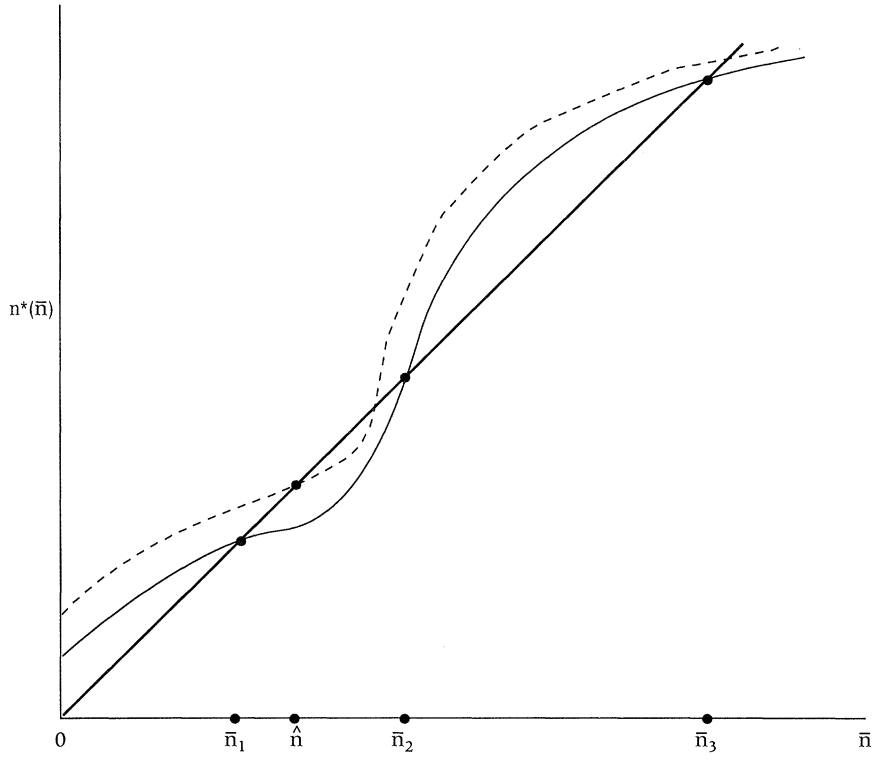
FIGURE 2 Desired number of children in a representative household, $n^*(\bar{n})$, as a function of average number of children born per household, $(\bar{n})$



form of so-called adaptive expectations). It is then easy to check that $\bar{n}_1$ and $\bar{n}_3$ are (locally) stable, while $\bar{n}_2$ is unstable. So our interest here lies in $\bar{n}_1$ and $\bar{n}_3$.

I have not offered a micro-foundation for $n^*(\bar{n})$. The model is of a reduced form. But all households may be better off at $\bar{n}_1$ than at $\bar{n}_3$. However, in view of the externality, neither equilibrium is a socially optimal state of affairs.[38] The optimal TFR may lie somewhere between $\bar{n}_1$ and $\bar{n}_3$ (say, at $\hat{n}$). If this were so, then from the social point of view TFR would be too low at $\bar{n}_1$ and too high at $\bar{n}_3$. In either situation there would be a need for government policy (e.g., a tax subsidy) of a kind that would sustain equilibrium TFR at $\hat{n}$. In Figure 2 the broken curve is the representative household's desired number of children as a function of the community's TFR when the optimum policy is in place. It intersects the 45° line at $\hat{n}$.

These are theoretical possibilities. Analytical reasoning tells us that a society could in principle get stuck at a self-sustaining mode of behavior characterized by high fertility (and low educational attainment), even when there is another, potentially self-sustaining mode of behavior characterized by low fertility (and high educational attainment).

This does not mean that the hypothetical society would be stuck with high fertility rates forever. External events could lead households to "coordinate" at $\bar{n}_1$ even though they had earlier "coordinated" at $\bar{n}_3$.[39] The external events could, for example, take the form of public exhortations aimed at altering household expectations about one another's behavior (e.g., family planning campaigns run by women). This is a case where the community "tips" from one mode of behavior to another, even though there has been no underlying change in household attitudes ($n^*(\bar{n})$ has not changed) to trigger the change in behavior.

In their aforementioned article Cleland and Wilson (1987: 9) argued that the only plausible way to explain the recent onset of fertility transitions among countries at widely different levels of economic development was an ideational change, "a psychological shift from, *inter alia*, fatalism to a sense of control of destiny, from passivity to the pursuit of achievement, from a religious, tradition-bound, and parochial view of the world to a more secular, rational, and cosmopolitan one." The authors may be right that societies have undergone ideational changes, but they are wrong in thinking that ideational change must be invoked to explain recent fertility transitions. The tipping behavior I have just discussed is not a response to ideational changes. This said, I know of no evidence that is able to discriminate between the two types of explanation.

In addition to being a response to external events, the tipping phenomenon can occur because of changes in the peer group on whose behavior households base their own behavior. This amounts to the function $n^*(\bar{n})$ shifting slowly. Such shifts also may fall short of an ideational change. As I indicate below, however, the process can precipitate a demographic transition.

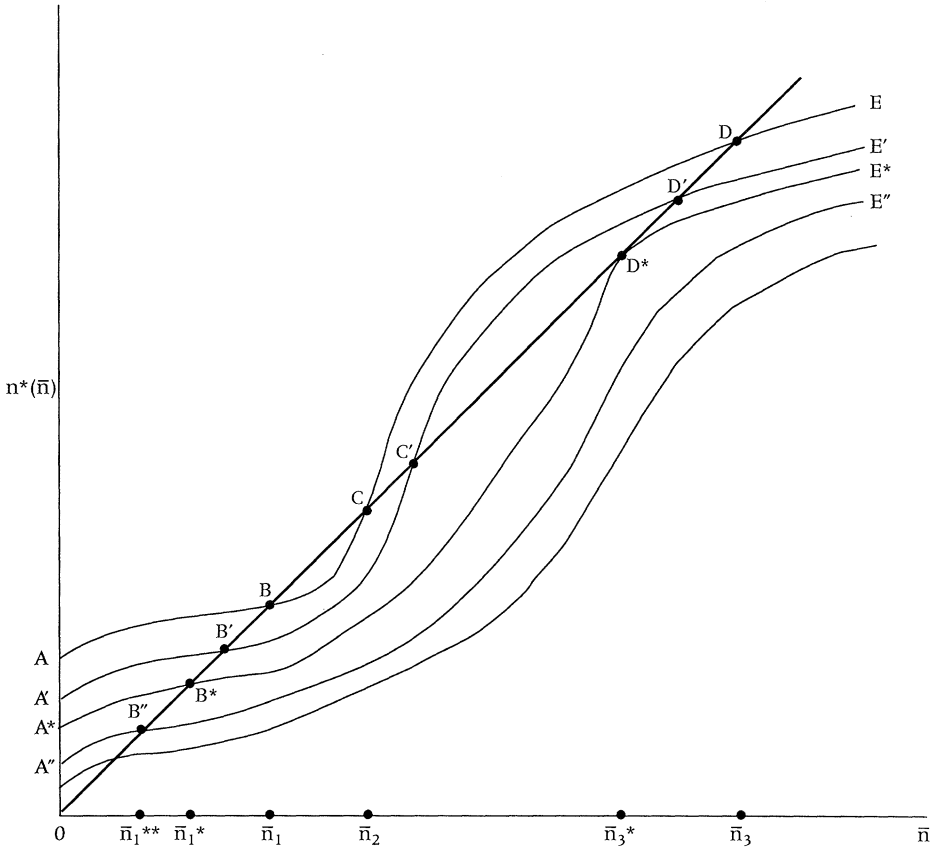
One pathway by which $n^*(\bar{n})$ can shift arises from the fact that people differ in their absorption of traditional practice. Inevitably there are those who experiment, take risks, and refrain from joining the crowd. They subsequently influence others. They are the tradition-breakers, often leading the way. It has been observed that educated women are among the first to make the move toward smaller families (see Farooq, Ekanem, and Ojelade 1987, for a commentary on West Africa). Members of the middle classes can also be the trigger, becoming role models for others.

Possibly an even clearer pathway is the influence that newspapers, radio, television, and now the Internet exert in transmitting information about other lifestyles (Freedman 1995; Bongaarts and Watkins 1996; Iyer 2000). The analytical point here is that the media may be a vehicle through which a new form of conformism increasingly becomes based on the behavior of a population wider than the local community: the peer group widens.

Such pathways can give rise to demographic transitions, in that fertility rates display little or no trend over extended periods, only to cascade downward over a relatively short interval, giving rise to the classic logistic curve of

diffusion processes. To illustrate this, consider Figure 3, which is based on Figure 2. Begin with an isolated community. The curve ABCDE is the representative household's demand for children as a function of the community's total fertility rate, $n^*(\bar{n})$. As with Figure 2, there are three equilibria, $\bar{n}_1$, $\bar{n}_2$, and $\bar{n}_3$, of which $\bar{n}_1$ and $\bar{n}_3$ are locally stable, and $\bar{n}_2$ is unstable. We are to imagine that households have equilibrated at D, where the total fertility rate is $\bar{n}_3$. Imagine now that the community begins to have exposure to the outside world. To grasp the point in the simplest possible way, assume that the rate at which the community is exposed to outside influence (as measured, say, by the rate of increase in the number of television sets in the community) is small and steady. It is natural to assume next that, as outside influence increases, $n^*(\bar{n})$ shifts downward slowly. This means that the equilibrium TFR declines slowly. In Figure 3 the curve A'B'C'D'E' represents one such transitional demand schedule. The corresponding equilibrium TFR is associated with D'. Since D' is locally stable,

FIGURE 3 A model of demographic transition



the assumption that the community equilibrates to D′ is correct. The underlying hypothesis is that outside influence is a slow-moving variable and that the community equilibrates quickly to changes in the extent of outside influence.

What would statistical demographers make of the process thus far? They would record that the community's TFR had declined in response to increasing exposure to the outside world. But they would record that the decline was slow. As time passes, the demand schedule in Figure 3 continues to shift downward slowly and the TFR declines slowly, until eventually the schedule attains the position where there are only two equilibria: $\bar{n}_1^*$ and $\bar{n}_3^*$. (The intermediate equilibrium point has vanished at this critical juncture.) This stage is represented by the curve A*B*D*E*. Since the community will have equilibrated at D*, statistical demographers would observe that there had so far been no dramatic decline in fertility.

But what happens when the curve shifts down slightly further, say to become the curve A″B″E″ in Figure 3? Now the schedule intersects the 45° line only once, at the stable equilibrium B″ (at a TFR of $\bar{n}_1^{**}$). But because TFR had only recently been substantially above $\bar{n}_1^{**}$, households will display disequilibrium behavior for a while, as they "seek" $\bar{n}_1^{**}$. Demographers would record a substantial decline in TFR to $\bar{n}_1^{**}$. Subsequent declines in TFR (one such decline is depicted in the lowest curve in Figure 3) again would be observed to be slow. Statisticians would record the period in which TFR declined sharply as a "demographic transition." In our model the transition would be an extended period of disequilibrium behavior. It is worth noting that, in showing how fertility cascades can occur, I have assumed household responses to changes in outside exposure to be nonlinear: the shape of $n^*(\bar{n})$ has the nonlinearity built into it.[40]

In a pioneering article Adelman and Morris (1965) found "openness" of a society to outside ideas to be a powerful stimulus to economic growth. It is possible that the recent fertility reductions experienced in India and Bangladesh (Table 3) were the result of the wider influence people have been subjected to via the media or of attitudinal differences arising from improvements in family planning programs. To be sure, fertility reductions have differed widely across the Indian subcontinent (not much reduction in Pakistan so far), but we should not seek a single explanation for so complex a phenomenon as fertility transition.[41]

Demographers have made few attempts to discover evidence of behavior that is guided in part by an attention to others. Two exceptions are Easterlin, Pollak, and Wachter (1980) and Watkins (1990). The former studied intergenerational influence in a sample of families in the United States. They reported a positive link between the number of children with whom someone had been raised and the number of children they themselves had.

In her study of demographic change in Western Europe over the period 1870–1960, Watkins (1990) showed that regional differences in fertil-

ity and nuptiality within each country declined. In 1870, before the large-scale declines in marital fertility had begun in most areas of Western Europe, demographic behavior differed greatly within countries: provinces (e.g., counties and cantons) differed considerably, even while differences within provinces were low. There were thus spatial clumps within each country, suggesting the importance of the influence of local communities on behavior. By 1960 differences within each country were less than they had been in 1870. Watkins explained this convergence in behavior in terms of increases in the geographical reach national governments enjoyed over the 90 years in question. The growth of national languages could have been the medium through which reproductive behavior spread.

One recent finding could also point to contagious behavior. Starting in 1977 (when the TFR in Bangladesh exceeded 6), 70 "treatment" villages were served by a massive program of birth control in Matlab Thana, Bangladesh, while 79 "control" villages were offered no such special service. The prevalence of contraceptive use in the treatment villages increased from 7 percent to 33 percent within 18 months, and then rose more gradually to a level of 45 percent by 1985. The prevalence also increased in the control villages, but only to 16 percent in 1985. Fertility rates in both sets of villages declined, but at different speeds, with the difference in fertility rates reaching 1.5 births per woman, even though there had been no difference to begin with (Hill 1992). If we assume that, although influence travels, geographical proximity matters, we could explain why the control villages followed the example of villages "under treatment," but did not follow them all the way. Contagion did not spread completely.[42]

Interactions among institutions

Externalities are prevalent when market and nonmarket institutions coexist. How and why might such externalities affect fertility behavior? A number of pathways suggest themselves (see also Dasgupta 1993, 1999).

Long-term relationships in rural communities of poor countries are frequently sustained by social norms—for example, norms of reciprocity. Social norms can be reliably observed only among people who expect to encounter one another in recurring situations.[43] Consider a community of "far-sighted" people who know one another and expect to interact with one another for a long time. By far-sighted, I mean someone who applies a low rate to discount future costs and benefits of alternative courses of action. Assume that the parties in question are not individually mobile (although they could be collectively mobile, as in the case of nomadic societies); otherwise the chance of future encounters with one another would be low, and people would discount heavily the future benefits of the current costs they incur for the purposes of cooperation.

Simply stated, if people are far-sighted and are not individually mobile, a credible threat by all that they would impose stiff sanctions on anyone who broke the agreement would deter everyone from breaking it. But the threat of sanctions would cease to have bite if opportunistic behavior became personally more profitable. The latter would happen if formal markets develop nearby. As opportunities outside the village improve, people with lesser ties (e.g., young men) are more likely to take advantage of them and make a break with those customary obligations that are enshrined in prevailing social norms. People with greater attachments would perceive this and infer that the expected benefits from complying with agreements are now lower. Norms of reciprocity would break down, making certain groups of people (e.g., women, the old, and the very young) worse off. This is a case where improved institutional performance elsewhere (e.g., growth of markets in the economy at large) has an adverse effect on the functioning of a local, nonmarket institution: it is a reflection of an externality.

When established long-term relationships break down, people build new ones to further their economic opportunities. Those who face particularly stressful circumstances resort to draconian measures to build new economic channels. Guyer (1994) has observed that in the face of deteriorating economic circumstances, some women in a Yoruba area of Nigeria have borne children by several men so as to create immediate lateral links with them. Polyandrous motherhood enables women to have access to more than one resource network.

In his well-known work Cain (1981, 1983) showed that where capital markets are nonexistent and public or community support for the elderly is weak, children provide security in old age. The converse is that if community-based support systems decline, children become more valuable. But we have just noted that community-based support systems in rural areas may degrade with the growth of markets in cities and towns. So there is a curious causal chain here: growth of markets in towns and cities can lead to an increase in fertility in poor villages, other things being the same. Earlier we deduced an influence running in the opposite direction. There we noted that growth of markets in towns and cities, by making children less reliable as an investment for old age, can lead to a reduction in fertility. Only formal modeling of the process would enable us to determine which influence dominates under what conditions.

Household labor needs and the local commons

The poorest countries are in great part agriculture-based subsistence economies.[44] Much labor is needed even for simple tasks. Moreover, many households lack access to the sources of domestic energy available to households in advanced industrial countries. Nor do they have water on tap. In semi-

arid and arid regions water supply is often not even close at hand, nor is fuelwood nearby when the forests recede. This means that the relative prices of alternative sources of energy and water faced by poor rural households are quite different from those faced by households elsewhere. In addition to cultivating crops, caring for livestock, cooking food, and producing simple marketable products, household members may have to spend several hours a day fetching water and collecting fodder and wood. These complementary activities have to be undertaken on a daily basis if households are to survive. Labor productivity is low because both capital and environmental resources are scarce. From an early age, children in poor households in the poorest countries mind their siblings and domestic animals, fetch water, and collect fuelwood, dung (in the Indian subcontinent), and fodder. Mostly, they do not go to school. Not only are educational facilities in the typical rural school woefully inadequate, but parents need their children's labor. Children between ages 10 and 15 years have been routinely observed to work at least as many hours as adult males (see, for example, Bledsoe 1994; Cleaver and Schreiber 1994; Filmer and Pritchett 1996).

The need for many hands can lead to a destructive situation when parents do not have to pay the full price of rearing their children, but instead share such costs with their community. In recent years, social norms that once regulated local resources have changed. Since time immemorial, rural assets such as village ponds and water holes, threshing grounds, grazing fields, swidden fallows, and local forests and woodlands have been owned communally. As a proportion of total assets, the presence of such assets ranges widely across ecological zones. In India the local commons are most prominent in arid regions, mountain regions, and unirrigated areas; they are least prominent in humid regions and river valleys (Agarwal and Narain 1989). There is a rationale for this, based on the human desire to reduce risks. Community ownership and control enabled households in semi-arid regions to pool their risks.[45] An almost immediate empirical corollary is that income inequalities are less where common-property resources are more prominent. Aggregate income is a different matter, though, and the arid and mountain regions and unirrigated areas are the poorest. As would be expected, dependence on common-property resources even within dry regions declines with increasing wealth across households.

Jodha (1986, 1995), studying evidence from more than 80 villages in 21 dry districts in India, concluded that, among poor families, the proportion of income based directly on their local commons is for the most part in the range of 15–25 percent. A number of resources (such as fuelwood and water, berries and nuts, medicinal herbs, resin and gum) are the responsibility of women and children. In a study of 29 villages in southeastern Zimbabwe, Cavendish (1998, 1999) arrived at even larger estimates: the proportion of income based directly on the local commons is 35 percent, with

the figure for the poorest quintile reaching 40 percent. Such evidence does not of course prove that the local commons are well managed, but it suggests that rural households have strong incentives to devise arrangements whereby they would be well managed.

A number of investigators—among them Howe (1986); Wade (1988); Chopra, Kadekodi, and Murty (1990); Ostrom (1990, 1992); and Baland and Platteau (1995)—have shown that many communities have traditionally protected their local commons from overexploitation by relying on social norms, by imposing fines for deviant behavior, and by other means. I argued earlier that the very process of economic development, as exemplified by urbanization and mobility, can erode traditional methods of control. Social norms are endangered also by civil strife and by the usurpation of resources by landowners or the state. For example, resource-allocation rules practiced at the local level have frequently been overturned by central fiat. A number of states in the Sahel imposed rules that in effect destroyed community management practices in the forests. Villages ceased to have authority to enforce sanctions against those who violated locally instituted rules of use. State authority turned the local commons into free-access resources.[46] As social norms degrade, whatever the cause, parents pass some of the costs of their children onto the community by overexploiting the commons. This is another instance of a demographic free-rider problem.

The perception of an increase in the net benefits of having children induces households to have too many. This is predicted by the standard theory of the imperfectly managed commons (see the Appendix). It is also true that when households are further impoverished owing to the erosion of the commons, the net cost of children increases (of course, household size continues to remain above the optimum from the collective point of view). Loughran and Pritchett (1998), for example, have found in Nepal that increasing environmental scarcity lowered the demand for children, implying that the households in question perceived resource scarcity as raising the cost of children. Apparently, increasing firewood and water scarcity in the villages in the sample did not have a strong enough effect on the relative productivity of child labor to induce higher demand for children. Environmental scarcity there acted as a check on population growth.

On the other hand, theoretical considerations suggest that, in certain circumstances, increased resource scarcity induces further population growth: as the community's natural resources are depleted, households find themselves needing more "hands." No doubt additional hands could be obtained if the adults worked even harder, but in many cultures it would not do for the men to gather fuelwood and fetch water for household use.[47] No doubt, too, additional hands could be obtained if children at school were withdrawn and put to work. But, as we have seen, mostly the children do not go to school anyway. In short, when all other sources of additional labor

become too costly, more children are produced, thus further damaging the local resource base and, in turn, providing the household with an incentive to enlarge yet more. This does not necessarily mean that the fertility rate will increase. If the infant mortality rate were to decline, there would be no need for more births in order for a household to acquire more hands. However, along this pathway poverty, household size, and environmental degradation would reinforce one another in an escalating spiral. By the time some countervailing set of factors diminished the benefits of having further children and, thereby, stopped the spiral, many lives could have suffered by a worsening of poverty. In the Appendix I provide a simple model to illustrate such possibilities.

Cleaver and Schreiber (1994) have provided rough, aggregative evidence of a positive link between population increase and environmental degradation in the context of rural sub-Saharan Africa; Batliwala and Reddy (1994) for villages in Karnataka, India; and Heyser (1996) for Malaysia. In a statistical analysis of data from villages in the Sindh region in Pakistan, Filmer and Pritchett (1996) tentatively reported a positive link between fertility and deterioration of the local natural-resource base. The macroeconomic statistics in Table 4 are not at variance with this possibility either.

None of these investigations quite captures what the theory I am sketching here tells us to study, namely, the link between desired household size and the state of the local natural-resource base. But they come close enough; limitations in existing data prevent investigators from getting closer to the theory.[48] In any event, these studies cannot reveal causal connections, but, excepting the study by Loughran and Pritchett (1998), they are consistent with the idea of a positive-feedback mechanism such as I have described. Over time, the spiral would be expected to have political effects, as manifested by battles for scarce resources, for example among competing ethnic groups (Durham 1979; Homer-Dixon, Boutwell, and Rathjens 1993; Homer-Dixon 1994). This last connection deserves greater investigation than it has elicited so far.[49]

To be sure, families with greater access to resources would be in a position to limit their size and propel themselves into still higher income levels. Admittedly, too, people from the poorest backgrounds have been known to improve their circumstances. Nevertheless, there are forces at work that pull households away from one another in terms of their living standards. Such forces enable extreme poverty to persist despite the growth in wellbeing for the rest of society.

Institutional reforms and policies

If in earlier days social scientists looked for policies to shape social outcomes for the better, their focus today is more on the character of institutions within

which people make decisions. But if policies that read well often come to naught in dysfunctional institutions, the study of institutions on their own is not sufficient: good policies cannot be plucked from air. There is mutual influence here, and the task of the social scientist is to study it.

Demographers, like economists, seek good news. There is a danger that the recent onset of demographic transitions in parts of the Indian subcontinent and signs of an onset in some of the urban regions of sub-Saharan Africa will make demographers complacent. A distinguished student of demography remarked to me recently that, in view of the many signs of demographic transitions everywhere, the "population problem" is now over.

But it is not over. The ultimate size of the world's population once the transitions have occurred will matter greatly. There is likely to be a world of difference between a global population of 11 billion and one of 5 billion, even if we ignored differences in their spatial distributions that would inevitably be implied (Cohen 1995). In this connection, it is worth stressing that some of the externalities I have identified in this article operate mainly *in* time, while others operate mainly *through* time (economists refer to them, respectively, as "static" and "dynamic" externalities). So even if world population were to stabilize, there would remain externalities whose presence calls for public policies.

In this article I have identified a number of institutional failures that are allied to pronatalist reproductive externalities. I have done this by trying to connect demographic and environmental perspectives. The perspective that emerges tells us that the most potent avenue for reducing the population problem in various parts of the world involves the simultaneous deployment of a number of policies, not a single panacea, and that the relative importance of the several prongs depends on the community in question. Thus, while family planning services (especially when allied to public health services) and measures that empower women (through both education and improved employment opportunities) are certainly desirable, other policies also commend themselves, such as the provision of infrastructural goods (e.g., cheap sources of household fuel and potable water), changes to property rights (e.g., the rules of inheritance), means of communication with the outside world (e.g., roads, telephones, radios, television, newspapers, and the Internet), and measures that directly increase the economic security of the poor. A number of these policies might well not have come to mind had we studied demographic problems in isolation.

In any event, the aim should not be to force people to change their reproductive behavior. Rather, it should be to identify policies and encourage such institutional changes as would "internalize" the externalities I have uncovered here. Recent declines in fertility rates in the Indian subcontinent and in parts of sub-Saharan Africa suggest that outside influence, via the media, may have been powerful. Observing lifestyles elsewhere can no

doubt be unsettling to many, but it can also give people ideas that are salutary. To the extent that reproductive behavior is based on conformism, modern communication channels, by linking the village to the outside world, have a powerful effect. But the media are likely to be hampered in arbitrary ways except in politically open societies. I have shown elsewhere (Dasgupta 1990; Dasgupta and Weale 1992) that in poor countries political and civil liberties are congruent with improvements in other aspects of life, such as income per head, life expectancy at birth, and infant survival. Subsequently, Przeworski and Limongi (1995) have shown that these liberties are negatively correlated with fertility rates. We therefore have several reasons for thinking that political and civil liberties have instrumental value, even in poor countries; they are not merely desirable ends. But each of the prescriptions offered by the new perspective presented here is desirable in itself and commends itself even when we do not have fertility rates of poor countries in mind. To me this is a most agreeable fact.

Admittedly, in all this I have looked at matters wholly from the perspective of parents. This is limiting.[50] But developing the welfare economics of population policies has proved to be extremely difficult.[51] Our ethical intuition at best extends to actual and future people; we do not yet possess a good moral vocabulary for including potential people in the calculus. I have tried to argue in this article that there is much we can establish even if we left aside such conceptual difficulties. Population policy involves a good deal more than making family planning services available to the rural poor. It also involves more than a recognition that poverty is the root cause of high fertility rates. The problem is deeper, but as I have tried to show, it is possible to subject it to analysis.

Appendix: The village commons and household size

The observation that increases in population size bring in their wake additional pressures on the local natural-resource base is, no doubt, a banality. So, in what follows I study the reverse influence: the effect of a deterioration of the local natural-resource base on desired household size.

I argued above that villagers' free-riding on the commons can impoverish households in such a way as to create an additional need for household labor. Such a need would translate itself into a demand for more surviving children if having more surviving children were the cheapest means of obtaining that additional labor. Of course, this is only one possibility; another is that the receding commons impoverishes households in such a way that, at the margin, children become too costly, with the result that the number of surviving children declines. In this Appendix I offer a formal account of both possibilities. The model outlined enables us to identify parametric conditions under which the various outcomes would be expected to occur. I then compare the noncooperative village to a cooperative one.

The model is timeless. Adjustments over time can then be analyzed in terms of comparative statics.

The single household

I consider an agriculture-based village economy consisting of N identical households. N is taken to be sufficiently large that the representative household's size does not affect the economy. The model is deterministic. Household size is assumed to be a continuous variable, which is a way of acknowledging that realized household size is not a deterministic function of the size the household sets for itself as a target.

Let n be the size of a household. Members contribute to production, but they also consume from household earnings. I aggregate inputs and outputs and assume that household production possibilities are such that net income per household member, y(n), has the quadratic form,

$$y(n) = -\alpha + \beta n - \gamma n^2, \text{ where } \alpha, \beta, \gamma > 0, \text{ and } \beta^2 > 4\alpha\gamma. \tag{1}$$

The quadratic form enables us to capture certain crucial features of a subsistence economy in a simple way, thereby permitting us to draw conclusions easily. For example, equation (1) presumes fixed costs in running a household, which is altogether realistic: in order to survive, a household must complete so many chores on a daily basis (cleaning, farming, animal care, fetching water and collecting fuelwood, cooking raw ingredients, and so forth) that single-member households are not feasible. Equation (1) also presumes that when the household is large, the costs of adding new members begin to overtake the additional income that is generated. This too is clearly correct.[52]

It follows from equation (1) that y(n) = 0 at

$$\underline{n} = \left[\beta - \sqrt{(\beta^2 - 4\alpha\gamma)}\right] / 2\gamma \tag{2a}$$

and

$$\overline{n} = \left[\beta + \sqrt{(\beta^2 - 4\alpha\gamma)}\right] / 2\gamma. \tag{2b}$$

$\underline{n}$ is the "fixed cost" of maintaining a household, while $\overline{n}$ could be interpreted to be the environment's "carrying capacity." I assume that the household "chooses" its size so as to maximize net income per head. Let n* denote the value of n at which y(n) attains its maximum and let y* denote the maximum. Then

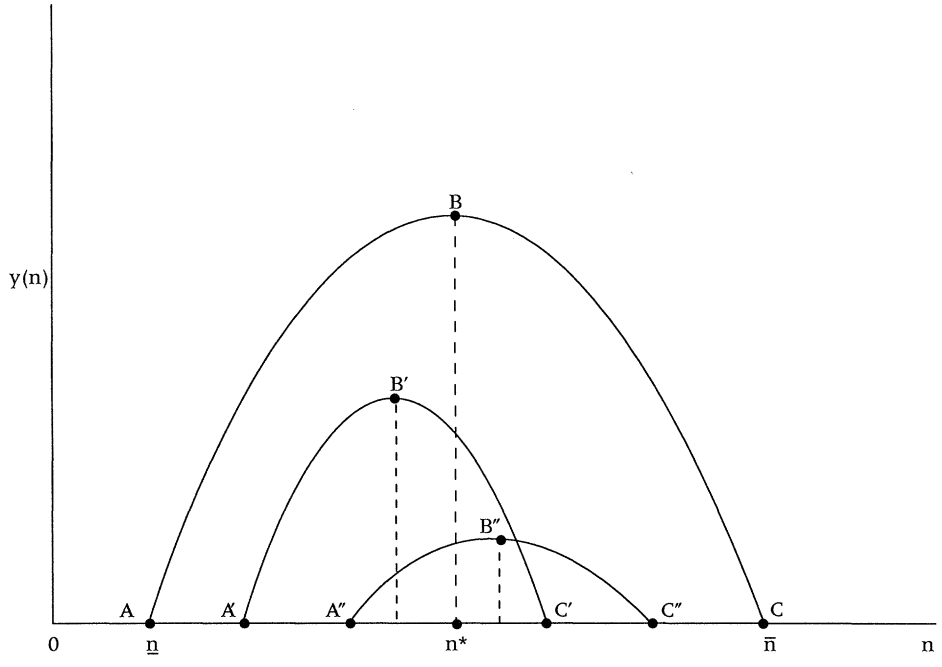
$$n^* = \beta / 2\gamma \tag{3a}$$

and

$$y^* = -\alpha + \beta^2 / 4\gamma. \tag{3b}$$

y(n) is depicted as the curve ABC in Figure A-1, where B is the point $(\beta/2\gamma, -\alpha + \beta^2/4\gamma)$.

FIGURE A-1 Household income per head, y(n), as a function of household size, (n)



Imagine now that the household faces an increase in resource scarcity. We are to interpret this in terms of receding forests and vanishing water holes. The index of resource scarcity could then be the average distance from the village to the resource base. So, an increase in resource scarcity would mean, among other things, an increase in $\underline{n}$.

But it would typically mean more. For example, equations (2a,b) tell us that the household would face an increase in resource scarcity if α, γ, and α/γ were to increase and β were to decline in such a way that $\bar{n}$ declines. Note too that in this case, both n^* and y^* would decline (equations (3a,b)). The resulting y(n) is depicted as the curve A′B′C′ in Figure A-1. In short, the increase in resource scarcity shifts the curve ABC to A′B′C′.

Consider instead the case where each of α, β, and γ increases, but in such ways that $\underline{n}$ and n^* increase, while $\bar{n}$ and y^* decline. This is the kind of situation in which a household finds that its best strategy against local resource degradation is to increase its size even while finding itself poorer. The resulting y(n) is depicted as the curve A″B″C″ in Figure A-1. In short, the increase in resource scarcity shifts the curve ABC to A″B″C″. This sort of case was noted originally in Dasgupta and Mäler (1991) and Nerlove (1991).

Social equilibrium

I now construct an equilibrium of the village economy. The state of the local natural-resource base is taken to be a function of the village population, which I write

as M. So I assume that α, β, and γ in equation (1) are functions of M. Write $\alpha = \alpha(M)$, $\beta = \beta(M)$, and $\gamma = \gamma(M)$. A symmetrical equilibrium of the village economy is characterized by $M^* = Nn^*$. That is, n^* and y^* are the solutions of

$$n^* = \beta(Nn^*)/2\gamma(Nn^*) \tag{4a}$$

and

$$y^* = -\alpha(Nn^*) + \left[\beta(Nn^*)\right]^2/4\gamma(Nn^*). \tag{4b}$$

I assume that a solution exists and that $n^* > 1$.

The optimum village

Consider next an optimizing village community.[53] It chooses n so as to maximize

$$y(n) = -\alpha(Nn) + \beta(Nn)n - \gamma(Nn)n^2. \tag{5}$$

Let $\hat{n}$ be the optimum household size. Then $\hat{n}$ is the solution of

$$\left[\beta(Nn) - 2n\gamma(Nn)\right] - N\left[\alpha'(Nn) - n\beta'(Nn) + n^2\gamma'(Nn)\right] = 0. \tag{6}$$

A comparison of equations (4a) and (6) tells us that $\hat{n} < n^*$ if

$$-\alpha'(Nn^*) + n^*\left[\beta'(Nn^*) - n^*\gamma'(Nn^*)\right] < 0. \tag{7}$$

That is, if equation (7) holds, the village is overpopulated in social equilibrium. An alternative way of thinking about the matter is to say that an institutional reform which reduces the "freedom of access" to the commons would lower fertility.

Now equation (7) certainly holds if

$$\alpha', \gamma' > 0 \text{ and } \beta' < 0 \text{ at } n = n^*. \tag{8}$$

But it holds also if

$$\alpha', \beta', \gamma' > 0,$$

and

$$\left[-\alpha' + \left(\beta\beta'/2\gamma\right) - \beta^2\gamma'/4\gamma^2\right] < 0 \text{ at } n = n^*. \tag{9}$$

The effect of increased resource scarcity

Let us study the implications for equilibrium household size and the standard of living consequent upon small exogenous shifts in the functions $\alpha(M)$, $\beta(M)$, and $\gamma(M)$. We assume that, prior to these shifts, the inequality depicted in equation (7) holds. The perturbations are taken to be sufficiently small so that equation (7) continues to hold in the new equilibrium.

Consider first the case where the perturbation consists of small upward shifts in $\alpha(M)$ and $\gamma(M)$ and a small downward shift in $\beta(M)$. Notice that if equation (8) holds, both n^* and y^* would be marginally smaller as a consequence of the perturbation. This is the case we would expect intuitively: a small increase in resource scarcity results in poorer but smaller households.

Now consider the case where equation (9) holds. Suppose the perturbation consists of small upward shifts in each of the functions $\alpha(M)$, $\beta(M)$, and $\gamma(M)$. We can set the relative magnitudes of the shifts such that the small increase in resource scarcity results in poorer but larger households—that is, y^* declines marginally but n^* increases marginally. This is the timeless counterpart of the positive feedback mechanism between population size, poverty, and degradation of the natural-resource base that was discussed in the text. Such a feedback, while by no means an inevitable fact of rural life, is a possibility. In this article I have argued that evidence of the experiences of sub-Saharan Africa and the northern Indian subcontinent in recent decades is not inconsistent with it.

Notes

This article synthesizes a class of ideas I have developed in Dasgupta (1992, 1993, 1995, 2000). While preparing the article I benefited greatly from discussions with Kenneth Arrow, Robert Cassen, Sriya Iyer, and Karl-Göran Mäler.

1 See, for example, Cassen (1978), Dyson and Moore (1983), World Bank (1984), Birdsall (1988), Robey, Rutstein, and Morris (1993), Sen (1994), and Bardhan (1996).

2 See, for example, Boserup (1981), Simon (1989), and Bauer (2000).

3 The I=PAT equation of Ehrlich and Holdren (1971), in which Impact on the environment is a function of Population, Affluence, and Technology, is used by many to express this concern.

4 The modern classic is Becker (1981).

5 Jones (1998) contains a review of contemporary growth models.

6 Daily (1997) is a collection of essays on the character of ecosystem services. See also Arrow et al. (1995) and Dasgupta, Levin, and Lubchenco (2000), both of which discuss the implications of the fact that destruction of ecosystems is frequently irreversible.

7 For first-hand accounts of daily life under the stresses of resource scarcity, see Agarwal (1986, 1989) and Narayan (2000). For attempts to develop the economics of such conditions, see Dasgupta (1982, 1993, 1995, 1996, 1997a, 1998a, 2000).

8 One of the rare exceptions is Bardhan and Udry (1999).

9 The early works are cited in Becker (1981). Hotz, Klerman, and Willis (1997) survey the field by studying fertility decisions in developed countries. Schultz (1997) makes thorough use of the new household economics for studying the demand for children in poor countries.

10 Surveying the field, Schultz (1988: 417–418) wrote: "Consequences of individual fertility decisions that bear on persons outside of the family have proved difficult to quantify, as in many cases where social external diseconomies are thought to be important.... The next step is to apply...microeconomic models [of household behavior] to understand aggregate developments in a general equilibrium framework. But progress in this field has been slow."

11 Kelley (1988) contains a review of the findings. See also the survey of empirical growth economics by Temple (1999), who adopts a skeptical view regarding the deleterious consequences of population growth in poor countries.

12 The total fertility rate (TFR) is the number of live births a woman would expect to

have if she were to live through her childbearing years and to bear children at each age in accordance with the prevailing age-specific fertility rates. If the TFR were 2.1 or thereabouts, population in the long run would stabilize.

13 Schultz (1997) confirms this effect for a pooled set of cross-country data.

14 For a fuller discussion see Daily et al. (1998).

15 Wealth per head is the correct index only if production processes are subject to constant returns to scale. If they are not, the statement in the text needs to be modified (see Dasgupta and Mäler 2000). I am ignoring such refinements here. For many years environmental and resource economists argued that GNP should be replaced by net national product (NNP) as a measure of social wellbeing so as to accommodate environmental concerns. This argument was wrong: NNP is not an adequate welfare measure; wealth is.

16 See also World Bank (1998). Serageldin (1995) reported on the World Bank's research program on sustainable development.

17 Drèze and Murthi (2000) have found no effect of income on fertility in a pooled set of district-level data from India.

18 In this respect, the literature I am alluding to resembles much contemporary economic theory.

19 Brock and Durlauf (1999) and Levin (1999) offer useful accounts of that structure in a technical and nontechnical manner, respectively.

20 Myrdal (1944) called such forms of feedback "cumulative causation."

21 Lutz and Scherbov (1990) offer a thoughtful review of why and how.

22 See Cleland (1996) for a demonstration of this.

23 To illustrate, with a random but representative example, I quote from a letter to the *Guardian* newspaper written by Anthony Young of Norwich, UK, on 24 April 2000. Tracing the prevailing famine in Ethiopia to overpopulation relative to Ethiopia's resource base, he writes: "There is an ethically acceptable set of measures for reducing rates of population growth: improvement in the education and status of women, coupled with making family planning services available to all."

24 Above low levels of education and contraceptive use, however, women's education and family planning outreach activities appear to be substitutes.

25 Subsequent to Cochrane's work, studies have found a positive association between maternal education and the wellbeing of children, the latter measured in terms of such indicators as household consumption of nutrients, birth spacing, the use of contraceptives, infant and child survival rates, and children's height (see Dasgupta 1993: ch. 12, for references). As an indication of orders of magnitude, the infant mortality rate in households in Thailand where the mother had no education was found to be 122 per 1,000 live births, compared with rates of 39 and 19 per 1,000, respectively, for women with primary and secondary education; see World Bank (1991). However, a common weakness of many such empirical studies is their "bivariate" nature.

In pooled cross-section data for poor countries in the 1970s and 1980s, Schultz (1997) has found that the total fertility rate is negatively related to women's and men's education (the latter's effect being smaller), as well as to urbanization and agricultural employment; and positively related to unearned income and child mortality. This is what the new household economics would lead one to expect.

26 In their careful analysis of district-level data in India from the 1981 and 1991 censuses, Drèze and Murthi (2000) have come the closest to claiming that a causal link exists between women's education and fertility. But their study was not designed to test the kind of theoretical reasoning I am pursuing here.

27 Hess (1988) has conducted time-series analysis that attests to a positive association between primary education and fertility in parts of sub-Saharan Africa.

28 Anthropologists have argued, however, that in parts of western sub-Saharan Africa prolonged breastfeeding is not a birth control measure, but a means of reducing infant mortality: traditionally, animal milk has been scarce in the region.

29 I am grateful to John Bongaarts for helpful conversations on this matter.

30 Chen, Huq, and D'Souza (1981) is a pioneering quantitative study on the behavioral antecedents of higher female than male

mortality from infancy through the childbearing ages in rural Bangladesh. See Dasgupta (1993) for further references. It should be noted that stopping rules governing fertility behavior based on sex preference provide a different type of information regarding such preference than do sex ratios within a population. To see this, suppose that in a society where sons are preferred, parents continue to have children until a son is born, at which point they cease having children. Assume that at each try there is a 50 percent chance of a son being conceived. Now imagine a large population of parents, all starting from scratch. In the first round 50 percent of the parents will have sons and 50 percent will have daughters. The first group will now stop and the second group will try again. Of this second group, 50 percent will have sons and 50 percent will have daughters. The first subgroup will now stop and the second will have another try. But at each round the number of boys born equals the number of girls. The sex ratio is 1.

The argument also implies that population remains constant. To confirm this, note that because each couple has exactly one son, couples on average have one son. But because the sex ratio is 1, couples on average have one daughter also. Therefore, the average couple has two children. This means that in equilibrium the size of the population is constant.

31 Writing about West Africa, Fortes (1978: 125–126) says "a person does not feel he has fulfilled his destiny until he or she not only becomes a parent but has grandchildren.... [Parenthood] is also a fulfillment of fundamental kinship, religious and political obligations, and represents a commitment by parents to transmit the cultural heritage of the community.... Ancestry, as juridically rather than biologically defined, is the primary criterion...for the allocation of economic, political, and religious status." See also Goody (1976). Cochrane and Farid (1989) remark that both the urban and rural and the educated and uneducated in sub-Saharan Africa have more, and want more, children than do their counterparts in other regions. Thus, even younger women there expressed a desire for an average of 2.6 more children than women in the Middle East, 2.8 more than women in North Africa, and 3.6 to 3.7 more than women in Latin America and Asia.

32 Between 1965 and 1987 the infant mortality rate in a number of the poorest countries in sub-Saharan Africa declined from about 200 per 1,000 live births to somewhere on the order of 150 per 1,000 live births (World Bank 1989).

33 Sundstrom and David (1988) apply this reasoning to parents in the United States prior to its Civil War.

34 This hypothesis could be tested by comparing the age structure of households that foster out with those that foster in.

35 To see that there is no distortion if the share of benefits and costs was the same, suppose c is the cost of rearing a child and N is the number of couples within a kinship. For simplicity, assume that each child makes available y units of output to the entire kinship, which is then shared equally among all couples. Suppose also that the cost of rearing each child is shared equally by all couples. Let n^* be the number of children each couple other than the one under study chooses to have. (I presently endogenize this.) If n were the number of children this couple produces, it would incur the resource cost $C=[nc+(N-1)n^*c]/N$, and eventually the couple would receive an income from the next generation equaling $Y=[ny+(N-1)n^*y]/N$. Denote the couple's aggregate utility function by the form $U(Y)-K(C)$, where both $U(.)$ and $K(.)$ are increasing and strictly concave functions. Letting n be a continuous variable for simplicity, it is easy to confirm that the couple in question will choose the value of n at which $yU'(Y)=cK'(C)$. The choice sustains a social equilibrium when $n=n^*$. It is easy to check that this is also the condition that is met in a society where there is no reproductive free-riding. It is a simple matter to confirm that free-riding occurs if the couple's share of the benefits from having children exceeds their share of the costs.

36 Among the prominent Nayyars of the southern state of Kerala, descent is matrilineal. Kerala is noteworthy today for being among the poorer Indian states even while attaining a TFR below 2.

37 n^* is taken to be a continuous variable as a way of acknowledging that realized household size is not a deterministic function of the size the household sets as a target for itself.

38 Because households are identical in this stylized model, by a socially optimal state I mean a Pareto optimum.

39 In game theory Figure 2 is called a coordination game.

40 Formally, the above is a model of demographic transitions viewed as "relaxation phenomena." The mathematical structure I have invoked is similar to one that has recently been used by oceanographers and ecologists in their exploration of tipping phenomena in ocean circulation and lake turbidity, respectively. See Rahmstorf (1995) and Scheffer (1997).

41 In this connection, the Indian state of Andhra Pradesh offers an interesting example. Female illiteracy there is a high 55 percent, but some 75 percent of the population has access to radio or television. The fertility rate is now 2.3.

42 I am grateful to Lincoln Chen for a helpful 1996 correspondence on this point.

43 This is the setting studied in the theory of repeated games. See Fudenberg and Tirole (1991).

44 I am thinking of countries in sub-Saharan Africa and the Indian subcontinent. In those countries the agricultural labor force as a proportion of the total labor force is on the order of 60–70 percent, and the share of agricultural-value added in GNP is on the order of 25–30 percent.

45 In his work on south Indian villages, Seabright (1997) has shown that producers' cooperatives, unconnected with the management of local commons, are also more prevalent in the drier districts.

46 See Thomson, Feeny, and Oakerson (1986) and Baland and Platteau (1996).

47 Filmer and Pritchett (1996) summarize empirical findings on children's time allocation to household activities in rural areas of poor countries.

48 However, Deon Filmer has informed me that his colleagues at the World Bank have found in a sample of Nepalese villages a positive relationship between (primary) school attendance and the availability of local natural resources.

49 Crook (1996) questions the poverty–population link. But because he treats population density and land productivity as exogenous variables, his is not quite a test of the thesis.

50 Enke (1966) is a notable exploration of the value of prevented births when the worth of additional lives is judged to be based entirely on their effect on the current generation. As a simplification, Enke took the value of a prevented birth to be the discounted sum of the differences between an additional person's consumption and output over the person's lifetime.

51 I have addressed some of the difficulties elsewhere (Dasgupta 1998b).

52 The analysis that follows can be developed more generally, without recourse to the quadratic function.

53 I avoid rigor here and assume (without justification) that the optimum is symmetric in households.

References

Adelman, I. and C. T. Morris. 1965. "A factor analysis of the interrelationship between social and political variables and per capita gross national product," *Quarterly Journal of Economics* 79(2): 555–578.

Agarwal, A. and S. Narain. 1989. *Towards Green Villages: A Strategy for Environmentally Sound and Participatory Rural Development.* New Delhi: Centre for Science and Environment.

Agarwal, B. 1986. *Cold Hearths and Barren Slopes: The Woodfuel Crisis in the Third World.* New Delhi: Allied Publishers.

———. 1989. "Rural women, poverty and natural resources: Sustenance, sustainability and struggle for change," *Economic and Political Weekly* 24(43): 46–65.

Alderman, H. et al. 1995. "Unitary versus collective models of the household: Is it time to shift the burden of proof?" *World Bank Research Observer* 10(1): 1–20.

Arrow, K. J. et al. 1995. "Economic growth, carrying capacity, and the environment," *Science* 268(5210): 520–521.

Baland, J.-M. and J.-P. Platteau. 1995. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Oxford: Oxford University Press.

Bardhan, P. 1996. "Research on poverty and development twenty years after redistribution with growth," in *Proceedings of the Annual World Bank Conference on Development Economics, 1995* (Supplement to the *World Bank Economic Review* and the *World Bank Research Observer*), pp. 59–72.

Bardhan, P. and C. Udry. 1999. *Development Microeconomics*. Oxford: Oxford University Press.

Batliwala, S. and A. K. N. Reddy. 1994. "Energy consumption and population," in F. Graham-Smith (ed.), *Population: The Complex Reality*. London: The Royal Society.

Bauer, P. 2000. *From Subsistence to Exchange and Other Essays*. Princeton, NJ: Princeton University Press.

Becker, G. 1981. *A Treatise on the Family*. Cambridge, MA: Harvard University Press.

Becker, G. and N. Tomes. 1976. "Child endowments and the quantity and quality of children," *Journal of Political Economy* 84(Supplement): 143–162.

Bernheim, B. D. 1994. "A theory of conformity," *Journal of Political Economy* 102(4): 841–877.

Birdsall, N. 1988. "Economic approaches to population growth," in H. Chenery and T. N. Srinivasan (eds.), *Handbook of Development Economics*, Vol. I. Amsterdam: North Holland.

Birdsall, N. and D. Jamison. 1983. "Income and other factors influencing fertility in China," *Population and Development Review* 9(4): 651–675.

Bledsoe, C. 1990. "The politics of children: Fosterage and the social management of fertility among the Mende of Sierra Leone," in W. Penn Handwerker (ed.), *Births and Power: Social Change and the Politics of Reproduction*. London: Westview Press.

———. 1994. "'Children are like young bamboo trees': Potentiality and reproduction in sub-Saharan Africa," in K. Lindahl-Kiessling and H. Landberg (eds.), *Population, Economic Development, and the Environment*. Oxford: Oxford University Press.

Bledsoe, C. and G. Pison (eds.). 1994. *Nupitality in Sub-Saharan Africa: Contemporary Anthropological and Demographic Perspectives*. Oxford: Clarendon Press.

Bongaarts, J. 1980. "Does malnutrition affect fecundity? A summary of the evidence," *Science* 208: 564–569.

———. 1990. "The measurement of wanted fertility," *Population and Development Review* 16(3): 487–506.

———. 1997. "The role of family planning programmes in contemporary fertility transitions," in G. W. Jones, R. M. Douglas, J. C. Caldwell, and R. M. D'Souza (eds.), *The Continuing Demographic Transition*. Oxford: Clarendon Press.

Bongaarts, J. and M. Cain. 1981. "Demographic responses to famine," Center for Policy Studies Working Paper no. 77. New York: Population Council.

Bongaarts, J. and S. C. Watkins. 1996. "Social interactions and contemporary fertility transitions," *Population and Development Review* 22(4): 639–682.

Boserup, E. 1981. *Population Growth and Technological Change*. Chicago: University of Chicago Press.

Brander, J. A. and M. S. Taylor. 1998. "The simple economics of Easter Island: A Ricardo-Malthus model of renewable resource use," *American Economic Revew* 88(1): 119–138.

Brock, W. A. and S. N. Durlauf. 1999. "Interactions-based models," Social Systems Research Institute, University of Wisconsin, Madison. Forthcoming in J. J. Heckman and E. Leamer (eds.), *Handbook of Econometrics*, Vol. 5. Amsterdam: North Holland.

Cain, M. 1981. "Risk and insurance: Perspectives on fertility and agrarian change in India and Bangladesh," *Population and Development Review* 7(3): 435–474.

———. 1983. "Fertility as an adjustment to risk," *Population and Development Review* 9(4): 688–702.
———. 1984. "Women's status and fertility in developing countries: Son preference and economic security," World Bank Staff Working Paper No. 682, Washington, DC.
Caldwell, J. C. 1981. "The mechanisms of demographic change in historical perspective," *Population Studies* 35(1): 5–27.
———. 1982. *Theory of Fertility Decline*. New York: Academic Press.
———. 1991. "The soft underbelly of development: Demographic transition in conditions of limited economic change," in *Proceedings of the Annual World Bank Conference on Development Economics 1990* (Supplement to the *World Bank Economic Review*), pp. 207–254.
Caldwell, J. C. and P. Caldwell. 1990. "High fertility in sub-Saharan Africa," *Scientific American* 262(5): 82–89.
Cassen, R. 1978. *India: Population, Economy, Society*. London: MacMillan.
Cavendish, W. 1998. "The complexity of the commons: Environmental resource demands in rural Zimbabwe," Working Paper, Centre for the Study of African Economies, University of Oxford.
———. 1999. "Poverty, inequality and environmental resources: Quantitative analysis of rural households," Working Paper, T.H. Huxley School, Imperial College of Science, Technology and Medicine, London.
Chen, L. C., E. Huq, and S. D'Souza. 1981. "Sex bias in the family allocation of food and health care in rural Bangladesh," *Population and Development Review* 7(1): 55–70.
Chopra, K., G. Kadekodi, and M. N. Murty. 1990. *Participatory Development: People and Common Property Resources*. New Delhi: Sage Publications.
Cleaver, K. M. and G. A. Schreiber. 1994. *Reversing the Spiral: The Population, Agriculture, and Environment Nexus in Sub-Saharan Africa*. Washington, DC: World Bank.
Cleland, J. 1996. "Population growth in the 21st century: Cause for crisis or celebration?" *Tropical Medicine and International Health* 1(1): 15–26.
Cleland, J. and C. Wilson 1987. "Demand theories of the fertility transition: An iconoclastic view," *Population Studies* 41(1): 5–30.
Coale, A. J. 1969. "The decline of fertility in Europe from the French Revolution to World War II," in S. J. Behrman, L. Corsa, and R. Freedman (eds.), *Fertility and Family Planning: A World View*. Ann Arbor: University of Michigan Press.
Cochrane, S. 1979. *Fertility and Education: What Do We Really Know?* Baltimore, MD: Johns Hopkins University Press.
———. 1983. "Effects of education and urbanization on fertility," in R. Bulatao and R. Lee (eds.), *Determinants of Fertility in Developing Countries*, Vol II. New York: Academic Press.
Cochrane, S. and S. Farid. 1989. "Fertility in sub-Saharan Africa: Analysis and explanation," World Bank Discussion Paper No. 43, Washington DC.
Cohen, B. 1993. "Fertility levels, differentials and trends," in K. A. Foote, K. H. Hill, and L. G. Martin (eds.), *Demographic Change in Sub-Saharan Africa*. Washington, DC: National Academy Press.
Cohen, J. 1995. *How Many People Can the Earth Support?* New York: W.W. Norton.
Cox, D. and E. Jimenez. 1992. "Social security and private transfers in developing countries: The case of Peru," *World Bank Economic Review* 6(1): 155–169.
Crook, N. 1996. "Population and poverty in classical theory: Testing a structural model for India," *Population Studies* 50(2): 173–186.
Cropper, M. and W. Oates 1992. "Environmental economics: A survey," *Journal of Economic Literature* 30(2): 675–740.
Daily G. (ed.). 1997. *Nature's Services: Societal Dependence on Natural Ecosystems* Washington, DC: Island Press.
Daily G. et al. 1998. "Food production, population growth, and the environment," *Science* 281: 1291–1292.

Das Gupta, M. 1987. "Selective discrimination against female children in rural Punjab, India," *Population and Development Review* 13(1): 77–100.

Dasgupta, P. 1982. *The Control of Resources.* Cambridge, MA: Harvard University Press.

———. 1990. "Well-being and the extent of its realization in poor countries," *Economic Journal* 100 (Supplement): 1–32.

———. 1992. "Population, resources and poverty," *Ambio* 21(1): 95–101.

———. 1993. *An Inquiry into Well-Being and Destitution.* Oxford: Clarendon Press.

———. 1995. "The population problem: Theory and evidence," *Journal of Economic Literature* 33(4): 1879–1902.

———. 1996. "The economics of the environment," *Environment and Development Economics* 1(4): 387–428.

———. 1997a. "Environmental and resource economics in the world of the poor," 45th Anniversary Lecture, Resources for the Future, Washington, DC.

———. 1997b. "Nutritional status, the capacity for work and poverty traps," *Journal of Econometrics* 77(1): 5–38.

———. 1998a. "The economics of poverty in poor countries," *Scandinavian Journal of Economics* 100(1): 41–68.

———. 1998b. "Population, consumption and resources: Ethical issues," *Ecological Economics* 24(2): 139–152.

———. 1999. "Economic progress and the idea of social capital," in P. Dasgupta and I. Serageldin (eds.), *Social Capital: A Multifaceted Perspective.* Washington, DC: World Bank.

———. 2000. "Reproductive externalities and fertility behaviour," *European Economic Review* (Papers & Proceedings), 44: 619–644.

———. 2001. "Valuing biodiversity," in *Enclyclopedia of Biodiversity.* New York: Academic Press.

Dasgupta, P., S. Levin, and J. Lubchenco. 2000. "Economic pathways to ecological sustainability," *BioScience* 50(4): 339–345.

Dasgupta, P. and K.-G. Mäler. 1991. "The environment and emerging development issues," in *Proceedings of the Annual World Bank Conference on Development Economics 1990* (Supplement to the *World Bank Economic Review*), pp. 101–132.

———. 1995. "Poverty, institutions, and the environmental-resource base," in J. Behrman and T. N. Srinivasan (eds.), *Handbook of Development Economics,* Vol. III. Amsterdam: North Holland.

———. 2000. "Net national product, wealth, and social well-being," *Environment and Development Economics* 5(1): 69–93.

Dasgupta, P. and D. Ray 1986. "Inequality as a determinant of malnutrition and unemployment, 1: Theory," *Economic Journal* 96(4): 1011–1034.

———. 1987. "Inequality as a determinant of malnutrition and unemployment, 2: Policy," *Economic Journal* 97(1): 177–188.

Dasgupta, P. and M. Weale. 1992. "On measuring the quality of life," *World Development* 20(1): 119–131.

Drèze, J. and M. Murthi. 2000. "Fertility, education and development: Further evidence from India," Working Paper No. 76, Centre for Development Economics, Delhi School of Economics.

Drèze, J. and A. Sen 1990. *Hunger and Public Action.* Oxford: Clarendon Press.

Durham, W. 1979. *Scarcity and Survival in Central America: Ecological Origins of the Soccer War.* Stanford, CA: Stanford University Press.

Dyson, T. and M. Moore 1983. "On kinship structure, female autonomy, and demographic behavior in India," *Population and Development Review* 9(1): 35–60.

Easterlin, R., R. Pollak, and M. Wachter. 1980. "Toward a more general model of fertility determination: Endogenous preferences and natural fertility," in R. Easterlin (ed.), *Population and Economic Change in Developing Countries.* Chicago: University of Chicago Press.

Eastwood, R. and M. Lipton. 1999. "The impact of changes in human fertility on poverty," Department of Economics, University of Sussex.

Ehrlich, P. and A. Ehrlich. 1990. *The Population Explosion*. New York: Simon and Schuster.
Ehrlich, P. and J. Holdren. 1971. "Impact of population growth," *Science* 171: 1212–1217.
Enke, S. 1966. "The economic aspects of slowing population growth," *Economic Journal* 76(1): 44–56.
Ezzell, C. 2000. "Care for a dying continent," *Scientific American* 282(5): 72–81.
Farooq, G., I. Ekanem, and S. Ojelade. 1987. "Family size preferences and fertility in South-Western Nigeria," in C. Oppong (ed.), *Sex Roles, Population and Development in West Africa*. London: James Currey.
Filmer, D. and L. Pritchett. 1996. "Environmental degradation and the demand for children," Policy Research Working Paper 1623, Policy Research Department, World Bank.
Fogel, R. W. 1994. "Economic growth, population theory, and physiology: The bearing of long-term processes on the making of economic policy," *American Economic Review* 84(3): 369–395.
Fortes, M. 1978. "Parenthood, marriage and fertility in West Africa," *Journal of Development Studies* 14(4, Special Issue on Population and Development): 121–149.
Freedman, R. 1995. "Asia's recent fertility decline and prospects for future demographic change," Asia-Pacific Population Research Report No. 1, East-West Center, Honolulu.
Fudenberg, D. and J. Tirole 1991. *Game Theory*. Cambridge, MA: MIT Press.
Goody, J. 1976. *Production and Reproduction*. Cambridge: Cambridge University Press.
———. 1996. "Comparing family systems in Europe and Asia: Are there different sets of rules?" *Population and Development Review* 22(1): 1–20.
Guyer, J. 1994. "Lineal identities and lateral networks: The logic of polyandrous motherhood," in C. Bledsoe and G. Pison (eds.), *Nupitality in Sub-Saharan Africa: Contemporary Anthropological and Demographic Perspectives*. Oxford: Clarendon Press.
Hajnal, J. 1982. "Two kinds of preindustrial household formation system," *Population and Development Review* 8(3): 449–494.
Hamilton, K. and M. Clemens. 1999. "Genuine savings rates in developing countries," *World Bank Economic Review* 13(2): 333–356.
Harford, J. D. 1998. "The ultimate externality," *American Economic Review* 88(1): 260–265.
Hess, P. N. 1988. *Population Growth and Socioeconomic Progress in Less Developed Countries*. New York: Praeger.
Heyd, D. 1992. *Genethics: Moral Issues in the Creation of People*. Los Angeles: University of California Press.
Heyser, N. 1996. *Gender, Population and Environment in the Context of Deforestation: A Malaysian Case Study*. Geneva: United Nations Research Institute for Social Development.
Hill, K. 1992. "Fertility and mortality trends in the developing world," *Ambio* 21(1): 79–83.
Homer-Dixon, T. F. 1994. "Environmental scarcities and violent conflict: Evidence from cases," *International Security* 19(1): 5–40.
Homer-Dixon, T., J. Boutwell, and G. Rathjens. 1993. "Environmental change and violent conflict," *Scientific American* 268(2): 16–23.
Hotz, V. J., J. A. Klerman, and R. J. Willis. 1997. "The economics of fertility in developed countries," in M. R. Rosenzweig and O. Stark (eds.), *Handbook of Population and Family Economics*. Amsterdam: North Holland.
Howe, J. 1986. *The Kuna Gathering: Contemporary Village Politics in Panama*. Austin: University of Texas Press.
IIED/WRI. 1987. *World Resources 1987*. New York: Basic Books.
Iyer, S. 2000. "Religion and the economics of fertility in South India," Ph.D. dissertation, Faculty of Economics, University of Cambridge.
Jodha, N. S. 1986. "Common property resources and the rural poor," *Economic and Political Weekly* 21: 1169–1181.
———. 1995. "Common property resources and the environmental context: Role of biophysical versus social stress," *Economic and Political Weekly* 30: 3278–3283.
Johnson, D. Gale. 2000. "Population, food, and knowledge," *American Economic Review* 90(1): 1–14.

Jolly, C. L. and J. N. Gribble. 1993. "The proximate determinants of fertility," in K. A. Foote, K. H. Hill, and L. G. Martin (eds.), *Demographic Change in Sub-Saharan Africa*. Washington, DC: National Academy Press.

Jones, C. I. 1998. *Introduction to Economic Growth*. New York: W.W. Norton.

Kelley, A. C. 1988. "Economic consequences of population change in the third world," *Journal of Economic Literature* 26(4): 1685–1728.

Kennedy, E. and R. Oniang'o. 1990. "Health and nutrition effects of sugarcane production in south-western Kenya," *Food and Nutrition Bulletin* 12(4): 261–267.

Kneese, A. and J. Sweeney. 1985, 1993. *Handbook of Natural Resource and Energy Economics*, Vols. I–III. Amsterdam: North Holland.

Lee, R. 1972. "Population growth and the beginnings of sedentary life among the !Kung bushmen," in B. Spooner (ed.), *Population Growth: Anthropological Implications*. Cambridge, MA: MIT Press.

Lee, R. D. and T. Miller. 1991. "Population growth, externalities to childbearing, and fertility policy in developing countries," *Proceedings of the Annual World Bank Conference on Development Economics 1990* (Supplement to the *World Bank Economic Review*), pp. 275–304.

Levin, S. A. 1999. *Fragile Dominion: Complexity and the Commons*. Reading, MA: Addison Wesley Longman.

Loughran, D. and L. Pritchett 1998. "Environmental scarcity, resource collection, and the demand for children in Nepal," mimeo., World Bank, Washington, DC.

Lutz, W. and S. Scherbov. 1999. "Quantifying the vicious circle model: The PEDA model for population, environment, development and agriculture in African countries," Discussion Paper, International Institute for Applied Systems Analysis, Laxenburg.

Mauro, P. 1995. "Corruption and growth," *Quarterly Journal of Economics* 110(3): 681–712.

Myrdal, G. 1944. *An American Dilemma: The Negro Problem and Modern Democracy*. New York: Harper & Row.

Narayan, D. (with R. Patel, K. Schafft, A. Rademacher, and S. Koch-Schulte). 2000. *Voices of the Poor: Can Anyone Hear Us?* Washington, DC: World Bank.

National Research Council. 1986. *Population Growth and Economic Development: Policy Questions*. Washington, DC: National Academy of Sciences Press.

Nerlove, M. 1991. "Population and the environment: A parable of firewood and other tales," *American Journal of Agricultural Economics* 75(1): 59–71.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

———. 1992. *Crafting Institutions for Self-Governing Irrigation Systems*. San Francisco, CA: ISC Press for Institute for Contemporary Studies.

Pritchett, L. H. 1994. "Desired fertility and the impact of population policies," *Population and Development Review* 20(1): 1–55.

Przeworski, A. and F. Limongi. 1995. "Democracy and development," Working Paper No. 7, Chicago Center on Democracy, University of Chicago.

Rahmstorf, S. 1995. "Bifurcations of the Atlantic thermohaline circulation in response to changes in the hydrological cycle," *Nature* 378: 145–149.

Robey, B., S. O. Rutstein, and L. Morris. 1993. "The fertility decline in developing countries," *Scientific American* 269(6): 30–37.

Scheffer, M. 1997. *The Ecology of Shallow Lakes*. New York: Chapman and Hall.

Schultz, T. P. 1988. "Economic demography and development," in G. Ranis and T. P. Schultz (eds.), *The State of Development Economics*. Oxford: Basil Blackwell.

———. 1997. "Demand for children in low income countries," in M. R. Rosenzweig and O. Stark (eds.), *Handbook of Population and Family Economics*. Amsterdam: North Holland.

Seabright, P. 1997. "Is cooperation habit-forming?" in P. Dasgupta and K.-G. Mäler (eds.), *The Environment and Emerging Development Issues*, Vol. II. Oxford: Clarendon Press.

Sen, A. 1994. "Population: Delusion and reality," *New York Review of Books* (22 September): 62–71.

Serageldin, I. 1995. "Are we saving enough for the future?" in *Monitoring Environmental Progress*, Report on Work in Progress, Environmentally Sustainable Development, World Bank, Washington, DC.

Serra, R. 1996. "An economic analysis of child fostering in West Africa," Ph.D. dissertation, Faculty of Economics, University of Cambridge.

Simon, J. L. 1989. "On aggregate empirical studies relating population variables to economic development," *Population and Development Review* 15(2): 323–332.

Solow, R. M. 1956. "A contribution to the theory of economic growth," *Quarterly Journal of Economics* 70(1): 65–94.

Sopher, D. E. 1980a. "Sex disparity in Indian literacy," in D. E. Sopher (ed.), *An Exploration of India: Geographical Perspectives on Society and Culture*. Ithaca, NY: Cornell University Press.

———. 1980b. "The geographical patterning of culture in India," in D. E. Sopher (ed.), *An Exploration of India: Geographical Perspectives on Society and Culture*. Ithaca, NY: Cornell University Press.

Stern, N. 1989. "The economics of development: A survey," *Economic Journal* 99(2): 597–685.

Sundstrom, W. A. and P. A. David. 1988. "Old age security motives, labor markets and farm family fertility in antebellum America," *Explorations in Economic History* 25(2): 164–197.

Temple, J. 1999. "The new growth evidence," *Journal of Economic Literature* 37(1): 112–156.

Thomson, J. T., D. H. Feeny, and R. J. Oakerson. 1986. "Institutional dynamics: The evolution and dissolution of common property resource management," in National Research Council, *Proceedings of a Conference on Common Property Resource Management*. Washington, DC: National Academy of Sciences Press.

Turner, B. L. and A. M. S. Ali. 1996. "Induced intensification: Agricultural change in Bangladesh with implications for Malthus and Boserup," in *Proceedings of the National Academy of Sciences* 93: 14984–14991.

United Nations Development Programme (UNDP). 1990, 1999. *Human Development Report*. New York: Oxford University Press.

Wade, R. 1988. *Village Republics: Economic Conditions for Collective Action in South India*. Cambridge: Cambridge University Press.

Watkins, S. C. 1990. "From local to national communities: The transformation of demographic regimes in Western Europe, 1870–1960," *Population and Development Review* 16(2): 241–272.

World Bank. 1984, 1990, 1991. *World Development Report*. New York: Oxford University Press.

———. 1989. *Sub-Saharan Africa: From Crisis to Sustainable Development*. Washington, DC: World Bank.

———. 1998. *World Development Indicators*. Washington, DC: World Bank.

———. 2000. *World Development Indicators*. Washington, DC: World Bank.

Wrigley, E. A. and R. S. Schofield. 1981. *The Population History of England 1541–1871: A Reconstruction*. Cambridge: Edward Arnold.