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Social Interactions and Contemporary Fertility Transitions

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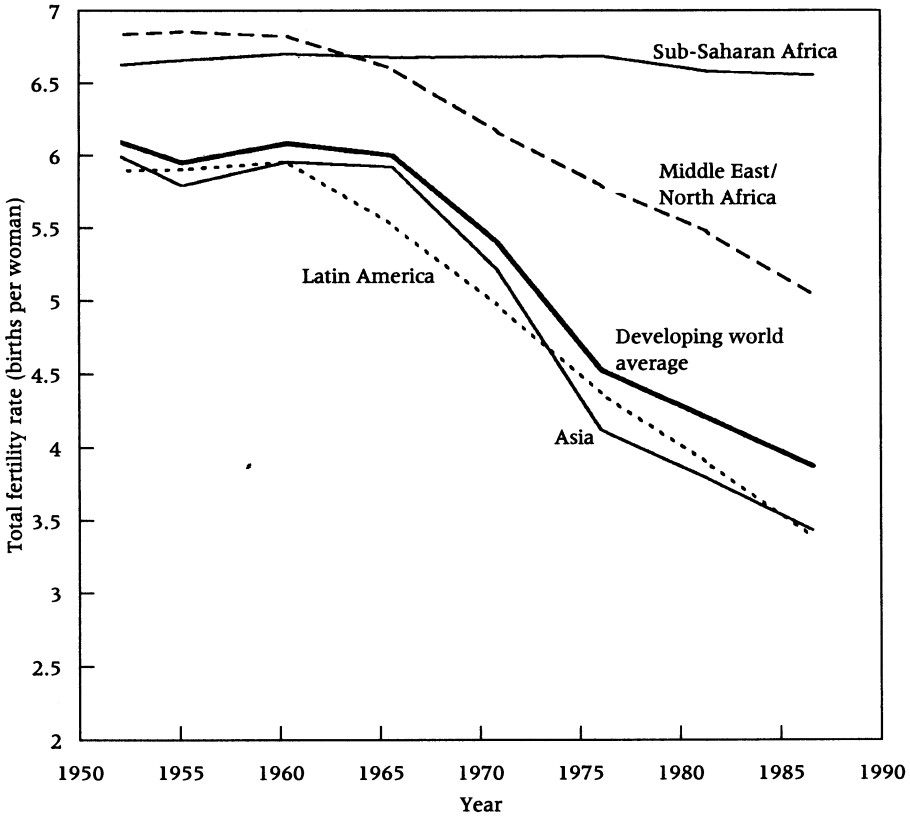
OVER THE PAST three decades, rapid fertility transitions have been observed in a majority of developing countries. Between the early 1960s (1960–65) and the late 1980s (1985–90), the total fertility rate of the developing world as a whole declined by an estimated 36 percent—from 6.0 to 3.8 births per woman (United Nations 1995). Declines have been most rapid in Asia and Latin America (–42 and –43 percent respectively), less rapid but still substantial in the Middle East and North Africa (–25 percent), and almost nonexistent in sub-Saharan Africa (see Figure 1). These averages conceal wide variations among countries in the timing of the onset of transitions and their subsequent pace. At one end of the spectrum are a few countries (for example, Hong Kong, Singapore) where a fertility transition started around 1960, followed by swift further reductions to and below replacement level. At the other extreme are countries, mostly in sub-Saharan Africa, that have not begun a transition.

These remarkable trends in reproductive behavior have been extensively documented in censuses and surveys, and the empirical record is not in dispute. The causes of these trends, however, are the subject of frequently contentious debate. Perhaps the most influential statement of the causes of fertility declines was formulated by Frank Notestein (1953). In traditional rural, agricultural societies, fertility was seen as necessarily high to offset high mortality and to insure population survival. As a society develops (modernizes), economic and social changes such as industrialization, urbanization, and increased education first lead to a decline in mortality, and subsequently also to a decline in fertility. The rising costs and declining economic value of children were the central forces Notestein believed to be driving fertility declines. The weakened motivation for having children, together with increased child survival, led to the adoption of fertility control.[1]

FIGURE 1 Total fertility rate by region of the developing world, 1950–55 to 1985–90



SOURCE: United Nations 1995.

Notestein's theory, along with other formulations of the impact of modernization on demographic behavior, came to be referred to as classical demographic transition theory, and stimulated a great deal of empirical research. A comprehensive attempt to test this theory was the massive European fertility study led by Ansley Coale, who used provincial-level data from European countries for the period 1870 to 1960 (Coale and Watkins 1986). Two key conclusions emerged from this work: (1) socioeconomic conditions were only weakly predictive of fertility declines, and transitions started at widely varying levels of development; (2) once a region in a country had begun a decline, neighboring regions with the same language or culture followed after short delays, even when they were less developed. The findings were unexpected and did not fit existing thinking about the demographic transition. Another body of empirical work was stimulated by the microeconomic theories of Gary Becker (1981), but evaluations of

these theories with data from surveys of individuals in 42 developing countries did not find the expected dominant influence of socioeconomic characteristics on fertility (Cleland and Wilson 1987). This and other research has demonstrated that there is no tight link between development indicators and fertility. Most traditional societies do have high fertility when compared to modern industrial societies, but the transition itself is poorly predicted by customary quantitative measures of development.

Despite these findings, the role of socioeconomic development in accounting for fertility declines remains inherently plausible, and benefit–cost models of individual fertility decisionmaking are central to the most influential interpretations of fertility decline, those by Richard Easterlin (1978) and John Caldwell (1982). Most contemporary analysts accept development as one of the driving forces of fertility transition, but they vigorously debate the precise variables and processes involved. These disagreements have been stimulating and fruitful, producing increasingly refined and detailed views that have guided empirical investigations. Yet there is still no agreement on why reproductive change began earlier in some countries than in others, or why some fertility transitions have been precipitous and others leisurely. A recent review of the literature by Charles Hirschman (1994) concludes, "The dilemma is that there is no consensus on an alternative theory to replace demographic transition theory. . . . So the debate continues with a plethora of contending theoretical frameworks, none of which has gained wide adherence" (p. 214).

Our analysis begins by examining the empirical record of trends in fertility and measures of social and economic development for 69 developing countries between 1960 and 1990. We find an important role for social and economic development. Our analysis also finds that the relationship between development and pretransitional fertility, the timing of the transition, and the pace of fertility decline deviate substantially from what would be expected if fertility and development were closely linked, but we are able to identify new and interesting empirical regularities. In the second part of the article we interpret these findings by pointing to the role of social interaction, which we conclude is a critical and neglected process in fertility transitions.

Fertility and development

A key objective of this study is to assess the extent to which the observed variation among developing countries in fertility levels and trends can be accounted for by conventional measures of development. After a brief examination of fertility change in developing countries, we focus on the relation between development and fertility in pretransitional societies, between development and the timing of the onset of transitions, and then on

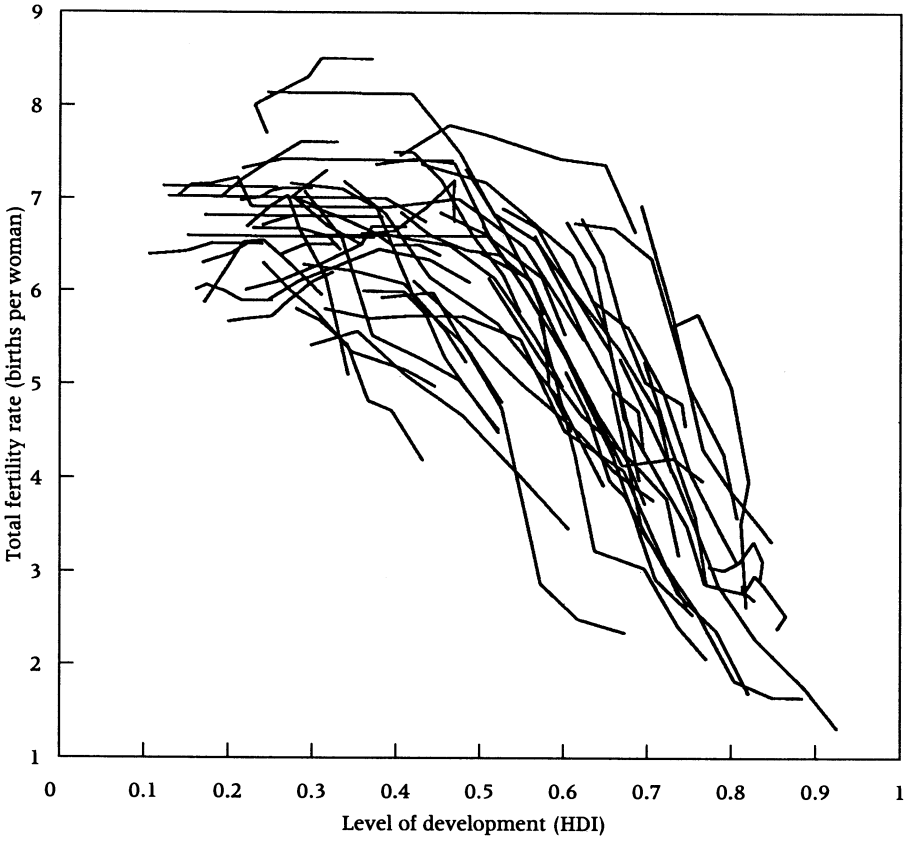
the relation between development and the rate of fertility decline once the transition is underway. The distinction between timing and pace is particularly important, since they independently influence the relative levels of fertility across countries at any given date.[2]

We define level of development in terms of conventional socioeconomic indicators such as income, urbanization, literacy, life expectancy, and the like. Instead of presenting our findings separately for each of these variables, we rely on the human development index (HDI) proposed by UNDP (1990: 109) as an overall measure of development for most descriptive purposes. This index has values ranging from 0 (least developed) to 1.0 (most developed), and it is calculated as a linear combination of three socioeconomic variables: life expectancy, literacy, and real GDP per capita (log of purchasing power parities—PPP). We have calculated this index for each of the 69 countries included here at five-year intervals from 1960 to 1985 (see Appendix A).[3] By relying on a single composite measure of development, the presentation of findings is greatly simplified without compromising the conclusions, which are typically the same when the analysis is repeated separately for individual socioeconomic variables.

Figure 2 plots the total fertility rate by level of development as measured by the HDI, with each country contributing one line consisting of six data points corresponding to six time periods, starting with the fertility rate in 1960–65 and the HDI for 1960, and ending with the fertility rate in 1985–90 and the HDI for 1985. Three conclusions are suggested by the data in Figure 2. First, there is a highly significant negative correlation between HDI and fertility ($R^2 = 0.6$). Fertility is generally highest among countries with low HDI scores and vice versa. Similar but on average weaker negative correlations exist for the effect of the different socioeconomic variables included in the calculation of HDI. A multiple linear regression with five independent variables (life expectancy, literacy, GDP per capita, urbanization, and percent of labor force in agriculture) yielded a slightly but not significantly higher correlation coefficient. Second, the relationship between fertility and levels of development is nonlinear. Up to levels of HDI around 0.4, fertility appears largely unresponsive to improvements in development. However, as the HDI rises beyond 0.6, nearly all countries are in transition. Third, and most important, fertility varies widely among countries at any given level of development. For example, in countries with HDI around 0.6, the total fertility rate ranges from less than 3 to more than 7 births per woman. Variation in widely available standard measures of development alone apparently provides only a partial explanation for fertility differences among countries.

The loose link between fertility and HDI and other development variables can in part be attributed to misspecification of the explanatory variables. If better indicators could be found to measure more directly the costs

FIGURE 2 Relationship between total fertility rate and development level (HDI) for 69 developing countries, 1960–65 to 1985–90



and benefits of children, the correlation with fertility would no doubt increase. However, a closer examination of the data included in Figure 2 revealed an unexpected finding: the relationship between fertility and development indicators shifts over time. This is evident from Figure 3, which plots estimates of average fertility by level of development (HDI) for two five-year periods—1960–65 and 1985–90. Countries with levels of development above 0.3 in 1960–65 had considerably higher fertility than countries with the same level of development in 1985–90. (A nonlinear multivariate regression analysis, presented in Appendix B, confirms the statistical significance of this finding.)

The impact of this shift can be demonstrated with a simple example. A hypothetical country with HDI = 0.5 in 1960 would be expected to have a total fertility rate of 6.7 births per woman, represented by point A in

FIGURE 3 Trend in average total fertility by level of development (HDI)

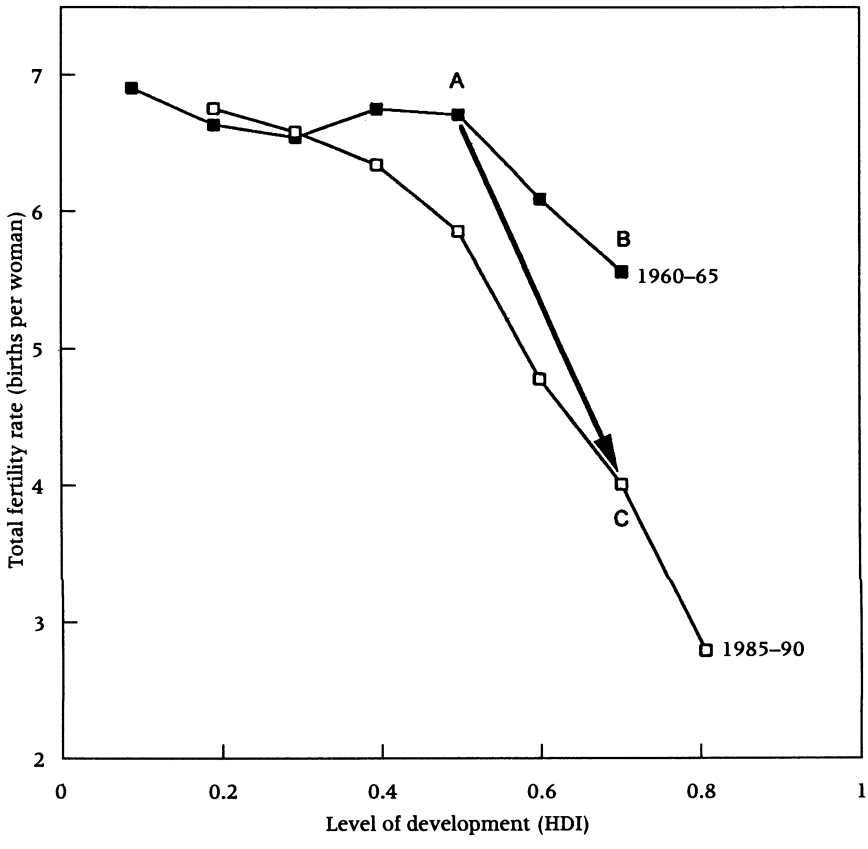


Figure 3. If this country developed to reach an HDI of 0.7 in 1985, then, in the absence of this shift, one would expect the trajectory of fertility over time to coincide with the upper graph in Figure 3, so that this country would end up at point B in 1985 with fertility at 5.6. In reality, however, fertility would (on average) have changed to 4.1 births per woman (that is, to point C, rather than B). The fertility decline between points A and C (2.6 births) therefore consists of two components: one representing development (A – B = 1.1 births) and an unexplained residual of 1.5 births (B – C). This residual can account for a large part of the fertility decline of countries. The same type of analysis led Samuel Preston (1975) to similar conclusions about the partial role of development in accounting for another example of widespread demographic change, that of mortality transitions in developing countries.[4]

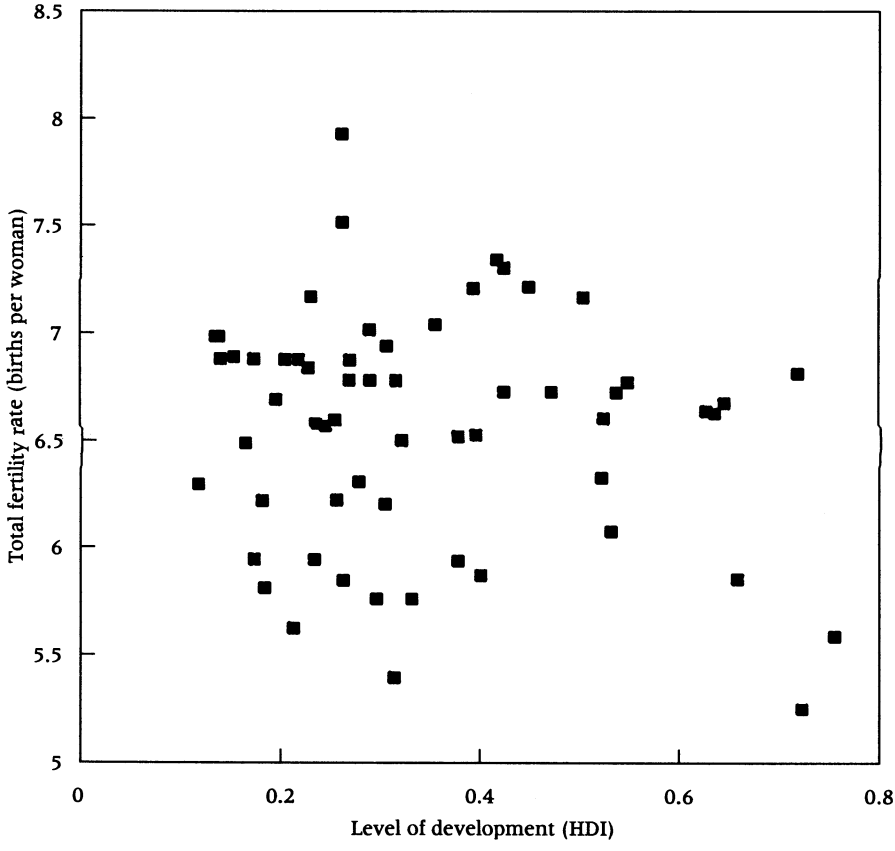
Family planning programs, which have grown in number and efficacy in recent decades, are partially responsible for this change in relation-

ship between development and fertility, but other factors are clearly also operating because even in countries with weak or nonexistent programs there is a substantial shift (see Appendix B). Before attempting to explain these findings, we examine in greater detail the link between development and fertility in different phases of fertility transitions.

Pretransition

In 1960–65, the total fertility rate of countries that had not yet entered the transition averaged 6.7 births with a standard deviation of 0.7.[5] There was some variation in regional averages: 6.3 in Asia, 6.6 in Latin America, 7.1 in the Middle East/North Africa, and 6.8 in sub-Saharan Africa. Figure 4 plots the pretransitional fertility of individual countries in 1960–65 by level of development (HDI) in 1960. Differences among countries were substan-

FIGURE 4 Relationship between total fertility rate and level of development (HDI) for pretransitional countries in 1960–65



tial, ranging from below 5.5 to slightly below 8 births, although the large majority fell between 6 and 7.5. Interestingly, there is no correlation between pretransitional fertility and the index of development (nor with individual socioeconomic variables), despite the wide range of development levels plotted in Figure 4.

The nature of pretransitional fertility has been the subject of numerous studies (Henry 1961; Knodel and van de Walle 1979; Coale and Watkins 1986; Bongaarts and Menken 1983; van de Walle 1992). One conclusion from this past research is that pretransitional fertility is "natural," that is, the large majority of couples do not consciously practice birth control to limit the number of children they have. The concept of natural fertility has been criticized in part because the indirect methods that were used to determine whether fertility was natural were not very accurate (Blake 1985; Wilson, Oeppen, and Pardoe 1988).[6] This measurement problem has been overcome in contemporary fertility surveys, in which couples can be asked directly about their birth control practices. For example, in the Demographic and Health Surveys only a very small percentage of couples report practicing modern or traditional contraception in pretransitional societies such as Burundi, Liberia, Mali, and Uganda (Rutenberg et al. 1991). What little contraception exists is concentrated among the more educated and urban married couples, and may not indicate a timeless pattern but rather the first stages of a fertility transition.

The existence of natural fertility does not mean that its level is the same in every society or that it is invariant over time within a society. As Figure 4 shows, there is considerable variation in the total fertility rates of pretransitional populations. In addition, historical studies have documented variations over time in the fertility of pretransitional societies (Wrigley and Schofield 1981; Dyson and Murphy 1985). These trends and differences are attributable to variations in proximate variables other than contraception (Bongaarts and Potter 1983). The most important of these proximate factors are the marriage pattern and the duration and intensity of breastfeeding. Natural fertility is highest in populations with low ages at marriage and short durations of breastfeeding, and it is lowest when marriage is late and breastfeeding long. Patterns of nuptiality and breastfeeding are, in turn, largely determined by community customs and are thus under social control (Watkins 1991).

The onset of a transition

As noted, one of the principal conclusions from analyses of fertility transitions in Europe is that they began under a wide range of socioeconomic circumstances. We now examine the evidence on this issue in the contemporary developing world. Table 1 indicates the year of the transition onset (as measured by a fall of 10 percent in fertility from its pretransitional maxi-

mum) as well as the human development index and several socioeconomic variables in that year for the countries among the 69 in our sample that began a transition between 1959 and 1988. These data demonstrate the enormous diversity in each of the indicators at the time of the transition onset. For example, in several countries the fertility decline did not begin until the HDI climbed above 0.7 (Costa Rica, Chile, Panama, Jamaica, and Mexico), while in five countries (Egypt, India, Haiti, Bangladesh, and Nepal) the HDI was below 0.4 at the onset of the transition. Differences between minima and maxima are similarly wide for each of the socioeconomic variables: life expectancy (47 to 67 years), literacy (25 to 97 percent), GDP per capita ($503 to $4,793), urbanization (11 to 100 percent), percent of labor force in agriculture (8 to 92 percent), and infant mortality (37 to 176 deaths per thousand).

Large differences in conditions at transition onset are also found within each major region. The ranges for HDI were 0.32 to 0.67 in Asia, 0.35 to 0.80 in Latin America, 0.36 to 0.68 in the Middle East/North Africa, and 0.50 to 0.61 in sub-Saharan Africa. There are no significant differences among the average HDIs at transition in Asia (0.49), Middle East/North Africa (0.49), and sub-Saharan Africa (0.54), but Latin America's average HDI of 0.61 was significantly higher than elsewhere.

The main implication of these findings is that, as in Europe, at the onset of a fertility decline the level of development as measured by conventional socioeconomic indicators is highly variable and has very limited power to predict a country's transition timing. While one can say with confidence that countries with an HDI below 0.30 are likely to be pretransitional, and countries with an HDI at 0.75 or above are almost certainly posttransitional, this range is so wide as to be of modest use for analytic or policy purposes. There is apparently no fixed threshold of development for entry into the transition. In this respect, the contemporary record is a continuation of the historical one.

Examination of the historical evidence in Europe shows that regions (geographically proximate provinces with a common language and elements of a common culture) tend to experience fertility decline at more or less the same time, largely independently of the level of development (Anderson 1986; Coale 1973; Lesthaeghe 1977; Watkins 1986). A transition typically first occurs in the most industrialized, literate, and urban provinces of a region, and then spreads after short delays to other provinces in the same region, even if these have far lower levels of development. To determine whether this finding also applies in the contemporary developing world, we rely here on macro-regions (consisting of countries as units) because time series of fertility and socioeconomic measures for regions within countries are not readily available.

Figures 5a and 5b plot the trend in the human development index over time for countries in Asia and Latin America. Each line represents

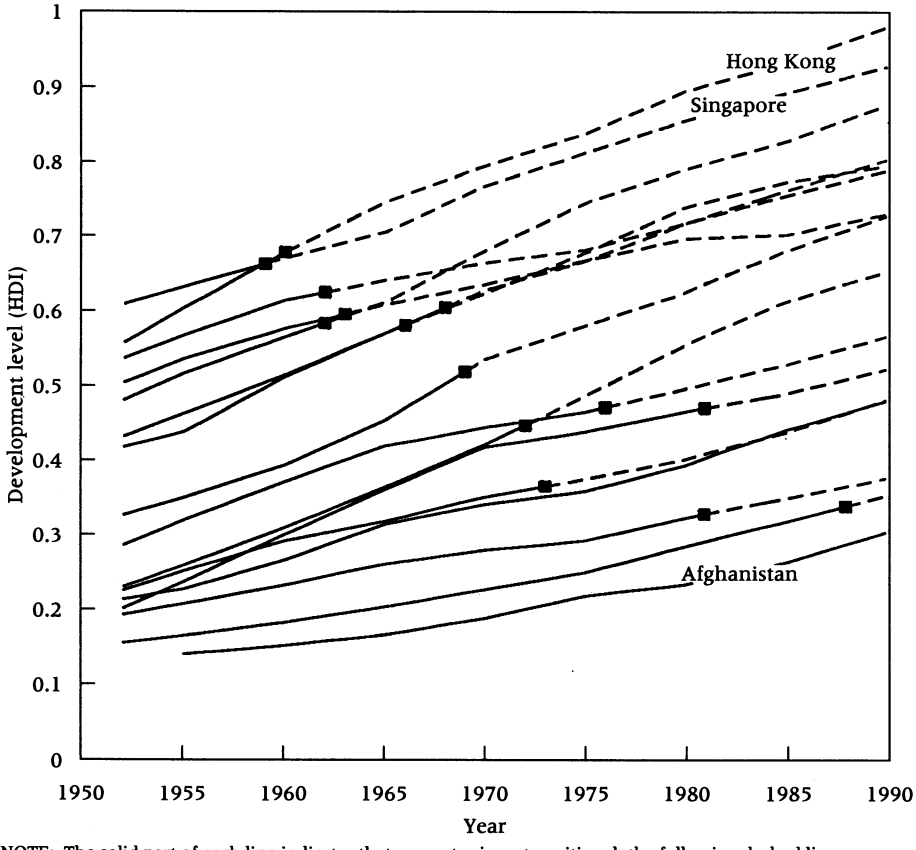
TABLE 1 Human development index (HDI) and selected socioeconomic variables in the year of the onset of the fertility transition: Developing countries whose onset of transition occurred between 1959 and 1988

Country	Transition year	Development index	Life expectancy (years)	Literacy rate (percent)	GDP per capita (US$)	Percent urban population	Percent labor force in agriculture	Infant mortality rate (per thousand births)
Singapore	1959	0.65	63	65	2394	100	9	37
Hong Kong	1960	0.67	65	66	2512	85	8	41
Korea (South)	1962	0.58	54	81	1012	30	63	70
Sri Lanka	1962	0.62	62	70	1370	19	56	65
Turkey	1962	0.45	50	38	1772	32	77	176
Philippines	1963	0.59	53	80	1279	31	59	75
Mauritius	1963	0.60	60	59	2242	36	34	62
Costa Rica	1965	0.73	63	86	2585	38	45	73
Malaysia	1966	0.57	57	56	2210	26	59	52
Brazil	1966	0.58	56	62	2148	52	45	102
Chile	1966	0.73	59	88	3631	73	27	94
Thailand	1968	0.60	56	76	1376	13	81	80
Colombia	1968	0.66	59	77	2278	56	40	80
Dominican Rep.	1968	0.57	56	65	1528	39	60	103
Egypt	1968	0.36	49	34	806	42	55	166
China	1969	0.51	57	56	858	18	76	73
Paraguay	1969	0.67	65	79	1443	37	51	57
Panama	1970	0.72	64	81	2561	47	38	46
Tunisia	1970	0.45	53	32	1947	44	45	127
Ecuador	1971	0.63	57	73	2095	40	54	97

Jamaica	1971	0.80	67	97	2955	42	28	43
Peru	1971	0.62	53	72	3051	58	45	114
Indonesia	1972	0.45	48	57	930	18	64	114
El Salvador	1972	0.56	57	59	1766	40	55	99
India	1973	0.36	50	36	649	21	71	131
Haiti	1974	0.35	48	29	879	22	76	129
Mexico	1974	0.74	63	77	4747	62	42	64
Nicaragua	1974	0.60	55	64	2647	50	49	99
Morocco	1975	0.43	53	28	1650	38	55	115
Myanmar	1976	0.47	50	74	503	24	66	116
Zimbabwe	1976	0.50	52	58	1260	20	62	87
Honduras	1977	0.54	56	60	1281	34	64	90
Bolivia	1978	0.55	50	66	1821	43	51	127
Guatemala	1978	0.55	56	48	2451	37	56	80
Bangladesh	1981	0.32	47	30	675	12	73	130
Papua-New Guinea	1981	0.47	50	43	1783	13	82	66
Botswana	1984	0.61	56	68	2536	19	34	71
Kenya	1984	0.52	56	63	898	19	76	77
Syria	1985	0.68	63	59	4793	49	29	53
Lesotho	1985	0.58	56	73	1243	17	85	93
Nepal	1988	0.33	51	25	770	11	92	110

SOURCE: See Appendix B.

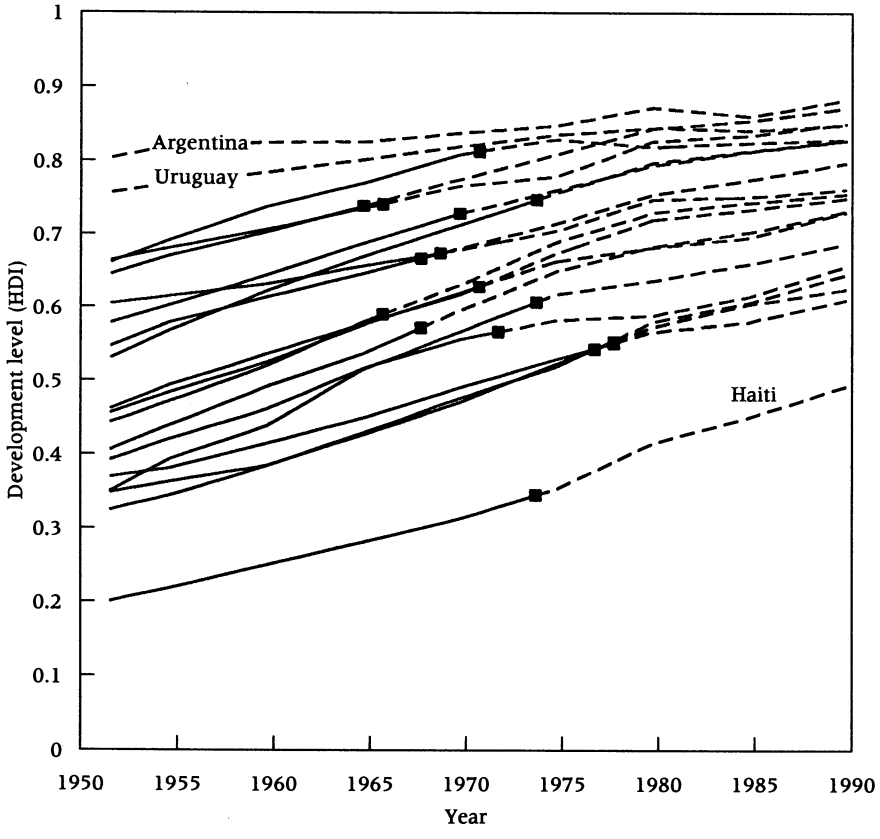
FIGURE 5a Trend in development level (HDI) and fertility transition status for 16 Asian countries



NOTE: The solid part of each line indicates that a country is pretransitional; the following dashed line represents the transitional phase. The square marker represents the transition point.

one country, and the upward slope of these lines indicates that countries have generally experienced a steady improvement in development since the 1950s. The solid part of every line indicates that a country is pretransitional, while the following dashed part represents the transitional phase (the square marker represents the transition point). In Asia, four countries entered the transition around 1960 (i.e., Singapore, Hong Kong, Korea, and Sri Lanka), while Bangladesh, Papua-New Guinea, and Nepal were the latest to begin a decline, in the 1980s. Afghanistan and Pakistan were still pretransitional countries in 1990. In Latin America, Costa Rica, Brazil, and Chile were the first to enter the transition (around 1965), and Bolivia and Guatemala were last (in 1978). Argentina and Uruguay experienced sustained fertility declines early in this century, and they are both transitional during the entire period considered here.

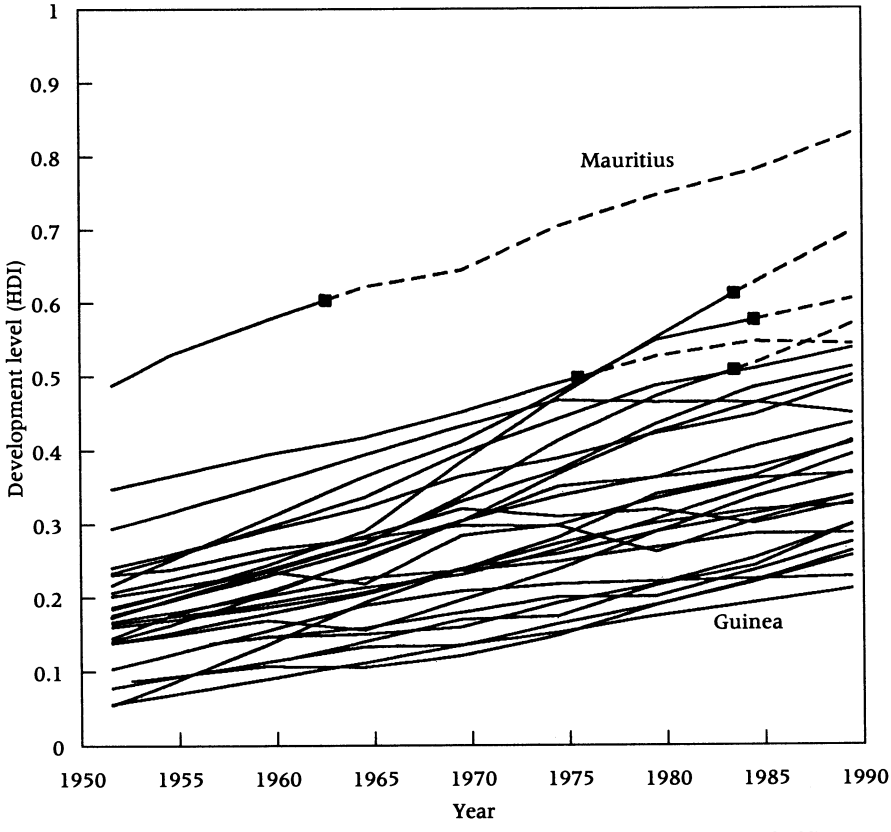
FIGURE 5b Trend in development level (HDI) and fertility transition status for 19 Latin American countries



NOTE: The solid part of each line indicates that a country is pretransitional; the following dashed line represents the transitional phase. The square marker represents the transition point.

The most interesting finding from Figures 5a and 5b is a clear reduction over time in the level of development associated with transition onset. Transitions are observed first among the most developed countries within each macro-region, and later transitions are initiated at much lower development levels. The significance of this pattern is confirmed with a logistic regression in which transition status (pre/post) is the dependent variable and the independent variables are the human development index and the time elapsed since the first country in the region entered the transition post-1950. These explanatory variables have a highly significant effect ($p < 0.01$) in both Asia and Latin America, and they predict the transition status of countries between 1960 and 1990 with 90 percent accuracy in Asia and 91 percent in Latin America. Apparently, even though the level of development alone is a relatively poor predictor of transition onset, the

FIGURE 5c Trend in development level (HDI) and fertility transition status for 28 sub-Saharan African countries



NOTE: The solid part of each line indicates that a country is pretransitional; the following dashed line represents the transitional phase. The square marker represents the transition point.

development level and years since the beginning of transition in the region together are highly predictive of transition status.

While these results are consistent with those obtained from previous analyses of the historical record in Europe, they are less consistent with classical demographic transition theory, which predicts neither the large variation in conditions at the time of transition nor the patterns evident in Figures 5a and 5b. The pattern of onsets of transitions observed here suggests a moving threshold model. That is, the first countries to begin a sustained fertility decline within a region do so only after relatively high levels of development have been attained. Once a few countries have entered the transition, the threshold drops for the remaining countries and the probability of entering a transition rises over time. The last countries to enter the transition have much lower levels of development than the region's "leaders." The most important implication of this moving threshold is that

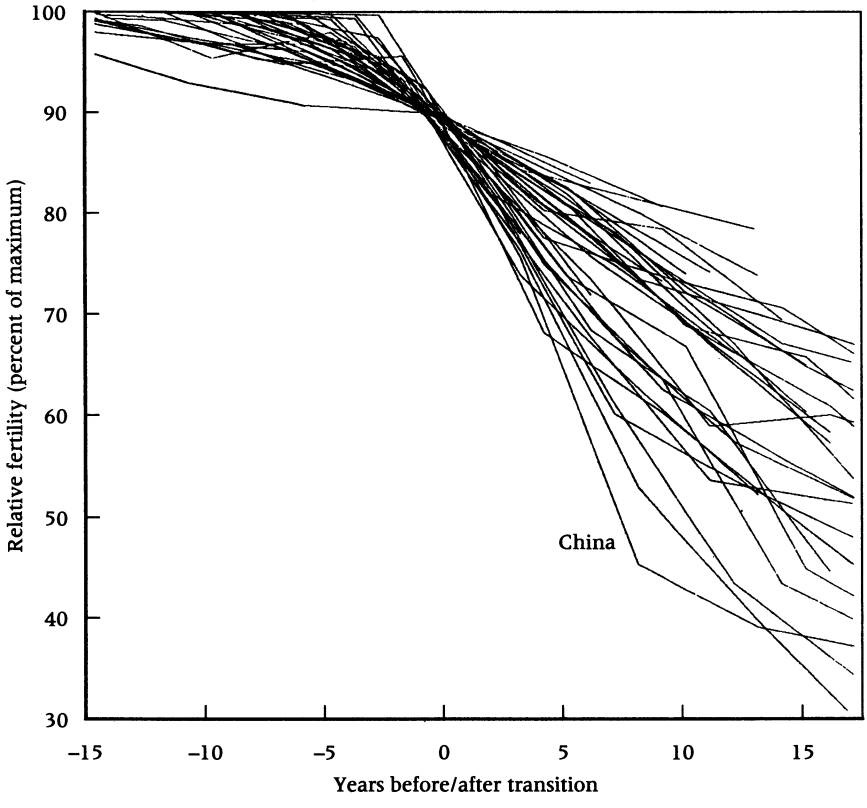
the difference in the timing of transitions between early- and late-starting countries in a region is reduced from many decades to just two or three. For example, Bangladesh's transition would have been delayed well into the next century if it had to wait until it achieved the same level of development as Hong Kong and Singapore had in 1960. As a consequence of the moving threshold, transition onsets in Asia and Latin America have been concentrated in the 1960s and 1970s.

The existence of a moving threshold could not be confirmed in sub-Saharan Africa and the Middle East/North Africa. This is presumably due in large part to the small number of transitions that have occurred in these two regions. For example, as is evident from Figure 5c, only five of 28 countries in sub-Saharan Africa had experienced a sustained fertility decline by the late 1980s. (Mauritius, represented by the top line in Figure 5c, would fit well in the Asian region, to which it is culturally closer than to sub-Saharan Africa.) If the moving threshold model turns out to be applicable in Africa, then substantial numbers of sub-Saharan countries can be expected to enter the transition in the next few decades, despite generally low levels of development.

Pace of fertility decline

Once a country has begun a transition, further declines follow almost invariably. This was the case in the past in Europe (Coale and Treadway 1986) and it is also true in the recent transitions in Africa, Asia, and Latin America. The relevant evidence for the developing world is summarized in Figure 6, which plots *relative* fertility (that is, fertility as a percentage of the pretransitional plateau level) by time elapsed since the onset of the transition for the 40 countries among the 69 in our sample that experienced a transition onset by 1975. In the first decade after entering the transition, the pace of fertility decline, as measured by the change in relative fertility, averaged 24 percent (that is, from 90 percent to 66 percent). As is evident from Figure 6, there is substantial variation in the pace of decline among countries: in a few instances, fertility declined by only 10 to 15 percent in the first ten years of the transition (in Bolivia, Haiti, Honduras, India, Nicaragua, and Zimbabwe), while in other populations the pace was very rapid—more than 30 percent per decade (Chile, China, Colombia, Costa Rica, Hong Kong, Mauritius, Mexico, Singapore, and Thailand). In general, the most striking feature of these transitions is the suddenness with which the fertility levels changed. Evidently, the onset of a transition marks a sharp and irreversible departure from the reproductive behavior of the past. The pace of fertility decline in the developing world as a whole has been substantially more rapid than observed in Europe around the turn of this century, as noted by Kirk (1971).

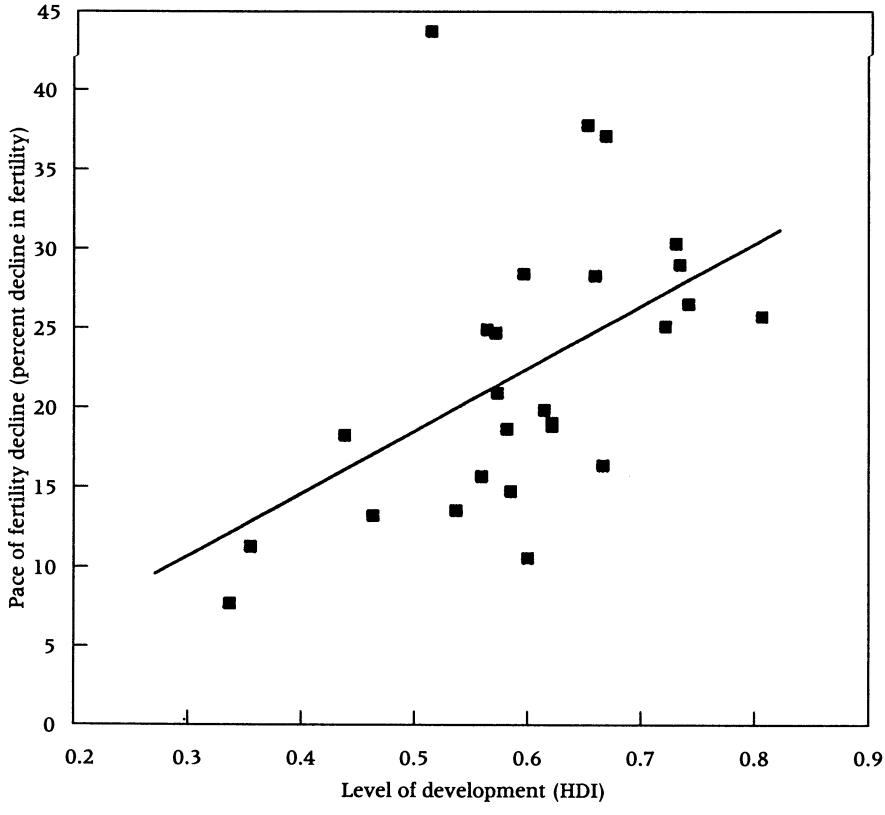
FIGURE 6 Relative fertility by year since transition onset, for 40 developing countries



In an initial attempt to explain variations in the pace of fertility decline, we tested the following hypotheses: (1) the rate of socioeconomic change is substantially faster after than before the onset of the transition, and (2) countries experiencing the most rapid fertility declines also have the most rapid rates of improvement in socioeconomic conditions. Neither of these propositions turns out to be valid. Trends in development indicators do not significantly change at the beginning of the transition. This is evident from Figures 5a, b, and c, which show no discontinuities in development trends as countries move past their transition points. Moreover, there is no correlation between the rate of change in development indicators and the rate of fertility decline during the first decade of the transition. On average, fertility changes during this decade at about the same pace in rapidly and slowly developing countries. Consequently, fertility decline is not simply an adjustment to changing socioeconomic circumstances.

These findings do not mean that the speed of fertility declines is random. Further analysis revealed a strong and highly significant correlation

FIGURE 7 Relationship between pace of fertility decline during the first decade of transition and level of development at transition onset: Developing countries in which transition began before 1975



between the rapidity of fertility decline and the *level* (not the rate of change) of development (HDI) at the time of transition onset (see Figure 7). In other words, countries that enter the transition at low levels of development tend to move relatively slowly toward lower fertility. In contrast, countries entering the transition "late," that is, after having reached relatively high levels of development, experience the most rapid declines once their transitions get underway.

A key factor in explaining this finding is likely to be a significant level of unwanted childbearing around the time of the transition onset (Westoff 1991; Bongaarts 1990). Unwanted fertility is caused by the absence of contraceptive use among some women who do not want to become pregnant (what was called the KAP-gap in the 1960s, and is currently termed unmet need for contraception) (Bongaarts 1991; Westoff and Ochoa 1991). This gap was particularly large in the relatively more developed countries of Asia and Latin America, where fertility declines began in the 1960s and

were subsequently relatively rapid (United Nations 1979). Evidently, development led to lower family size preferences, but these preferences were not immediately translated into lower actual fertility; once they began to be implemented, however, fertility fell rapidly. Thus, relatively high levels of development at the onset of fertility declines are associated with relatively high levels of unmet need and unwanted fertility, and these are in turn associated with a relatively rapid pace of fertility decline.

The potential or actual role of family planning programs in reducing fertility has thus far not been discussed. This is primarily because reliable time series of indicators of program effort do not exist for the 1960s and 1970s, when a large proportion of developing countries began their transitions. It is therefore not possible to estimate either the level of program effort at transition onset or its trend in the first decade of the transition. However, substantial numbers of countries initiated programs in the past three decades, and their role in reducing fertility obviously cannot be ignored. Since family planning programs help to satisfy unmet need for contraception, one would expect them to play a role in contemporary fertility decline. Recent analyses of the effect of family planning programs have found a significant impact on fertility levels in the late 1980s (Bongaarts, forthcoming). Whether this program effect operates primarily by accelerating the pace of fertility decline or by affecting the timing of transition onset cannot be determined with available data.

Toward an explanation

The preceding empirical analysis confirmed the inverse association between development and fertility, an association postulated by Notestein and many subsequent theorists. Our empirical results gain added significance from previous comparative projects in historical societies and contemporary developing countries that also found a weaker-than-expected relation between development and changes in reproductive behavior (Coale and Watkins 1986; Cleland and Wilson 1987). Taken together, these and other unexplained patterns of reproductive change have led a number of analysts to propose that the diffusion of information about methods of birth control is an important mechanism of fertility change (e.g., Freedman and Takeshita 1969; Knodel and van de Walle 1979; Rogers 1983; Retherford and Palmore 1983; Watkins 1987; Cleland and Wilson 1987; Montgomery and Casterline 1993; Rosero-Bixby and Casterline 1993).[7] Diffusion refers to the process by which innovation spreads among regions, social groups, or individuals, often apparently independently of social and economic circumstances.

Critics of diffusion approaches in demography have made several key points. One objection concerns content; what it is that is thought to be diffusing. Here diffusionists have been criticized for their narrow emphasis on birth control techniques, sometimes coupled with an assumption that

what is of interest is the "vertical" transmission of information about modern contraception from Western programs to third world peoples (Greenhalgh 1995). A second objection is that diffusion has often been inferred, for example from associations between fertility and language, rather than observed. These two objections can be overcome. A third objection, made since the time of Durkheim, is that diffusion merely "oils the machine": it may be a mechanism of change that contributes to our understanding of the pace of change, but it explains neither the timing nor the direction of change (Kreager 1993; McNicoll 1980, 1996). This critique is more potent, and we return to it later.

We build directly on the literature on diffusion, while modifying some of its concepts in order to take these cogent critiques into account. In what follows we use the term *social interaction* to signal a broader view of what spreads and how it spreads. We do not limit our interest to the spread of birth control techniques, or even to the spread of ideas about these techniques, but extend it also to ideational change more generally. We view social interaction as not only vertical, but also horizontal: it includes the active evaluation and transformation of new information and ideas by peers. Our analysis suggests possible directions to follow in measuring social interaction directly, such that our fertility models could include not only indicators of socioeconomic circumstances, but also indicators of the content of social interaction and of the local, national, and international channels through which it flows.

Our aim is to extend current theories of fertility change by suggesting the additional power of social interaction in accounting for variations in the timing of the onset of fertility transitions and in their pace. We will not present direct evidence to establish this link; rather, we hope our interpretations will stimulate further research, including new efforts at modeling and data collection. We begin by discussing the process of social interaction as it occurs in the personal networks of small communities, since we believe that much of the critical action occurs at this level. We then turn to features of the macro-level environment that channel social interaction within and across countries.

The process of social interaction

It is possible to distinguish analytically at least three aspects of social interaction that are likely to be relevant for fertility change: the exchange of information and ideas, the joint evaluation of their meaning in a particular context, and social influence that constrains or encourages action. These categories intersect with those of Casterline, Montgomery, and Rosero-Bixby,[8] who distinguish between social learning and social influence. In this section we expand on these three aspects of social interaction at the level of personal networks, drawing on research in Nyanza Province, Kenya,

in order to make the notion of social interaction less abstract and more intuitively plausible. Later we suggest that the process is similar at higher levels of aggregation (e.g., communities and countries).

Information and ideas

The simplest story of social interaction and fertility change focuses on the techniques of fertility control. The critical assumption is that there is an "unmet need." In terms of Coale's (1973) formulation, fertility is within the calculus of conscious choice and individuals want fewer children. There are obstacles, however, to the implementation of their preferences, one of which is a lack of information about acceptable means of fertility control. This information is then provided either by other individuals or by program efforts (media messages, clinics), with consequences for contraceptive use. This story has no features that should disturb those committed either to development frameworks or to neoclassical economic frameworks. The role of social interaction is confined to the spread of information about the availability of new contraceptive technology.

It is not difficult to modify this story to include information about the determinants of demand for children. This modification is suggested by recent research in Nyanza Province, where fertility is still high and where some socioeconomic change has occurred. It was found that men and women in this province are engaged in pervasive and frequent conversations about the implications of these changes for family size preferences and the use of modern contraception; most of these debates occur in the course of day-to-day activities, among men and women who are similar to one another in terms of socioeconomic characteristics and cultural patterns (Watkins, Rutenberg, and Green 1995).[9]

When socioeconomic conditions change rapidly, as they are doing in Kenya and in many other developing countries, information about new prices (e.g., the cost of education) is likely to be considered imperfect, and uncertainty about the future return on present investments is likely to be great.[10] In such circumstances, individuals can increase the evidence available to them by discussing with others in similar circumstances the relevant prices, as well as the categories of costs and benefits (work, childcare) and the appropriate weights to be assigned to each (see also March and Olsen 1979; Bikchandani, Hirshleifer, and Welch 1992; and Banerjee 1992).

Ideas are not so different from information. Perhaps because ideas seem "softer" than income and prices, or perhaps because they are difficult to measure in surveys, demographers have been reluctant to consider their influence. But it is evident that ideas can be potent stimuli for behavior: Christianity, communism, and democracy have been exceptionally influential worldwide, and feminism may ultimately belong in this category. It has been postulated that ideas may influence fertility: "new ideas and mod-

els, covering many aspects of life, may affect the demand for children by changing aspirations for other things wanted both for the children and parents" (Freedman 1979: 4). These ideas may be as proximate to fertility change as the idea disseminated by family planning programs that the use of modern contraception to control fertility within marriage is legitimate, or as distant as Western images of the family spread through school textbooks (Caldwell 1976) or even "local" versions of soap operas displayed in *telenovelas* (Faría and Potter 1994; Hannerz 1992).

Evaluation

The transmission of information and ideas is often clothed in what Hammel (1990) has called "evaluative clouds of commentary." In passing on information that it cost a friend so much to send a child to secondary school, a Kenyan man might add "but it was worth it, because now my friend's son has a regular job and can send money to help his parents"; in commenting on a friend's observation that there are advantages to having many children, a woman might remark "but it is hard to look after many children because they are so noisy; it is easier to care for a few."

Evaluation goes beyond the sharing of information because it involves a social process, one that is more complex than a broadcast from transmitters or opinion leaders to receivers.[11] In conversation, information and ideas are translated into terms that are meaningful in the local context and are jointly evaluated.[12] The information and ideas may be new, as when a Kenyan woman discussing modern contraception asked whether "white man's medicine rhymes with black women's bodies." The evaluation may also, however, reinterpret what had been well known. That "it's hard to look after many children" is not new information in Kenyan communities, where fertility rates are high; what is new is that such a statement is considered as a rationale for a reduced demand for children. Such discussions contribute to change in the way that norms concerning reproductive behavior are articulated or behavior justified, and thus contribute to the norms themselves and their relation to action (Lockwood 1995).

Social influence

A third category of social interaction is social influence, the effect of individuals' perceptions of the views of others on their own behavior. Our assumptions are that individuals prefer the approval of others, particularly of relevant others (for example, their peers or reference groups or those in positions of power over them), to their disapproval, and that they may modify their behavior—and perhaps even their preferences—to this end (see also Preston 1986). In interaction with others, individuals can establish the extent to which others approve or disapprove. In the areas of Kenya

described above, this is often done in a tentative fashion, by gossiping about those who are not present: floating a trial balloon permits an individual to gauge the reaction of others without risk.

Social influence is likely to be a critical factor in maintaining high fertility. At the early stages of a fertility transition, when deliberate control of fertility is still considered deviant, social influence may constrain behavior that demographers as objective observers assume is in the actors' best interest. Thus, where individuals estimate social disapproval to be strong, even cosmopolitans may hesitate to express or adopt preferences for smaller families (Crook 1978).[13] Similarly, social disapproval of contraception may in part account for a frequently found gap between preferences for fewer children and the absence of contraceptive use that we noted earlier.

Once fertility declines are underway, the direction of the effect of social influence appears to shift. Instead of discouraging fertility change, it begins to encourage a decline in the demand for children and behaviors toward limiting fertility. The reasons for this shift are likely to involve an accumulation of reproductive innovators and debates about their behavior.[14] Although the exchange of information and ideas can be characterized as simply "oiling the machine" of fertility change, social influence is likely to be crucial to setting its direction.

A few caveats are in order. First, the distinction among the trio of information and ideas, evaluation, and social influence is crisper analytically than it is in practice: research in Kenya shows that they often occur simultaneously. Second, although we have discussed the nature of social interaction in terms of the literal conversations of individuals in private settings, we do not mean to define the notion of social interaction so narrowly. Information may be conveyed by observation, and the approval or disapproval of others can be inferred from their behavior as well as from their commentary (Montgomery and Casterline 1996). The media transmit not only messages from family planning programs, but also attractive visions of new consumer goods and of the lifestyles of the rich and famous (Westoff and Rodríguez 1995). And social interaction occurs in official forums, as when representatives of governments and NGOs meet to design population policy. Lastly, we do not mean to imply that social interaction can only lead to the adoption of Western reproductive patterns. Some social interactions may lead to their rejection, to contraceptive discontinuation (DeClerque et al. 1986), or to the modification of Western reproductive patterns in the local context (Bledsoe et al. 1994).

Channels of social interaction

Social interaction is not random, but patterned. By channels of social interaction, we mean the grooves on a social map through which informa-

tion and ideas, evaluation, and social influence flow. The social map consists of groups defined by spatial proximity (villages, regions) and/or social proximity (ethnicity, education, occupation). The term communities applies to both geographic and social groups. Without channels, the communities would be isolated; the channels connect them, determining the range and intensity of the flow of social interaction. Below we propose that examining the channels of social interaction may allow us to understand the variations in the timing of the onset of fertility transitions and their pace that we described above, variations that evidently cannot be well understood on the basis of development alone. We begin by discussing the channels of social interaction that are closest to the individuals who ultimately have more or fewer children. We then discuss the channels that connect communities within a country and those that connect countries within a global society.

Local channels of social interaction

Much social interaction on a day-to-day basis occurs in the context of personal networks, the building blocks of communities. In these networks, the exchange of information and ideas and their evaluation are frequent, and the approval or disapproval of other members of the network is particularly meaningful.

What characteristics of personal networks might matter for fertility change? It is intuitively plausible that those whose networks include others who practice (or who are believed to practice) family planning successfully are more likely to adopt it themselves. Such was found to be the case in a study of Korean women's networks and in research in progress in Bangladesh (Rogers et al. 1976; Kincaid 1994; the Korean data were reanalyzed by Montgomery and Chung 1994, and by Valente 1995).

In addition, it is likely that characteristics of networks beyond whether they contain family planners are relevant for reproductive behavior. Networks may be categorized by their size, the geographic and social proximity of their members, and the strength of the ties between their members (Marsden 1990; Wellman and Wortley 1990; Burt 1984). For example, Granovetter (1974; 2nd ed. 1995) has shown that new information about job opportunities was less readily available in socially homogeneous networks than in heterogeneous networks, and Bott (1971) has shown that homogeneous networks permitted less autonomy for innovative behavior with regard to the division of household labor by gender.

It is not difficult to extend these ideas to fertility change. In Kenya, personal networks in which fertility preferences and family planning were discussed were relatively homogeneous. They consisted primarily of relatives and neighbors of the same gender (men talked with men, women

with women) and ethnicity (virtually all were Luo) and with much the same levels of education and wealth (few had more than primary education, and most were poor farmers). Some networks, however, crossed the boundaries of age, gender, ethnicity, educational level, and wealth, and some spanned large geographic areas, as when women on an island in Lake Victoria reported conversations that occurred when they were visiting their husbands working in Nairobi or other urban centers where family size preferences are lower and contraceptive use higher.[15]

The determinants of personal networks are not well understood, but it is likely that, as in Kenya, they are shaped by proximity, both geographic and social. Language is likely to be particularly important, in part because a common language is a prerequisite for interpersonal interaction.[16] Development is also important in accounting for variation in networks. Development is accompanied by social differentiation (e.g., increased diversity in occupations and educational levels), thus influencing the potential for network heterogeneity that is thought to be conducive to innovation. In Kenya as in many other developing countries where the distribution of educational facilities and development resources is uneven, individuals who proceed to higher education or seek jobs outside of agriculture are likely to have to go beyond the local area to do so, thus expanding the geographical range of their networks. This turns our attention to the national channels of social interaction that connect communities, the spatial and social aggregations of personal networks.

National channels of social interaction

In the earlier empirical analysis, we found that fertility declines were more rapid in some countries than in others. The pace of a national decline is in part the consequence of the length of time that elapses between the onset of fertility decline in some communities and its onset in others. If the lags are long, national fertility transitions are leisurely and differences among communities are sharp; if the lags are short, fertility transitions are rapid and differentials blurred. Some of the channels of social interaction that connect communities are carved by individuals following the routes of economic activity (e.g., migration), whereas others are incised on the social map by the actions of governments (e.g., the communication and transportation infrastructure) as well as by culture (e.g., language and ethnicity).

We would expect more rapid fertility decline in countries where a multiplicity of channels connects communities, and slower fertility decline where such channels are sparse. The level of development is one determinant of the extent of national channels of interaction. A higher level of GDP is associated with a greater division of labor, thus stimulating labor migration. In addition, countries with a higher level of GDP can afford a

transportation and communication infrastructure that facilitates internal social interaction (visits, mail), and more extensive media facilities that can penetrate community boundaries with soap operas and with advertisements for appealing consumer goods. It is thus not surprising that, as we have demonstrated above, the pace of fertility decline was associated with the level of development at the time of the onset of a country's fertility decline.

Fertility declines may be slower in countries where channels of social interaction are uneven, integrating some communities into the national society and isolating others. Economic development may be uneven, due, for example, to uneven endowments of natural resources or the predilections of investors. The state also plays a role, since it has the power to influence the distribution of development resources (e.g., educational and health facilities) and of transportation and communication facilities. Although in principle the modern nation-state is equally concerned with the welfare of all its citizens, in practice governments may favor some groups in the distribution of its resources. Lastly, language channels social interaction, not only because interpersonal interaction across communities presupposes a common language, but also because activities of national organizations are hindered in a multilingual setting, and indeed may follow directions indicated by ethnic rivalries.[17] The distribution of channels of social interaction may thus explain frequently observed regional differentials in fertility within a country.

Global channels of interaction

Just as the pace of national fertility declines is likely to be associated with the availability of channels that connect communities within a country, so also the pace of global fertility transition is likely to be influenced by channels that connect countries within the global society. It is obvious that few if any countries are isolated from the world community. The spread of Christianity and of plague in previous eras suggests that there have long been personal and institutional links among the populations of the world. There is no doubt, however, that such links have multiplied in the last century (Giddens 1990; Hannerz 1992). As a result, some men and women from Kenya have been abroad for work or for school (and many others would like to go); they wear T-shirts saying "Experiment with a Chemist" or "La Fiesta de Cinco de Mayo," and they listen to World Cup scores on Sony radios (and cheer for African teams).

The proliferation of international channels is associated with the growth of a world economy and is evident in multinational corporations that manage an international division of labor (Wallerstein 1974). Other channels are the consequence of a world society that includes subnational, national, and macro-regional associations with universalistic doctrines (e.g.,

environmental organizations) as well as world-level organizations with collective goals (e.g., the UN, the World Bank) (Meyer 1994). The population movement provides a relevant example of a network of global actors. Since World War II, organizational actors in this movement have aimed to promote lower fertility around the world. Foundations, NGOs (e.g., IPPF), and national organizations of global reach (e.g., USAID) have supported what de Swaan (n.d.) has termed "a relatively small cabal of international experts" who have studied the relation between population growth and development, disseminated new information and ideas to national functionaries, and attempted to influence government policy (Piotrow 1973; Donaldson 1990; Harkavy 1995; Hodgson and Watkins 1996).[18] Examples of successful population programs elsewhere encourage governments to take action; international organizations display such examples, help governments interpret them, and encourage leaders to adopt population policies and programs. In accord with its collective goals, over the decades the UN has called national leaders together at Bucharest, Mexico City, and Cairo to establish international population policy. At these meetings, national leaders behaved much like the members of personal networks: they exchanged information, evaluated the relation between population and development, and—at Cairo—vigorously debated in formal sessions and at dinner the new ideas of reproductive health (McIntosh and Finkle 1995).

Participation in the global society is influenced by factors internal to the country as well as by global actors. Countries that are more developed have a greater proliferation of personal and institutional channels that connect them to countries outside their borders, for example through trade, labor migration, tourism, and international media. Global actors such as multinational corporations, UN agencies, and foundations also forge such links, offering individuals jobs and opportunities for schooling abroad, and offering governments capital, development assistance, and contraceptive supplies. Other countries are more isolated, either as a consequence of government policy (China during its Cultural Revolution) or because they were judged to offer less profitable venues for the investment of international resources.

The appreciation of international links is rare in demographic analysis, yet it seems likely that the extent of a country's participation in a global society is relevant for the timing of the onset of its fertility transition.[19] Consider our finding that once a few countries in a macro-region began a fertility transition, the transitions in the remaining countries occurred earlier than would have been predicted by their level of development. Interaction among countries is likely to be more intense within macro-regions than across them. As in our consideration of national channels of interaction, we also expect the availability of and variation in international channels to be associated with relative levels of development (migrants go from

less developed to more developed locations) and with a shared language (e.g., Spanish in most of Latin America) or culture (e.g., among the Chinese-origin populations of East Asia).[20] Thus, just as friends who are contraceptive users are likely to be models for others in their personal networks, because of geographical and cultural proximity Hong Kong is likely to be considered a model for Asia, Costa Rica a model for Latin America.

Implications for transition theory

We have found that socioeconomic development (as measured here by the HDI) is related to fertility. Countries that are more developed tend to have lower fertility than less developed countries, both because they began their transition earlier and because it proceeded more rapidly. Taken together, these results imply that at any given date, standard measures of development are reasonably highly correlated with the level of fertility. Our examination of the empirical record of contemporary fertility transitions left us with several puzzles, however. Initially, fertility is unresponsive to development, resulting in delays in the onset of transition. Once a few countries in a macro-region enter the transition, other countries follow sooner than expected. As time goes by, the onset of the transition occurs at ever lower levels of development. Moreover, once a transition is underway, fertility changes more rapidly than can plausibly be interpreted as the result of changes in demand created by changing socioeconomic circumstances alone. The pace of fertility decline is not related to the pace of development, as might be expected, but rather to the level of development when the transition began.

To explain these puzzles we proposed a key role for social interaction, which is important at three levels of aggregation. Just as personal networks connect individuals, so channels of social interaction connect social and territorial communities within a nation, and nations within the global society. Through these channels, actors at these three levels exchange and evaluate information and ideas, and exert and receive social influence.

We conclude, then, that social interaction is a critical process that should have a central role in any comprehensive and realistic theory of fertility. No attempt will be made to elaborate such a theory, but its key elements can be sketched.

Pretransition

In most developing countries before the mid-1960s, natural fertility prevailed. The simplest explanation, that at low levels of development the demand for children matched or exceeded its supply, is unsatisfactory. In contemporary pretransitional countries in which wanted fertility has been

measured, it was always below the observed level, yet there was no evident fertility decline at the national level (Bongaarts 1990; Westoff 1991).[21]

There are several reasons why natural fertility may persist for a considerable period as a society develops. Perhaps for many couples in the least developed countries fertility was not within the calculus of conscious choice or the deliberate control of fertility within marriage was not licit. And in those pretransitional countries where there has been some development, its effects on the demand for children may nonetheless have been weak, or knowledge of techniques of control either limited or considered too costly. Under these circumstances, at the individual level even rational economic calculators may have continued childbearing because the costs of childbirth and childcare were perceived to be less than the costs—broadly defined—of control and because there was little penalty for the overproduction of children. Similarly, natural fertility would have persisted as long as the penalties for population growth at the aggregate level were low.

Natural fertility also may have persisted in part because of the characteristics of the channels of social interaction in countries with little socioeconomic development. It is likely that the personal networks in which reproductive behavior was debated were largely homogeneous, thus offering few opportunities for the entry of new ideas legitimating the calculation of the costs and benefits of children or the control of fertility within marriage, or new information concerning techniques of fertility control. Even when new ideas and information did enter a community, members of these networks may have evaluated them as inappropriate. Social influence thus acted initially as a constraint on the adoption of innovative behavior by those individuals who preferred to stop childbearing. In addition, when levels of development are low there are fewer channels permitting social interaction across community or national boundaries: thus, even if family limitation were to have become established in some local communities—as occurred in certain areas of mid-nineteenth-century Hungary (Demeny 1968)—it would not have been as likely to be swiftly communicated to other communities as it would be today.

Transition onset

As a country develops, the costs of children begin to rise and their benefits decline. The resulting decline in the demand for children accounts largely for the observed inverse correlation between development indicators and the level of fertility. We also believe that social interaction processes are essential to accounting for variations in the timing of the onset of declines across communities within a country or across countries within a global society.

In a hypothetical world of isolated individuals, one with full information and no uncertainty, development would lead immediately to a change

in desired family size and to lower actual fertility through the adoption of birth control measures (except when desired family size exceeds natural fertility). In reality, matters turned out quite differently. There are delays—sometimes considerable—between development and the onset of fertility declines. These may be due to lags in the formation of new preferences as well as lags in the adoption of fertility control that are evident in the KAP-gap. In addition, the delays were variable, as indicated in our analysis by substantial differences across countries in levels of development at the onset of a fertility transition.

How can we account for delays and the variability in their length? At the individual level it appears likely that in the earliest stage of fertility change there is considerable uncertainty about the implications of development for family size preferences and for the use of fertility control as an appropriate response. Individuals do not assess these implications in isolation. Rather, personal networks gather evidence of the experience of a few innovators and jointly evaluate this experience before network members modify their reproductive behavior. As noted, social influence and lack of information inhibit changes in reproductive behavior initially. However, once examples of individuals who announce or display their changed preferences or their use of modern contraception multiply, they influence the attitudes and behavior of others. (This might be modeled as a contagion process, as in Rosero-Bixby and Casterline 1993, 1994; Montgomery and Casterline 1993; and Montgomery and Chung 1994.) Debates about the meaning of these changes become more common, as networks take the experiences of their relatives, friends, and neighbors into account and reevaluate the implications of development for the costs and benefits of children, assess the advisability and safety of modern contraception, and reinterpret behavioral norms such that they encourage rather than retard reproductive change. Thus, social interaction triggers changes in preferences and fertility behavior. Differences in the extent to which networks are open or closed to new information and innovative behavior could then account in part for variability in lags between socioeconomic and reproductive change.

If communities and countries were isolated from one another, each would go through this process alone. One of the concomitants of development, however, is a proliferation of channels of social interaction: personal and institutional links are forged among communities within the same country and among countries, facilitating widespread social interaction. Consequently, as time goes by, the probability of entering the transition rises for those communities and countries that have not yet done so. This provides a plausible explanation for the apparent acceleration of the onset of transitions that occurred in the developing world in the late 1960s and 1970s as demonstrated by the moving threshold for transition onset in Figures 5a and 5b.

Pace

The pace of fertility decline within a country depends on the level of development, both because it influences the demand for children and because it facilitates or hinders social interaction. Where levels of development are high at the onset of a transition, fertility change can occur rapidly because demand for smaller families is typically widespread and the unmet need for contraception relatively high. In addition, cascading changes in reproductive behavior can occur because development is associated with a multiplication of the channels through which information, ideas, and social influence flow. National media seem to be particularly important because of their capacity to spread images of alternative lifestyles across barriers of ethnicity and language, class, and geography. Factors such as these provide a plausible explanation for our finding that the pace of fertility decline is related to the level of development at the onset of a transition rather than to the pace of subsequent development (see Figure 7).

Uneven development and variations in institutional and cultural contexts within a country can affect the extent of channels of social interaction among communities and are thus likely to have an independent influence on the pace of fertility transitions. We expect, for example, that countries where the government acts to equalize the distribution of resources and where there is a single language are likely to have relatively rapid fertility declines. These variations in pace among countries would occur with or without family planning programs, and regardless of the strength of program effort. However, active programs can hasten the speed of a decline, both by supplying contraceptive techniques and by introducing new ideas into personal networks (for example, the legitimacy of contraceptive use in marriage).

National channels of social interaction are particularly relevant in understanding the pace of national fertility transitions once they have begun, whereas global channels are particularly relevant to the timing of the onset of fertility transitions across countries and thus to the pace of global fertility transition. By now, all countries participate in a global economy that exchanges goods, services, and labor and in a global society that exchanges and evaluates information and ideas. Given current levels of economic development and the proliferation of global channels of interaction, we expect that over the next three decades or so few countries will fail to experience the onset of a fertility transition.

Conclusions

Our theoretical framework follows Notestein and those of his successors who consider socioeconomic conditions to be the principal underlying force

that brings about the initial fertility transitions. We agree that development is potent: it changes the costs and benefits of children and hence the demand for them. In addition, it multiplies the channels of social interaction, such that all countries and, we believe, most individuals participate in exchanges through local, national, and international channels about the advantages and disadvantages of fewer children or techniques of modern contraception. We conclude, however, that development alone is insufficient to account for observed variations in the timing of the onset of transitions or in variations in their pace and that social interaction should be taken into account. Before the transition onset, social interaction can inhibit fertility change. But once innovative fertility behavior has been adopted by a group of individuals within a community, by a community within a country, or by a few countries within a region, social interaction can become a powerful force that accelerates the pace of transition in the rest of the community, the nation, or the world society, and stimulates its onset elsewhere. We suspect that this is also the case in other areas of demographic research, such as mortality change. One important consequence for future empirical work is that demographic models that omit social interaction are misspecified (see also Land and Deane 1992).[22]

The pace of global fertility transition may be more leisurely in the future than in the past. The countries that have not yet shown evidence of the onset of a fertility transition have experienced relatively little socioeconomic change and are relatively isolated. Yet no country has been untouched by some level of development within its boundaries, none are isolated from information and ideas or from social influence originating outside their boundaries, and all can observe and evaluate the experience of others. Although further research is needed to pinpoint the precise role and nature of social interaction in different settings and to distinguish its effects from those of development, it is, we believe, a key factor in influencing the pace of a global fertility transition that we expect to continue.

APPENDIX A Human development index (HDI) for 69 countries in the developing world, 1960–85

Country	1960	1965	1970	1975	1980	1985
Asia						
Afghanistan	0.14	0.16	0.18	0.21	0.23	0.26
Bangladesh	0.22	0.25	0.27	0.28	0.32	0.34
China	0.38	0.44	0.53	0.57	0.62	0.67
Hong Kong	0.67	0.73	0.78	0.83	0.89	0.92
India	0.28	0.31	0.34	0.37	0.39	0.43
Indonesia	0.30	0.35	0.41	0.48	0.55	0.61
Korea (South)	0.55	0.60	0.67	0.74	0.78	0.82
Malaysia	0.50	0.56	0.61	0.67	0.73	0.77
Myanmar	0.36	0.41	0.43	0.46	0.49	0.52
Nepal	0.17	0.19	0.22	0.24	0.28	0.31
Pakistan	0.25	0.30	0.33	0.35	0.39	0.43
Papua-N.G.	0.29	0.35	0.41	0.43	0.46	0.48
Philippines	0.56	0.60	0.62	0.66	0.69	0.69
Singapore	0.66	0.69	0.76	0.80	0.85	0.88
Sri Lanka	0.60	0.63	0.65	0.67	0.71	0.75
Thailand	0.50	0.56	0.62	0.66	0.71	0.75
Latin America						
Argentina	0.77	0.79	0.81	0.83	0.84	0.83
Bolivia	0.37	0.42	0.46	0.52	0.57	0.60
Brazil	0.51	0.57	0.62	0.68	0.72	0.74
Chile	0.69	0.72	0.76	0.77	0.82	0.83
Colombia	0.60	0.63	0.67	0.71	0.75	0.77
Costa Rica	0.69	0.73	0.77	0.80	0.84	0.85
Dominican Rep.	0.48	0.53	0.59	0.64	0.68	0.70
Ecuador	0.53	0.57	0.61	0.66	0.71	0.73
El Salvador	0.45	0.51	0.55	0.57	0.58	0.61
Guatemala	0.40	0.44	0.48	0.52	0.56	0.57
Haiti	0.24	0.27	0.31	0.35	0.41	0.45
Honduras	0.37	0.42	0.47	0.51	0.57	0.60
Jamaica	0.73	0.76	0.80	0.82	0.81	0.82
Mexico	0.61	0.66	0.70	0.75	0.79	0.81
Nicaragua	0.43	0.51	0.56	0.61	0.63	0.65
Panama	0.63	0.68	0.72	0.75	0.79	0.81
Paraguay	0.62	0.65	0.67	0.70	0.74	0.74
Peru	0.51	0.57	0.61	0.65	0.67	0.69
Uruguay	0.81	0.81	0.83	0.84	0.86	0.85
Middle East/ North Africa						
Egypt	0.29	0.34	0.37	0.43	0.47	0.52
Morocco	0.27	0.33	0.38	0.42	0.48	0.53
Sudan	0.23	0.25	0.27	0.28	0.32	0.33
Syria	0.40	0.46	0.51	0.59	0.65	0.68
Tunisia	0.34	0.39	0.44	0.52	0.59	0.65
Turkey	0.42	0.48	0.55	0.62	0.66	0.71

APPENDIX A (continued)

Country	1960	1965	1970	1975	1980	1985
Sub-Saharan Africa						
Benin	0.21	0.24	0.25	0.26	0.28	0.30
Botswana	0.25	0.30	0.39	0.47	0.55	0.62
Burkina Faso	0.11	0.13	0.15	0.18	0.21	0.24
Burundi	0.18	0.17	0.21	0.25	0.30	0.35
Cameroon	0.25	0.28	0.34	0.38	0.44	0.49
Central African Rep.	0.20	0.22	0.25	0.27	0.30	0.32
Chad	0.16	0.17	0.19	0.22	0.22	0.25
Ghana	0.30	0.33	0.37	0.39	0.43	0.45
Guinea	0.13	0.15	0.15	0.17	0.19	0.21
Ivory Coast	0.22	0.26	0.31	0.37	0.43	0.47
Kenya	0.24	0.28	0.34	0.42	0.47	0.52
Lesotho	0.31	0.37	0.41	0.48	0.55	0.57
Liberia	0.24	0.27	0.31	0.35	0.37	0.38
Madagascar	0.30	0.34	0.40	0.44	0.49	0.51
Malawi	0.19	0.22	0.25	0.28	0.31	0.33
Mali	0.12	0.12	0.14	0.17	0.21	0.24
Mauritius	0.57	0.61	0.64	0.70	0.74	0.77
Mozambique	0.26	0.29	0.33	0.32	0.33	0.31
Niger	0.13	0.16	0.19	0.19	0.23	0.26
Rwanda	0.24	0.23	0.29	0.31	0.34	0.37
Senegal	0.20	0.23	0.24	0.28	0.32	0.36
Sierra Leone	0.17	0.20	0.22	0.23	0.24	0.24
Somalia	0.16	0.17	0.18	0.21	0.23	0.27
Togo	0.15	0.21	0.25	0.29	0.35	0.37
Uganda	0.27	0.29	0.31	0.31	0.27	0.32
Zaire	0.22	0.26	0.31	0.36	0.37	0.41
Zambia	0.36	0.40	0.43	0.47	0.47	0.47
Zimbabwe	0.40	0.42	0.45	0.49	0.53	0.55

SOURCE: See discussion in text.

APPENDIX B Regression analysis of the determinants of fertility

The relationship between fertility and its determinants is assumed to be represented by a logistic function of the form:

$$F_{n,r,t} = \frac{H - L}{1 + \exp\left(a + \sum_i b_i x_{i,n,t} + c_r y_r + d_t z_t\right)} + L$$

where $F_{n,r,t}$ is the total fertility rate (births per woman) in country n, region r, at time t. Estimates of fertility rates were taken from United Nations (1993).

Eighteen independent variables were included in the regression. H and L are, respectively, the average maximum and minimum values of F from 1960–65 to 1985–90; $x_{i,n,t}$ represents six socioeconomic measures (life expectancy, literacy, infant mortality, log of GDP per capita [PPP], percent urban population, and percent labor force in agriculture). Also included were three regional dummy variables (y_r) for, respectively, Latin America, Middle East/North Africa, and sub-Sa-

haran Africa; and five dummy variables (z_t) for time periods from 1965–70 to 1985–90. The sources for estimates of $x_{i,n,t}$ for 69 countries[23] at five-year intervals from 1960 to 1985 are as follows: life expectancy, infant mortality, and percent urban population from United Nations (1993); literacy (percent of adults) and percent labor force in agriculture from UNDP (1992);[24] and GDP per capita (PPP) from Summers and Heston (1991).

The first nonlinear regression model was estimated using pooled data for all 69 countries with six observations per country for time periods from 1960–65 to 1985–90. The results, summarized in Table B1, indicate statistically significant effects of dummy variables for time for periods from 1970–75 to 1985–90. Results were similar for a second regression, also shown in the table, that excluded 16 countries from among these 69 with moderate and strong family planning programs.

TABLE B1 Regression coefficients for the determinants of the total fertility rate, 1960–65 to 1985–90, 69 developing countries and a subset of these countries defined by family planning program strength

Explanatory variables	69 countries	Countries with weak or nonexistent family planning programs[a]
Socioeconomic indicators		
GDP per capita (log PPP in dollars)	–0.131	–0.872*
Infant mortality (per 1,000 births)	0.025*	0.028*
Life expectancy (years)	0.214*	0.283*
Literacy rate (percent)	0.029*	0.038*
Percent urban	0.011	0.081*
Percent labor force in agriculture	–0.014*	0.018
Demographic variables		
Maximum fertility (H)	6.847*	6.77*
Minimum fertility (L)	1.983*	2.62*
Region		
Asia	—	—
Latin America	–1.683*	–2.27*
Middle East/North Africa	–1.304*	–1.13*
Sub-Saharan Africa	–0.859*	–1.94
Time period		
1960–65	—	—
1965–70	0.380	0.349
1970–75	0.817*	0.939*
1975–80	1.099*	1.168*
1980–85	1.168*	1.202*
1985–90	1.230*	1.084*
Constant	–16.07	–19.81
R^2	0.81	0.76
N	414	300

* Significant at p = 0.05.

[a] Program effort measures from Lapham and Mauldin (1984). Programs with an effort score above 55 were rated moderate or strong.

Notes

This article was written while Watkins was a visiting associate at the Population Council, and was improved by stimulating interaction with John Casterline, Geoffrey McNicoll, and Mark Montgomery. The authors are also grateful for comments from Deborah Barrett, Jere Behrman, Ronald Freedman, Susan Greenhalgh, John Meyer, Steven Sinding, and Charles Westoff.

1 Notestein's views were more complex than this brief summary suggests. For example, he concluded that "urban-industrial development will not be sufficient to bring about the demographic transition" (Notestein 1953: 29), and he recognized the possibility of exceptions, such as the birth rate declines in agrarian France in the eighteenth century and later in Bulgaria (p. 17; see also Hodgson 1983).

2 For example, a country may have relatively low fertility in 1990 because its transition began early but proceeded slowly, or because its transition began only recently but fertility declined precipitously.

3 All developing countries for which the explanatory variables were available are included, except for the major oil exporters (e.g., Kuwait, Libya, Saudi Arabia), whose highly unusual development experience we will not examine. Sources of demographic and socioeconomic data are listed in Appendix B. For comments on the quality of these data, see Heston (1994) and Srinivasan (1994).

4 Shifts in the relationships between life expectancy and income per capita, and between fertility and income per capita were also noted by the World Bank (1984), based on data for the early 1970s and early 1980s, but no tests for statistical significance were undertaken.

5 Countries are considered pretransitional if fertility has declined less than 5 percent from its pretransition maximum.

6 There are other criticisms of the concept of natural fertility, particularly the interpretation that the absence of parity-specific control indicates that the control of fertility within marriage was not, in Coale's (1973) phrase, within "the calculus of conscious choice." Some find it implausible that pretransitional fertility was not consciously controlled, and interpret evidence of spacing births within marriage as showing that marital fertility was under conscious control (Bean, Mineau, and Anderton 1990; Santow 1995; Bledsoe et al. 1994). Since the definition by Henry (1961) refers to parity-specific stopping behavior, not spacing, we do not find this objection fatal. We also disagree with critics who find the absence of deliberate individual control of marital fertility implausible.

7 Interest in diffusion processes has a long tradition in the social sciences, but it has been not so much a theory guiding research as a search for a plausible explanation when other models appeared to be inadequate in accounting for observed empirical patterns (for a review, see Kreager 1993). In demography, the observation that there were geographic, temporal, social, and cultural patterns of fertility decline in Europe and developing countries led to the conclusion that the diffusion of new ideas about the means of fertility regulation was important, as in the influential formulations of Knodel and van de Walle (1979) and Cleland and Wilson (1987). In addition, demographers have amassed considerable direct evidence of person-to-person communication, much of it gathered in the context of examining the impact of family planning programs and largely theoretical. An illuminating study by Freedman and his colleagues was one of the first to demonstrate the role of interpersonal communication in spreading information about birth control: they found that information distributed in an intervention program spread from the experimental areas to the control areas via informal contacts (Freedman and Takeshita 1969). The 1960s and early 1970s produced abundant studies documenting the pervasiveness of such communication, though rarely in a multivariate context (Hill, Stycos, and Back 1959; Palmore 1968; Rogers and Kincaid 1981; Rosenfield, Asavasena, and Mikhanorn 1973; Misra 1967). For more recent ex-

amples, see Entwisle et al. (1992), Schuler, Choque, and Rance (1994), and Mita and Simmons (1995); for a review, see Watkins (1993).

8 We are indebted to a series of papers by John Casterline, Mark Montgomery, and Luis Rosero-Bixby. In their early papers they identify three behavioral mechanisms for social interaction diffusion effects: information flow, demonstration effects, and change in normative context (Rosero-Bixby and Casterline 1993, 1994; Montgomery and Casterline 1993). More recently, they have shifted to a focus on two major behavioral mechanisms that subsume these three mechanisms: social learning and social influence (Montgomery and Chung 1994; Montgomery and Casterline 1996). Our concept of social influence is similar to theirs. We find it useful, however, to distinguish analytically what might be considered two aspects of social learning: their information flow and demonstration effects, and the transformation of meaning that we believe occurs as new information and ideas are jointly evaluated by peers (Watkins and Danzi 1995; Watkins, Rutenberg, and Green 1995).

9 The ongoing research in Kenya referred to here is described in Watkins, Rutenberg, and Green (1995); Watkins, Rutenberg, and Wilkinson (1995); and Rutenberg and Watkins (1996). The data, collected among Luos in Nyanza Province in 1994 and 1995, include in-depth interviews with 40 women and 40 men, eight focus groups of women, and a household survey of approximately 800 women and 800 men. The samples, methods of data collection, and evaluation of data quality are described in Watkins et al. (1995). In the in-depth interviews, respondents were asked about their conversations concerning family size and family planning. In the household survey, respondents were asked how many people they had talked with about family planning, and when and where these conversations took place, as well as some characteristics of their network partners. Approximately three-quarters of the women and slightly fewer men reported at least one such conversation; for those who reported any conversation, the average number of conversational partners was between three and four. Half of the conversations reported took place in the last month, and a quarter in the last week.

10 Accumulating evidence from qualitative interviews shows that those who are participating in a fertility transition often explain it in part by invoking the monetary costs and benefits of children (see, for example, Knodel, Havanon, and Pramualratana 1984). In Kenya, both men and women report conversations with others about the dearth of opportunities to earn sufficient income and the high cost "these days" of school fees, clothing, and medical expenses. They illustrate their remarks with stories of successful, or unsuccessful, investments: for example, a friend who sacrificed to educate a child and now benefits from the help the child provides, or another whose child was unable or unwilling to help his parents.

11 In writings on diffusion in developing countries (e.g., of agricultural techniques, modern contraception) the image is often hierarchical and mechanical: information is transmitted from experts to receivers and is assumed to progress from socially deviant innovators through opinion leaders to the general public (see, for example, Rogers 1983; Brown 1981; Lin 1973; Mahajan, Muller, and Bass 1991).

12 This is sometimes called a "two-stage" process, and is discussed in Katz and Lazarsfeld (1955).

13 Social control operates in modern as well as traditional settings (Watkins 1991). Once a fertility transition is well underway, social influence may lead those for whom the costs of children are low and the benefits high to change their preferences or their behavior (Schneider and Schneider 1984).

14 The concept of "tipping points" might help to explain shifts in the direction of social influence (see, for example, Schelling 1978; Aguirre, Quarantelli, and Mendoza 1988; Nakićenović 1991).

15 Differences in the timing and pace of reproductive change among Italian and Jewish women living in similar socioeconomic contexts in the United States in the 1930s were associated with differences in their networks (Watkins and Danzi 1995). Because the friends of the Italian women were similar to one another (most were poorly edu-

cated Catholics with little experience beyond the neighborhood, either at school or at work), these women were slow to receive information about family planning methods, and had little normative room to adopt innovative behavior. The Jewish women's networks, in contrast, were more varied in terms of the educational or occupational experience of their members, and they were more likely to include members of other ethnic groups among whom fertility control was more established. The heterogeneous networks of Jewish women thus facilitated change, whereas the homogeneous networks of the Italians hindered it.

16 In addition, linguistic differences signal different mental models: the expectation that someone with a different language does not share one's own mental models would inhibit the joint evaluation of new information or ideas (for a similar point, see Denzau and North 1994). Other cultural patterns might also be explored. For example, polygyny permits men to rotate wives between their urban workplace and their rural home, thus exposing rural women to urban influences (Parkin 1978); where purdah is practiced or where caste divisions are strict, there is likely to be less social interaction across communities.

17 For example, there is considerable variation in demand for children, contraceptive use, and levels of fertility across Kenya (but little variation across educational levels) (Brass and Jolly 1993). Central Province, where Kikuyus predominate, has consistently had one of the highest levels of contraceptive use of all the regions of Kenya, and Nyanza Province, where Luos predominate, the lowest. The political economy has favored Central Province over Nyanza Province. The road system in Central Province was developed early, due to the efforts of the colonial government to counter the Mau Mau insurgency of the 1940s and 1950s. Since Independence, Central Province has been privileged by the state, whereas Nyanza Province has been in political opposition (Bates 1981). The new national government headed by Jomo Kenyatta privileged his own ethnic group, the Kikuyus, in ways that facilitated profitable commercial agriculture. Subsequently, President Moi favored Central and Western Provinces in many ways, including the establishment of facilities of public education. In contrast, in Nyanza Province development opportunities are sparse, roads are poor, and there are no universities.

18 Unlike the typical process of social influence in local communities, international experts can exert social influence by providing substantial funds to tempt the reluctant.

19 For example, in a multivariate analysis using techniques of event history analysis, Barrett (1995) found that the timing of a country's adoption of a population policy was associated not only with its GDP and population density, but also with measures of international linkages (e.g., signing the 1966 UN Declaration on Population and participation in international conferences). In a variety of other policy areas (e.g., education, the incorporation of women into the public sphere), the adoption of new policies and institutions is associated both with a country's characteristics and with activities at the global level; moreover, the country's particular characteristics matter less as time goes on (Thomas et al. 1987; Meyer, Ramírez, and Soysal 1992; Berkovich 1995).

20 See Goodkind (1991) for an example of common demographic behavior across Chinese-origin societies.

21 Wanted fertility is estimated as completed fertility, analogously to the standard total fertility rate, except that births in excess of desired family size are eliminated.

22 Our theoretical framework suggests the need for the collection of new data: qualitative data that would permit a better understanding of the nature of social interaction in particular local contexts, measures of network characteristics, and measures of the extent and direction of national and global channels of social interaction. Some of these measures are likely to be closely associated with development (e.g., the infrastructure of transportation and communication), others less so (e.g., linguistic heterogeneity or homogeneity). For example, correlations between development and linguistic heterogeneity are low (Lieberson, Dalto, and Marsden 1981). Our focus on social interaction also suggests reinterpretation of some standard variables. Education, which is perhaps the most reliable predictor of lower fer-

tility, may signal not only individual competence or the possibility of higher wages, but also a shift in the characteristics of an individual's network; similarly, the networks of women who work in a factory or office are likely to differ from those who work at home, thus offering another interpretation of female labor force participation.

23 See note 3.

24 Literacy data were available only for 1970 and 1985, and percent labor force in agriculture only for 1960 and 1985. Logistic interpolation and extrapolation were used to obtain estimates for other time points from 1960 to 1985.

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