053 (0.74)	-0.039 (0.68)	-0.174 (0.80)	0.188 (0.68)	-0.086 (1.06)
Goats or sheep		0.077 (1.06)	0.064 (1.11)	0.081 (0.38)	-0.253 (0.85)	0.087 (1.08)
<i>Rural residence^a</i>	0.393 (6.24)	0.286 (3.53)	0.122 (2.00)	0.920 (3.40)		
<i>Goodness of fit</i>						
χ^2 (own education)	10.65 [0.00]	3.78 [0.00]	10.97 [0.00]	0.44 [0.95]	3.91 [0.00]	1.92 [0.03]
χ^2 (husband's education)	38.98 [0.00]	7.57 [0.00]	11.12 [0.00]	0.26 [0.93]	3.90 [0.00]	3.63 [0.00]
F (all covariates)	362.14 [0.00]	249.20 [0.00]	218.17 [0.00]	8.61 [0.00]	78.00 [0.00]	177.81 [0.00]
R ²	0.67	0.67	0.69	0.20	0.65	0.68
Number of observations	4,201	4,201	3,129	1,072	1,407	2,794

Note: The values are ordinary least squares (OLS) estimates. The regressions also include controls for age (represented by dummies for each five-year age group), marital status, and presence of husband in household. *t*-statistics are in parentheses, and *p*-values are in square brackets.

a. Dummy variable: value is 1 if condition is true; 0 otherwise.

b. The coefficients represent the difference in the number of children born to a woman with a given education level and a woman with no education, holding other background characteristics constant.

Source: Authors' calculations based on CSO and IRI/Macro International (1989).

cated. Nevertheless, a good part of the effect of female education does appear to operate through income and the estimated effects decline from between one-quarter and one-half; this decline is greatest among the better educated. In order to take account of all unobserved community level heterogeneity, including income differences, we have also estimated the models with community fixed effects. The education effects are very similar to those reported in the second column. For example, the fixed-effects estimates indicate that women with twelve or more years of schooling have 0.972 fewer children than those with no schooling; the estimate without fixed effects is 0.974.

Although these regressions control for the age of the woman, it is possible that the effects of education vary with age because the number of children ever born rises with age and there have been dramatic increases in educational attainment among recent cohorts in Zimbabwe.⁵ The third and fourth columns of table 1 present separate regressions for younger women (under thirty-five years old) and older women (thirty-five years old and above).

Among older women, there is no significant relationship between education and fertility. Among younger women, however, even fairly low levels of primary schooling are associated with lower fertility. This suggests that investments in education over the last decade are likely to have a substantial payoff in terms of reduced fertility in coming decades. The powerful negative association between education and fertility is largely an urban phenomenon (fifth column). Since younger, urban women are more likely to be participating in the formal labor market than their older or rural counterparts, this suggests that growth in employment opportunities may have a substantial impact on fertility rates in Zimbabwe. This is a hypothesis that warrants careful scrutiny: if true, then it may be that recent declines in labor demand will be associated with a flattening of the fertility-education profile.

A very similar pattern emerges for the impact of education on age at first birth (not shown). Women who complete primary school have their first child about seven months later than those who do not (and this difference is significant); women who complete eleven years of schooling wait another two years before having a child. The biggest effect, however, is among women with at least twelve years of schooling: they delay childbirth for five years relative to those without any schooling. Among older women, there is little evidence of a significant relationship between education and age at first birth except for the tiny fraction with more than ten years of schooling; in fact, relative to women with no schooling, those with less than six years of education tend to give birth at earlier ages. For more recent cohorts, in contrast, the impact of education is positive at all levels of education and significant for women with at least four years of schooling. Apparently part of the negative correlation between education and fertility among recent cohorts can be attributed to delay of the first birth.

Like age at first birth, birth space tends to rise with education and the effect is significant only among better educated, younger, and urban women. Counterbalancing this trend is a decline in birth space across cohorts: women age forty-five to forty-nine space their children about two months further apart than twenty-five to twenty-nine year olds. Although significant, this difference in birth space is small; so assuming that the more recent cohorts do not continue childbearing longer than their mothers, it seems reasonable to expect the relationship between education and completed fertility to become more powerful in years to come.

5. In addition to the fact that the impact of public investments will differ across cohorts, it is possible that the end of the civil war in 1980 brought with it greater stability in Zimbabwean households which may have resulted in a baby boom in the early 1980s.

Returning to the second column in table 1, the husband's education follows the same inverse U shape reported for women.⁶ Male education has a significantly depressing impact on fertility only at the top of the education distribution (nine or more years of schooling) and only among younger women. In fact, conditional on wife's education and income, men who have some primary schooling tend to have more children than those with no education at all; this effect is large and significant among young women.

As discussed earlier, male education effects do not have an unambiguous interpretation and are likely to be capturing both the role of income and the value of time. About 30 percent of married women are not living with their husbands; in those households, husband's education should have no value-of-time effect: we find that husband's education is positively, but not significantly, associated with fertility. Among couples living together, however, the husband's education effect is negative and significant if he has completed primary school. (The coefficient on completed primary school is -0.29 with a t -statistic of 2.0 and on completed Form 2 it is -0.61 with a t -statistic of 3.6.) Recognizing that husband's presence is not exogenous, these results suggest that the effect of his education on demographic outcomes does combine the role of income and the value of time, with the latter being especially important among the better educated.

The dummies for ownership of assets also capture income effects. They are small and, apart from cars, insignificant. The effect of car ownership is substantially smaller among younger women, and it is only among older women that these income measures are jointly significant.

In sum, there is a negative association between education and fertility, albeit among the better educated. The shape of the relationship appears to have changed among recent cohorts, with education becoming a powerful force behind fertility decline in Zimbabwe. Understanding the mechanisms underlying the change in this relationship is key for policy design and will be taken up again later. Even after controlling for education and income, rural women tend to have significantly more children, although this gap may be declining over time. Among older women (thirty-five and above), rural women report about one more birth than those in urban areas, but among women less than thirty-five years old the difference is only about one-seventh of a child. This is a large decline in the urban-rural gap, although it is obviously impossible to determine at this time whether it will be completely offset by rural women having more children later in life. A natural hypothesis would be that the urban-rural gap reflects differences

6. The models have also been estimated using dummies for each year of husband's education (paralleling the female specification). To save space, we report results for the more parsimonious specification because the restrictions it imposes are not rejected and effects of other covariates are essentially unaffected by the choice. Although the main results are captured in the more parsimonious specification, the semiparametric estimates are useful to draw direct comparisons between male and female education effects. At the top of the distribution, the negative effect of husbands' education is about two-thirds the magnitude of women's education: the coefficients on eleven years and twelve or more years of schooling are -0.49 and -0.72 , respectively, with t -statistics of 3.7 in both cases. In addition, the inverse U shape of husband's education is more striking (and significant).

in infrastructure in the two sectors. Without data on the services available to each woman over her childbearing life, it is impossible to test this empirically. However, contraceptives are used to control fertility, and it is possible to assess whether current infrastructure has any impact on current contraceptive use. We turn now to that question.

Contraceptive Usage

In the following two subsections, tables 2 and 3 present the estimated effects of household and community characteristics on the probability that a woman is currently using a modern method. Since the dependent variable is dichotomous, we assume errors are distributed as a Gaussian, and estimate a probit model by maximum likelihood. Estimated coefficients have been translated into slopes and are multiplied by 100 in the tables.⁷

In view of the tiny fraction of women who are using traditional methods, we do not distinguish them in the tables. Estimates based on a trivariate multinomial logit indicate that few of the characteristics in these data explain the choice to use traditional methods.⁸ Recall that of 27 percent of women who are using modern methods, 24 percent use the pill. We have also estimated quadrivariate multinomial logits (distinguishing women who use the pill, other modern methods, traditional methods, and no method). In our view, the data do not have enough information for us to reliably estimate the determinants of other modern methods, so we discuss only robust results here. Paralleling table 1, we begin with household characteristics in table 2 and then examine the impact of community characteristics on contraceptive use in table 3.

Household Characteristics

Many studies have demonstrated that better educated women are more likely to adopt contraceptives. Although this is also true in Zimbabwe, the effect is significant only after women have completed several years of primary school, and the relationship is not monotonic (table 2). Among women who did not complete primary school, the function is fairly flat, and these women are about 4 percent more likely to adopt contraceptives than those without any schooling. There is, however, a dramatic step in the function at completion of primary school (seven years of education), when the impact doubles to 8 percent. It is hard to imagine that women learn about the value of contraceptives only in their final year of primary school; instead, this suggests that there is something intrinsically different between women who do and do not complete primary school. This interpretation is bolstered by the fact that the estimated effect for women who complete eight years of school-

7. The coefficient estimates, β , are multiplied by the mean probability, which is the value of the cumulative density function of the normal distribution evaluated at the sample mean, $\Phi(\bar{x}\beta)$. The tables report $100 \beta \Phi(\bar{x}\beta)$.

8. Older women and women in households with cattle are more likely to use traditional contraceptives over no method and modern methods.

Table 2. *Probability of a Woman's Currently Using a Modern Contraceptive Method: Role of Education and Income*

Variable	Woman's education only	Women's education and household income	By woman's age		By woman's residence		Including community characteristics ^a
			Less than 35	35 or older	Urban	Rural	
<i>Woman's education (completed years)^b</i>							
1	4.432 (1.13)	3.455 (0.88)	5.888 (1.21)	-0.568 (0.08)	12.033 (1.00)	1.981 (0.52)	3.461 (0.89)
2 (complete preschool)	2.201 (0.81)	1.313 (0.48)	1.586 (0.45)	1.152 (0.26)	5.950 (0.74)	0.581 (0.22)	1.615 (0.59)
3	3.038 (1.19)	3.176 (1.23)	5.147 (1.54)	0.217 (0.05)	1.911 (0.25)	3.211 (1.27)	3.546 (1.38)
4	4.666 (1.85)	4.584 (1.80)	4.111 (1.30)	5.616 (1.30)	7.885 (1.18)	3.112 (1.21)	5.355 (2.11)
5	4.060 (1.97)	3.928 (1.86)	4.546 (1.75)	2.298 (0.63)	0.578 (0.09)	4.071 (2.00)	4.667 (2.21)
6	4.314 (2.00)	3.764 (1.68)	3.344 (1.26)	3.814 (0.89)	2.838 (0.47)	3.611 (1.61)	4.045 (1.80)
7 (complete primary)	8.153 (4.61)	7.320 (3.85)	6.557 (2.90)	9.116 (2.48)	12.743 (2.58)	4.535 (2.31)	7.620 (3.96)
8	7.272 (2.33)	5.843 (1.82)	4.466 (1.27)	15.511 (1.75)	6.633 (0.93)	5.056 (1.45)	6.487 (2.03)
9 (complete Form 2)	10.863 (4.66)	7.848 (3.08)	8.374 (2.88)	2.301 (0.41)	8.970 (1.58)	7.502 (2.55)	8.152 (3.20)
10	11.768 (3.23)	9.102 (2.41)	9.274 (2.30)	5.238 (0.43)	9.068 (1.20)	9.784 (2.17)	8.840 (2.34)
11 (complete Form 4)	13.454 (6.08)	8.902 (3.50)	8.811 (3.12)	14.928 (1.96)	10.776 (1.93)	8.584 (2.76)	8.776 (3.45)
12 or more	21.366 (5.39)	15.895 (3.79)	14.213 (2.99)	29.167 (2.89)	16.010 (2.21)	31.290 (3.64)	16.733 (4.01)
<i>Husband's education (completed years)^b</i>							
Complete preschool		1.137 (0.31)	0.516 (0.11)	4.144 (0.64)	-2.313 (0.18)	2.150 (0.61)	0.689 (0.19)
Some primary school		1.935 (1.10)	2.633 (1.17)	0.190 (0.07)	3.377 (0.68)	1.549 (0.90)	1.658 (0.95)
Complete primary school		1.729 (0.99)	2.093 (1.00)	-0.805 (0.24)	1.872 (0.42)	1.434 (0.81)	1.451 (0.84)
Complete Form 2		3.314 (1.57)	2.395 (0.97)	4.865 (1.16)	6.580 (1.36)	0.634 (0.27)	2.741 (1.31)
More than Form 2		5.892 (2.76)	6.629 (2.75)	-2.616 (0.50)	8.099 (1.71)	4.293 (1.75)	5.602 (2.64)

ing is actually smaller (albeit not significantly) than for those with one less year of education: surely, they are not learning not to value contraceptives in their first year at secondary school.⁹ Additional years of secondary school are

9. Many estimates of the relationship between education and wages also indicate steps associated with the completion of particular levels of education; these steps have often been attributed to credentialism (although selection seems like a plausible alternative hypothesis). For contraceptive usage, however, it is far from clear how or why credentialism should play any role.

Table 2. (continued)

Variable	Woman's education only	Woman's education and house- hold income	By woman's age		By woman's residence		Including community charac- teristics ^a
			Less than 35	35 or older	Urban	Rural	
<i>Household assets^b</i>							
Motorcycle or bicycle		3.486 (2.98)	3.072 (2.23)	3.328 (1.46)	6.005 (2.39)	2.428 (1.89)	2.870 (2.45)
Car		-0.779 (0.42)	-2.412 (1.10)	4.236 (1.09)	-3.280 (1.10)	3.325 (1.18)	-0.741 (0.40)
Radio		0.796 (0.67)	0.716 (0.53)	0.583 (0.23)	0.256 (0.09)	0.792 (0.63)	0.605 (0.51)
Television		4.519 (2.40)	1.927 (0.90)	13.585 (3.32)	5.633 (2.02)	5.042 (1.29)	5.189 (2.78)
Cattle		-2.131 (1.50)	-3.016 (1.82)	1.173 (0.42)	-2.336 (0.27)	-1.514 (1.16)	-1.568 (1.08)
Goats or sheep		-3.793 (2.71)	-3.926 (2.38)	-2.834 (1.06)	-13.650 (1.45)	-2.550 (2.01)	-1.684 (1.16)
<i>Rural residence^b</i>	-5.305 (4.48)	-0.565 (0.38)	0.222 (0.13)	-3.711 (1.13)			0.868 (0.40)
<i>Goodness of fit</i>							
χ^2 (own education)	61.41 [0.00]	25.25 [0.01]	17.15 [0.14]	17.69 [0.13]	14.35 [0.28]	22.42 [0.03]	26.43 [0.01]
χ^2 (all covariates)	562.53 [0.00]	596.93 [0.00]	490.50 [0.00]	123.45 [0.00]	261.35 [0.00]	321.35 [0.00]	551.08 [0.00]
Likelihood	-2,087	-2,064	-1,511	-534	-721	-1,323	-2,031
Pseudo R^2	0.15	0.16	0.18	0.11	0.20	0.14	0.17
Number of observations	4,201	4,201	3,129	1,072	1,407	2,794	4,201

Note: The values are maximum likelihood probit estimates transformed into derivatives. Asymptotic *t*-statistics are reported in parentheses, and *p*-values are in brackets. Regressions also include controls for age (represented by dummies for each five-year age group), ethnicity, marital status, and presence of husband in household.

a. See table 3 for a list of community characteristics.

b. Dummy variable: value is 1 if condition is true; 0 otherwise.

Source: Authors' calculations based on CSO and IRI/Macro International (1989, 1991) and ZNEPC (1992).

associated with slightly higher probabilities of adopting modern methods, although the next dramatic step is among women who go beyond "O" levels (twelve years or more): they are 20 percent more likely to be using a modern method relative to women without any schooling. This pattern is remarkably similar to the relationship between education and fertility, apart from the spike at completion of primary school.

Ever-married women are significantly more likely than women who have never been married to be using a modern method. Their probability of adopting contraception tends to rise with age until around thirty and then declines. Women in rural areas are significantly less likely to be using a modern method.

In the second column of table 2, husband's education and dummies for ownership of assets are added to the regression in an attempt to control for income. Apparently the entire rural-urban gap in contraceptive usage can be attributed to income differences (as measured here): the rural effect becomes very small and is not significant. Recall that in the case of fertility the rural-urban gap persists after controlling for income, although it is much smaller for younger women. Both of these results probably reflect the higher investment in infrastructure in rural areas in recent years (since independence). Husband's education is positively and significantly associated with the probability that a woman is a contraceptive adopter, but the effect is far from smooth and is significant only at the top of the education distribution.

Income, as measured by the dummies for asset ownership, should not be contaminated by current labor supply and leisure choices (although they may reflect previous labor supply). Women in households with a bicycle or motorcycle or a television are significantly more likely to be using a modern method. In contrast, however, women in households with goats and sheep are less likely to use contraceptives. The exact reason is far from clear: it may be that this is a poor measure of income (because, for example, no information is provided about the number, type, or value of the animals); it may reflect more traditional attitudes among these women; or, it may reflect greater demand for child labor in households with livestock.¹⁰ It is most unfortunate that until DHS data on income or household resources are collected, it is not going to be possible to address these issues with these otherwise extremely rich surveys.

Income (as measured here) does account for part, but certainly not all, of the impact of female education on contraceptive usage. The role of income tends to be greater at the top of the education distribution where the estimated education effects are reduced by about a third; at the bottom of the education distribution, the effect is reduced by about 10 percent. While the general shape of the relationship remains intact, the steps at seven and twelve or more years of schooling are, if anything, even more pronounced.

Women are stratified into two age groups in the third and fourth columns of table 2. The effect of education on contraceptive usage is substantially flatter for younger (fifteen to thirty-five years old) relative to older (thirty-five to forty-nine years old) women. For example, older women who have completed eleven years of schooling are more than twice as likely to use contraceptives as those who had one less year of schooling, and only half as likely to be adopters than women with more schooling. In comparison, among younger women the differences among those who attend secondary school are small except for those

10. Since ownership of goats and sheep is unrelated to fertility (table 1), endogeneity is probably not the dominant explanation. Moreover, dropping the covariate has little effect on any other covariates other than cattle ownership (which becomes absolutely larger and significant). This is because the two covariates are highly correlated (0.62). Ownership of cattle, goats, and sheep is not exclusively a rural phenomenon; over 5 percent of urban households own cattle, and another 5 percent own sheep or goats; these proportions increase to about 50 percent among rural households.

with twelve or more years of schooling whose usage rate is about 50 percent higher than the rest. The impact of these older, better educated women on aggregate usage rates is small because those with eleven years or more of education account for only 4 percent of the sample; in contrast, over 15 percent of younger women have achieved this level of schooling.

There is far more noise in the education-usage function among older women, and thus it is only among younger women that secondary schooling is associated with significantly higher probabilities of using modern methods relative to those without any schooling. For both younger and older women, however, the step at completion of primary school remains large and significant and it is twice as large for older women. This suggests that the role of selection may be declining over time, which seems consistent with the substantial changes in the government's education policy since independence in 1980.¹¹

The fifth and sixth columns of table 2 stratify the sample on sector of residence. The income effects in the two sectors are qualitatively similar (at least when they are significant) and the negative impact of goats and sheep persists even within the rural sector. For women in rural areas, the effect of education tends to be smaller (at the secondary level), and there is little evidence of a step at completion of primary school. In contrast, among urban women, there is a large and significant step at seven years of schooling, and the impact on usage is almost as large as the impact of having twelve years or more education. In the final column of the table, all measures of infrastructure, discussed later, are included in the regression. The results are remarkably similar to those in the second column (except that goats and sheep no longer significantly affect use); the same is true for a model that includes community fixed effects and so we conclude that our main results are not contaminated by unmeasured community characteristics.

In sum, education is positively associated with contraceptive usage, even after controlling for income, although the relationship is neither smooth nor monotonic, let alone linear. In fact, a regression that is linear in education would yield quite misleading inferences: the estimated impact is about 1 percent for each year of schooling. However, it is clear from the second column in table 2, for example, that the education-usage function is essentially flat at the bottom of the education distribution. If all women with four or five years of education were to spend another year at school, then contraceptive usage would not be likely to rise. Furthermore, the semiparametric estimates suggest that the estimated education effect does not solely reflect the productivity gains of additional schooling (in home production or in the market) but is intertwined with other factors such as selection of women to complete particular levels of schooling. It would, therefore, be inappropriate to infer that contraceptive usage would

11. For older women, there is an even bigger step at eight years of schooling, but this is an anomaly; less than 0.5 percent of sample women completed just one year of secondary school among this cohort. In view of the pre-independence government's education policy, which funneled very few people into secondary school, this is not surprising.

increase dramatically if all women were to complete primary school; rather, we need to understand the mechanisms whereby better educated women are choosing to use contraceptives.

The results for ever use of contraceptives are broadly the same as for current use although the slopes of the function are steeper as, taken cumulatively, better-educated women are much more likely to have ever used a modern method than women without any schooling. For example, relative to women without any education, those who have completed primary school are about 20 percent more likely to have used modern methods and this probability is closer to 50 percent among those who have completed twelve or more years of schooling.

Two additional results emerge from the multinomial logit models, which distinguish the pill from other modern methods. First, older women are more likely to have adopted other methods (mostly sterilization), and second, income plays a bigger role with ownership of a car, radio, and television all having a significant, positive impact on the use of other modern methods, relative to the pill.

Community Characteristics

Since independence, public health policy in Zimbabwe has sought to bring basic health services to the majority of the population and there have been substantial investments in new infrastructure. Family planning has traditionally been under the aegis of government and quasi government clinics, although since independence there has been a substantial shift toward the use of CBDS. Has the provision of these services had any impact on contraceptive usage?

Table 3 reports estimated probabilities based on probit models that include all the household characteristics discussed earlier along with a series of measures of the availability of community services. The first four columns in the table examine their impacts on the probability a woman has ever used modern contraceptive methods. The first column includes measures of general health infrastructure, the second focuses on the role of CBDS, and the third examines the impact of detailed indicators of clinic services.¹² All measures of services are included in the fourth column. The remaining columns of the table examine the impact of community services on current usage of modern methods. The same format is repeated in the fifth through eighth columns. Results of regressions estimated separately for women less than thirty-five and for those older are reported in the ninth and tenth columns; in the eleventh and twelfth columns, women are stratified on the basis of their completing primary school. The final

12. Measures of general infrastructure are drawn from CSO and IRD/Macro International (1989); all other measures are drawn from ZNFPC (1992). Reported standard errors do not take into account the multilevel nature of the regressors. Allowing within-district correlation in the unobservables and estimating the variance-covariance matrix as a grouped infinitesimal jackknife (Huber 1967; Efron 1982) has no impact on inference. In some cases, estimated standard errors are smaller; in others they are bigger. This suggests that intradistrict correlations are not key in this application and, in view of the very complex design matrix (which also includes covariates measured at the cluster level), we prefer to report conventional estimates of standard errors. In order to allow complete flexibility and control for income to the fullest extent possible, husband's education is specified as dummies for each year of schooling in table 3.

Table 3. *The Effects of Community Services on Ever-Use and Current Use of Modern Contraceptives*

Variable	Ever use				Current use							
	General health infrastructure	Community-based distributors	Clinic services	All variables	General health infrastructure	Community-based distributors	Clinic services	All variables	By woman's age		By woman's education	
									Less than 35	35 or older	Less than primary	Primary or more
<i>General infrastructure^a</i>												
General hospital	6.617			7.048	3.112			3.355	4.804	-1.104	4.447	2.007
within 30 kilometers	(2.27)			(2.24)	(2.11)			(2.14)	(2.66)	(0.35)	(2.01)	(0.85)
Rural hospital	-5.129			-2.414	-1.682			-0.079	-1.262	3.906	-0.159	-0.154
within 30 kilometers	(1.25)			(0.56)	(0.77)			(0.04)	(0.47)	(0.92)	(0.05)	(0.04)
Clinic (built after 1980)	-0.285			1.007	-0.705			-0.254	-1.234	1.680	-0.456	-0.219
within 30 kilometers	(0.13)			(0.43)	(0.63)			(0.21)	(0.90)	(0.70)	(0.26)	(0.13)
Rural hospital with electricity	6.264			0.607	2.578			-1.276	0.700	-7.153	-2.855	1.314
with electricity	(1.42)			(0.13)	(1.11)			(0.52)	(0.24)	(1.54)	(0.83)	(0.35)
Clinic with electricity	9.250			7.486	3.243			2.197	-0.269	7.677	2.264	1.901
with electricity	(2.90)			(2.20)	(2.04)			(1.31)	(0.14)	(2.35)	(0.96)	(0.73)
Mobile family planning clinic visits	4.137			7.304	1.748			3.499	2.060	8.158	4.848	2.153
with electricity	(1.73)			(2.80)	(1.45)			(2.67)	(1.36)	(3.14)	(2.64)	(1.08)
Mobile immunization unit visits	5.580			2.462	1.659			-0.359	0.916	-4.779	-2.407	2.045
with electricity	(2.09)			(0.83)	(1.19)			(0.24)	(0.52)	(1.61)	(1.17)	(0.82)
Health worker visits	0.497			-0.560	-0.243			-0.882	-1.572	0.202	-2.487	1.284
with electricity	(0.22)			(0.23)	(0.21)			(0.74)	(1.15)	(0.08)	(1.43)	(0.74)
Community-based distributor visits		5.319		4.317		3.463		2.964	3.272	1.952	2.315	3.435
with electricity		(2.32)		(1.81)		(2.98)		(2.47)	(2.38)	(0.82)	(1.3)	(1.99)
<i>Community-based distributor characteristics^a</i>												
Sample kit		-0.434		0.570		0.137		1.614	2.270	1.142	0.500	2.814
with electricity		(0.15)		(0.15)		(0.09)		(0.86)	(1.05)	(0.30)	(0.18)	(1.03)
Bike		5.353		2.754		3.721		4.376	4.392	4.417	6.157	3.046
with electricity		(1.73)		(0.73)		(2.39)		(2.35)	(2.06)	(1.16)	(2.36)	(1.07)
Blood pressure		11.804		25.095		10.073		12.936	15.959	20.701	6.524	18.494
with electricity		(0.70)		(1.10)		(1.22)		(1.17)	(1.25)	(0.93)	(0.41)	(1.11)
Stethoscope		-8.468		-21.012		-8.350		-11.612	-14.832	-19.186	-5.198	-16.604
with electricity		(0.53)		(0.97)		(1.06)		(1.10)	(1.23)	(0.90)	(0.34)	(1.05)
Taken ZNFPC course		29.420		18.353		11.424		9.728	2.462	32.896	16.389	-2.346
with electricity		(2.62)		(1.37)		(1.94)		(1.42)	(0.31)	(2.47)	(1.76)	(0.22)

(Table continues on the following page.)

Table 3. (continued)

Variable	Ever use				Current use				By woman's education			
	General health infra-structure	Community-based distributors	All Clinic variables	All variables	General health infra-structure	Community-based distributors	All Clinic variables	All variables	By woman's age Less than 35	35 or older	Less than primary	Primary completed or more
<i>Clinic characteristics</i>												
Number of needles		2.400 (2.01)	3.692 (2.82)			1.866 (3.27)	2.698 (4.35)	1.476 (2.00)	5.932 (5.00)	3.286 (3.98)	1.323 (1.29)	
Lap-kits in stock ^a		119.404 (1.99)	117.703 (1.72)			41.281 (1.42)	10.411 (0.32)	-22.421 (0.56)	63.813 (1.09)	2.036 (0.04)	11.952 (0.26)	
Distributes condoms ^a		11.110 (2.13)	6.593 (1.13)			5.628 (2.01)	4.290 (1.40)	2.780 (0.80)	10.903 (1.63)	8.747 (1.92)	-0.669 (0.15)	
Distributes Depo Provera ^a		2.902 (0.58)	0.952 (0.16)			2.725 (1.08)	0.028 (0.01)	-3.638 (1.05)	7.008 (1.22)	1.202 (0.29)	-4.224 (0.92)	
Distributes other methods ^a		-2.966 (0.98)	0.599 (0.17)			-1.794 (1.20)	1.138 (0.65)	3.031 (1.52)	-4.008 (1.10)	0.904 (0.35)	3.152 (1.23)	
Suggests natural methods ^a		-19.458 (2.40)	-17.568 (1.98)			-7.943 (1.86)	-7.762 (1.68)	-8.718 (1.58)	-5.551 (0.66)	-13.291 (1.96)	-1.436 (0.21)	
Has at least one doctor ^a		6.886 (0.33)	-16.165 (0.74)			1.949 (0.19)	-12.292 (1.15)	-9.884 (0.80)	-12.546 (0.58)	-33.784 (2.08)	7.329 (0.48)	
Number of nurses		16.093 (2.27)	18.308 (2.27)			4.655 (1.33)	7.081 (1.80)	9.181 (2.00)	1.472 (0.19)	6.547 (1.06)	6.018 (1.12)	

<i>Test statistics</i>												
χ^2 tests												
Infrastructure	30.77			25.92	18.95			18.48	15.33	21.35	18.42	4.91
	[0.00]			[0.00]	[0.02]			[0.02]	[0.05]	[0.01]	[0.02]	[0.77]
CBD characteristics		15.43		7.37		22.41		19.23	18.53	7.90	11.33	11.31
		[0.02]		[0.29]		[0.00]		[0.00]	[0.01]	[0.25]	[0.08]	[0.08]
Clinic			24.18	25.18		23.11		30.20	13.58	31.74	29.21	8.49
			[0.00]	[0.00]		[0.00]		[0.00]	[0.09]	[0.00]	[0.00]	[0.39]
All services				62.69				64.29	46.72	52.56	54.74	23.66
				[0.00]				[0.00]	[0.00]	[0.00]	[0.00]	[0.37]
All covariates	1,541	1,526	1,535	1,574	804	808	808	850	730	187	228	628
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Likelihood	-2,139	-2,147	-2,142	-2,123	-2,057	-2,055	-2,055	-2,034	-1,489	-509	-1,036	-994
Pseudo R ²	0.26	0.26	0.26	0.27	0.16	0.16	0.16	0.17	0.20	0.16	0.10	0.24

Note: The values are maximum likelihood probit estimates transformed into derivatives. Asymptotic *t*-statistics are in parentheses, and *p*-values are in square brackets. All regressions include controls for woman's education, husband's education, marital status, presence of husband, age (represented by dummies for each five-year age group), ethnicity, and residence in rural area. The number of observations is 4,201.

a. Dummy variable: value is 1 if condition is true; 0 otherwise.

Source: Authors' calculations based on CSO and IRD/Macro International (1989). Measures of general health infrastructure are drawn from CSO and IRD/Macro International (1991); all other measures are drawn from ZNFPC (1992).

four columns allow us to determine the extent to which service availability and quality have differential effects on younger and older cohorts as well as to evaluate the likely distributional impact of public health investments.

General health infrastructure. Women who live within 30 kilometers of a general hospital are significantly more likely to use modern methods than women who live farther from a general hospital. This is a robust result, observed in all specifications and also reported in Guilkey and Cochrane (1992). It is, however, true only in rural areas because there is a hospital in virtually every urban area. Within the rural sector about 25 percent of sample women live within 30 kilometers of a general hospital, and these women are 10 percent more likely to use contraceptives than are other rural women. This does not simply reflect income differences across rural areas because the estimated effects in table 3 are conditional on the effect of income (to the extent that it is captured by the woman's marital status, her husband's education, and household asset ownership).

If the income-related measures are not included in the regression, the inference is unchanged but the magnitude of the effect is about 25 percent bigger. The increased magnitude reflects the fact that service availability is positively correlated with income and underscores the discussion above about the importance of controlling for income in order to interpret the regression results.¹³ It turns out (ninth through twelfth columns in table 3) that the benefits of general hospitals are greatest among younger women and also among the least educated; the latter result suggests these investments may be reaching the poorest women. Rural hospitals, in contrast, are not associated with a greater probability that a woman has adopted contraceptives.

Although every community in the ZDHS is within 30 kilometers of a clinic, half of these clinics have been open only since independence. We thus determine whether the impact of newer clinics is different from that of clinics that were established before 1980. The answer, from table 3, is clearly no. However, if the clinics have been located in areas where fertility was high with the intent of raising contraceptive usage, it may be argued that their placement should be treated as endogenous and inferences about their impact would be incorrect. This implies that new clinics should be located in areas where fertility is relatively high among women who would have completed their fertility by the early 1980s. We can evaluate the empirical importance of the argument by estimating a reduced form model in which all household and community characteristics are regressed on the number of children ever born to women over the age of forty in 1988. The effect of a new clinic is not only tiny in magnitude (0.05 with a *t*-statistic of 0.1) but it is also negative. This suggests that placement of health facilities was not primarily motivated by a concern over fertility. In fact, the

13. In general, estimated magnitudes tend to be greater in absolute value when income is excluded from the regressions, and for some community characteristics the effects become significant. Policy analysis based on models that do not control for income will therefore not only lead to overestimates of the effects of a program in these data but also to misleading inferences.

best predictors for the opening of a facility since independence are rural location and absence of modern water and sewerage infrastructure.

About three-quarters of rural hospitals and half the clinics are serviced by electricity: we use this as a measure of the quality of the infrastructure. From table 3, the availability of electricity does seem to matter at clinics, especially with respect to ever use, which suggests that this dimension of quality has a bigger effect on older women. This inference turns out to be correct: according to the results in the tenth column, older women who live within the vicinity of a clinic that has electricity are about 8 percent more likely to be using contraceptives.

Around half the sample women live in areas that receive regular visits from mobile immunization units and health workers. These units have no direct impact on women's contraceptive usage. Those mobile units that provide family planning services operate in remote and sparsely populated areas: although they operate in about 60 percent of the clusters, only a third of the women in the sample live in those clusters. The units do appear to have a powerful effect on use of contraceptives: it is approximately the same in magnitude as the effect of a general hospital in the area, after controlling for all other infrastructure. This is true for both current use and ever use. Mobile family planning units have their greatest impact among the poor as they seem to be successfully serving women with little education, for whom the impact is about the same as a general hospital. The units also tend to serve older women. These results suggest that equipping all mobile health units with family planning services may prove to be a good investment.

Taken together, the availability and quality of infrastructure do affect the probability that a woman uses modern methods: this is true for all women, young and old, and for those with less education but not for the better educated. Apparently, investments in infrastructure have been of greatest benefit to the poorest, at least in terms of increased contraceptive usage.

CBD characteristics. CBDs are an integral part of the delivery of family planning service in Zimbabwe today. Started in 1967 as a field educator program with a primary focus on urban and periurban areas, the CBD program grew dramatically during the 1980s and shifted its focus to rural women. Whereas in 1970 there were 50 CBDs, by 1982 about 300 were working, and by 1987 there were some 668 CBDs associated with ZNFPC (ZNFPC 1992). CBDs are selected by the communities they work in and are typically (but not universally) female. In theory, after a six-week course conducted by ZNFPC, the CBD is equipped with a bicycle, some elementary medical equipment, and supplies of oral contraceptives and condoms. The CBD is supposed to visit each woman in the local community in an attempt to educate, motivate, and screen her suitability for oral contraceptives and, if appropriate, issue her with a four-week supply of contraceptives. At the end of this cycle the woman is directed to visit the local clinic (with which the CBD is associated) for a complete checkup. All being well, the CBD resupplies her for another four weeks. If, after four visits, the woman is

not having any method-related problems, she is supplied with three cycles of pills and the CBD visits her once every three months.

Women in areas with CBDs are significantly more likely to be using modern contraceptives and to have ever used modern methods. This effect is larger for younger women and insignificant for older women. Although one goal of the CBD program is outreach to those who do not otherwise have access to family planning services, these data indicate that the impact of CBDs is actually larger on the *better educated* and is significant for that group but not for the less educated (although the gap is not significant).

Drawing on data from the Zimbabwe Situation Analysis Study we have attributed information on the quality of representative CBDs to each district. Two factors matter: whether the CBD has a bicycle and whether the CBD has taken a course from the ZNFPC. Both these quality indicators are more important (and significant) for women with little education. Stratifying on sector of residence, the presence of a CBD in the area has a significant effect only in the urban sector, and these quality indicators are only significant in the rural sector. This may suggest that all CBDs in the urban sector are effective in motivating women to use contraceptives or that they are simply filling a demand that would be satisfied through another outlet (such as the ZNFPC clinic). In the rural sector, however, investments in simple equipment (bicycles) and training may have a payoff both in terms of improved motivation and also better access to women in more remote areas.¹⁴

Although CBD characteristics do have a significant impact on current contraceptive usage, they are not associated with the probability that a woman has ever used a modern method; this suggests that the CBD program has been more effective in recent years. This is consistent with the fact that CBD characteristics have no impact on usage by older women but do affect the probability among younger women.

CBDs tend to be located in lower income areas in Zimbabwe, and it turns out that inference regarding their impact on usage relies on simultaneously controlling for household resources (education and asset ownership). When household characteristics are excluded from the model, the CBD visits are not associated with higher contraceptive usage. This is another example that demonstrates the importance of controlling for local resources in these sorts of analyses.

Clinic characteristics. Finally, we turn to characteristics of clinics (again drawing on data for the district from the Zimbabwe Situation Analysis Study). Two measures of “quality” stand out as being significant. The first is the number of needles in stock, which has a positive impact on current and ever usage; the effect is significant for both young and older women (and very large for the latter) and is significant only for women with less education. This result is

14. These and the results for a general hospital in the area are the only ones that depend on stratification of the sample by sector of residence. These estimates are, therefore, not reported in the tables.

consistent with the effect of a general hospital and indicates that poorer women are using facilities that are better equipped.¹⁵

The second significant characteristic of clinic quality is the number of nurses, which also has a positive effect on usage, especially among younger women. Facilities with at least one doctor, however, tend to be associated with a lower probability of using modern methods among the less well educated. Negative effects of doctors have been reported in other studies of contraceptive usage (Feyisetan and Ainsworth 1996) and child health (Thomas, Strauss, and Henriques 1990).

The majority of women in Zimbabwe use oral contraceptives and so the model includes information about whether other methods are available in the clinic. It appears that providing a range of family planning options does not have a significant effect on usage except, perhaps, condoms among the less well educated. If the clinic has a policy of suggesting natural methods, then modern method usage tends to be lower in the area, again among the less educated. Taken together, clinic services and quality affect the probability of using modern methods, but only among older women and the less well educated.

Other dimensions of quality and availability of services. The two community surveys are very rich, and a number of other dimensions of quality and availability of services have been included in other specifications. These include whether particular methods were in stock at the time of the survey and whether personnel were available for consultation; neither turns out to have a significant effect. Prices of services comprise two components: the financial cost of the service and the time cost associated with getting to the facility. Price data are hard to collect particularly when there is heterogeneity in quality of services; we have experimented with including the price of a package of pills and find that it has no effect on usage. In part, this is because there is very little heterogeneity in the price (for example, *all* ZNFPC clinics in the survey charge Z\$0.20). Similarly, experiments with a variety of specification of distance to facilities (which captures part of the time costs) indicate that distance does not have an impact on usage. The one exception is distance to ZNFPC facilities; the closer the facility, the more likely a woman uses modern methods. In view of the earlier discussion regarding the failure of local informants to identify ZNFPC facilities, it is not obvious how to interpret this result. We have also chosen to exclude pharmacies from the analysis—for the same reason. On the basis of our knowledge of the country, several informants identified pharmacies that were not the closest, and many informants failed to identify a pharmacy at all.

15. Lap-kits, which are used to perform sterilization, have a significant positive effect on ever use (when only clinic characteristics are included in the regression). The effect is negative for young women but positive for older women (although neither is significant); this suggests that older women who have used contraceptives are more likely to have had a laparotomy. However, the results should be treated with caution because less than 5 percent of clinics have lap-kits.

In sum, it would seem that, at least with the measures of availability and quality used in this analysis, investments in infrastructure have a positive impact on the adoption of modern methods (from table 3, the χ^2 for all community service characteristics for current use is 64.3). These effects are significant for both young and old women and for the less educated but not the better educated. It is quite likely that the better educated acquire their contraceptives from private sources and so public investments are not only productive but they also serve a distributional role by bringing family planning to the poorer women of Zimbabwe. As an additional check on the robustness of these results, models have been estimated which control for all observable and unobservable community characteristics by including a community fixed effect in a linear regression. While the fixed effect sweeps out the direct impact of all the community services, it is still possible to examine differences in the impact of these services on women across the education distribution. The contrasts drawn out in this article are also apparent in the fixed-effects estimates with several of the interactive effects being significant. For example, the interaction between education and visits by a CBD is positive and significant, indicating that even after controlling for all community heterogeneity (and also potential problems associated with selective program placement), CBDs tend to have a bigger impact on the contraceptive usage of better educated women relative to women with little education.

IV. CONCLUSIONS

There can be little doubt that the availability and quality of family planning and health services in the community are associated with higher rates of adoption of modern contraceptives in Zimbabwe and these effects tend to be larger for less educated women. Public health policy has sought to bring CBDs to all communities in Zimbabwe: according to our results, this is likely to be associated with increased adoption of modern methods. Mobile family planning clinics seem to have an even more powerful impact on adoption of contraceptives as does the presence of a general hospital in the area. It is especially important that the impact of these two investments in infrastructure is larger among women with little education.

Not only do these services have a significant impact on usage but the magnitude is substantial. For example, if a hospital, mobile family planning unit, and CBD were all introduced to a community where they did not previously exist, then our estimates suggest that contraceptive usage would be raised from 30 percent to 40 percent, on average. This is a very large effect. For example, in terms of the impact on contraceptive adoption rates, it is equivalent to giving a woman who has only completed preschool an additional seven years of schooling (so she completes Form 2).

Education also has a direct, powerful impact on contraceptive usage and fertility, especially among younger and urban women for the case of fertility. Part of

the impact of education may be attributed to the role of income and part to unobservable differences among women who complete particular grades (at least for contraceptive usage). It behooves us to better understand the mechanisms that underlie these correlations: one possibility is that education's impact on contraception use and fertility reflects increased labor market opportunities for educated women in post-independence Zimbabwe.

Table A-1. *Sample Means: Individual and Household Characteristics*

Variable	By woman's age			By woman's residence	
	All women	Less than 35	35 or older	Urban	Rural
<i>Women's contraceptive use and knowledge (percent)</i>					
Know modern method	95.38	94.95	96.64	97.23	94.45
Currently use modern method	27.21	27.96	25.00	33.62	23.98
Currently use pill	23.54	25.95	16.51	27.65	21.47
Currently use traditional method	4.98	3.80	8.40	2.63	6.16
Ever used modern method	48.42	46.47	54.10	55.86	44.67
<i>Fertility</i>					
Number of children ever born	2.95	1.86	6.15	2.28	3.29
Number born in last 5 years	0.79	0.83	0.71	0.64	0.88
Completed fertility (women age 45 and older)	6.83	n.a.	n.a.	4.99	7.51
Number of births in last year	0.17	0.19	0.11	0.13	0.19
Age at first birth (years)	18.84	18.49	19.49	19.14	18.70
Child survival rate (percent)	91.96	93.30	89.42	94.77	90.65
<i>Household characteristics</i>					
Women with completed years of education (percent)					
0	13.64	10.07	24.07	6.47	17.25
1	1.64	1.28	2.71	0.71	2.11
2 (complete preschool)	4.05	2.81	7.65	1.99	5.08
3	4.86	3.29	9.42	2.63	5.98
4	4.95	4.06	7.56	3.84	5.51
5	9.47	7.96	13.90	5.05	11.70
6	9.19	9.46	8.40	6.18	10.70
7 (complete primary)	21.59	23.62	15.67	22.17	21.30
8	4.71	5.91	1.21	4.90	4.62
9 (complete Form 2)	8.76	10.13	4.76	13.43	6.41
10	3.14	3.99	0.65	4.62	2.40
11 (complete Form 4)	12.26	15.47	2.89	23.67	6.51
12 or more	1.74	1.95	1.12	4.34	0.43
More than primary school	30.61	37.46	10.63	50.96	20.37
Husbands present (percent)	44.58	39.02	60.82	49.18	42.27
Husbands with completed level of education (percent)					
Preschool	1.81	1.47	2.80	0.64	2.40
Some primary school	16.14	10.87	31.53	8.60	19.94
Complete primary school	18.76	17.90	21.27	15.42	20.44
Complete Form 2	9.16	9.24	8.96	12.01	7.73
More than Form 2	13.07	14.51	8.86	23.10	8.02
Age of respondent (years)	27.82	23.28	41.08	27.22	28.12

Table A-1. (continued)

Variable	By woman's age			By woman's residence	
	All women	Less than 35	35 or older	Urban	Rural
Households that own assets (percent)					
Bicycle or motorcycle	26.66	25.95	28.73	26.72	26.63
Car	11.69	12.08	10.54	25.66	4.65
Radio	45.82	48.19	38.90	74.91	31.17
Television	14.76	15.50	12.59	39.30	2.40
Cattle	40.66	38.99	45.52	5.12	58.55
Goats or sheep	41.61	40.17	45.80	4.34	60.38
Percentage of women who are:					
Shona ^a	78.15	77.82	79.10	69.72	82.39
Married	62.91	56.09	82.84	55.37	66.71
Divorced	10.12	8.15	15.86	12.22	9.06
Resident in rural sector	66.51	64.88	71.27	0.00	100.00

n.a. Not applicable.

a. Ethnic group in Zimbabwe.

Source: Authors' calculations based on CSO and IRD/Macro International (1989).

Table A-2. *Sample Means: Community Characteristics*

Variable	Cluster level	Sample women		
		All	Urban	Rural
<i>General infrastructure (percent)</i>				
General hospital	50.1	51.1	98.2	27.4
Rural hospital	25.7	26.3	7.7	35.7
With electricity	18.6	19.1	7.7	24.8
Clinic built since 1980	45.5	47.4	24.4	59.1
Clinic with electricity	47.3	45.5	98.1	19.1
Visited by health worker	28.7	62.9	38.8	75.1
Visited by mobile immunization unit	42.5	43.6	0.0	65.6
Visited by mobile family planning unit	61.7	30.7	9.9	41.2
<i>Community-based distributor (percent)</i>				
Visited by CBD	60.5	62.8	34.5	77.1
CBD has sample kit	50.1	51.3	31.4	61.3
CBD has bike	39.5	39.1	20.3	48.5
CBD has blood pressure gauge	20.8	21.6	15.5	24.7
CBD has stethoscope	19.7	20.5	13.9	23.8
CBD has taken ZNFPC course	50.8	51.4	34.5	60.0
<i>Clinic characteristics</i>				
Number of needles in stock (thousands)	3.0	2.7	2.2	2.9
Lap-kits (percent)	3.6	2.7	1.6	3.2
Distribute condoms (percent)	92.2	91.1	98.4	87.4
Distribute Depo Provera (percent)	15.0	15.9	21.7	13.0
Distribute other methods (percent)	41.3	40.3	67.8	26.5
Suggest natural methods (percent)	6.6	6.1	5.4	6.5
Have at least one doctor (percent)	13.2	10.1	25.9	2.1
Number of nurses	8.0	7.2	14.9	3.3
Sample size	166	4,201	1,407	2,794

Source: Authors' calculations based on CSO and IRD/Macro International (1989). Measures of general health infrastructure are drawn from CSO and IRD/Macro International (1991); all other measures are drawn from ZNFPC (1992).

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