

**Population, Resources, and Welfare:  
An Exploration into Reproductive and Environmental Externalities\***

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## Prologue

Population growth elicits widely different responses from people. Some believe it to be among the causes of the most urgent problems facing humankind today (e.g., Ehrlich and Ehrlich, 1990), while others permute the elements of this causal chain, arguing, for example, that contemporary poverty and illiteracy in poor countries are the causes, rather than the consequences, of rapid population growth ("poverty is the problem, not population", or, "development is the best form of contraceptive", or, "the problem is not population, but lack of female education/autonomy", or, "reducing child mortality is the surest route to lowering fertility", or, "contraceptives are the best form of contraceptive", as the sayings go).<sup>1</sup> Still others claim that even in the poorest countries today population growth can be expected to provide a spur to economic progress.<sup>2</sup> Among the many who remain, there is a wide spectrum of views, both on the determinants of population growth and on the effects of that growth on the natural-resource base and human welfare. It would seem not only that our attitudes toward population size and its growth differ, there is no settled view on how the matter should be studied. As with religion and politics, we all have opinions on population and most of us hold on to them with tenacity.

In this article I bring together theoretical and empirical findings to argue that such divergence of opinion is unwarranted. In Sections 1-2 the conjecture is offered that differences persist because the interface of population, resources and welfare at a spatially localised level has been a relatively neglected subject of interest. Neglect by experts is probably also the reason why the nexus has attracted much popular discourse, which, while often illuminating, is frequently descriptive, not analytical.

It is not uncommon among those who do write about population, resources and welfare to adopt a global, future-oriented view: the emphasis frequently is on the deleterious effects a large and increasingly affluent population would have on Earth in the future.<sup>3</sup> This slant has been instructive, but it has drawn attention away from the economic misery and ecological

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<sup>1</sup> See, for example, Cassen (1978), Dyson and Moore (1983), World Bank (1984), Birdsall (1988), Robey et al. (1993), Sen (1994), and Bardhan (1996).

<sup>2</sup> See, for example, Boserup (1981), Simon (1989), and Bauer (2000).

<sup>3</sup> The famous "I=PAT" equation of Ehrlich and Holdren (1971), that Impact on the environment is a function of Population, Affluence and Technology, is used by many to express this concern.

degradation endemic in large parts of the world today. Disaster is not something for which the poorest have to wait, it is occurring even now. Moreover, among the rural poor in poor countries, decisions on fertility, on allocations concerning education, food, work, health-care, and on the use of the local natural-resource base are in large measure reached and implemented within households that are unencumbered by compulsory schooling and visits from social workers, that do not have access to credit and insurance in formal markets, that cannot invest in well-functioning capital markets, and that do not enjoy the benefits of social security and old-age pension. These features of rural life direct us to study the interface of population growth, poverty, and environmental stress from a myriad of household, and ultimately individual, viewpoints (Section 3). So, rather than adopt a macroscopic, futuristic outlook, I assume a micro-cosmic, contemporary perspective in this article.

Women's education and reproductive health have come to be seen in recent years as the most effective channels for influencing fertility. In Sections 4-5 I provide an outline of the theoretical and empirical reasons why they are so seen. It is an interesting analytical feature of education and reproductive health that they can be studied within a framework where households make decisions in isolation of other households. So, the theory of demand for education and reproductive health can be made to be a branch of the "new household economics", which has been much engaged in the study of households deciding without concern of what other households do.<sup>4</sup> But theoretical considerations suggest that there are a number of factors arising from interhousehold linkages which could also influence fertility decisions. In this article I am much interested in exploring such linkages. Interestingly, they include those in which women's education and reproductive health play a role. The findings I report are consistent with the contemporary emphasis on women's education and reproductive health. These matters are explored in Sections 7-8 and the Appendix. The conclusion I reach is that there is something which should be called the population problem. I also argue that in the Indian sub-continent and sub-Saharan Africa the problem has for a long while been an expression of human suffering, and that the problem could well persist even if all regions of the world were to make the transition to low fertility rates.

## **1 Complaints**

It is as well first to identify some of the ways social scientists have framed the links

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<sup>4</sup> The modern classic is Becker (1981).

between population growth, resources, and human welfare. I review them in this section. It will enable us to compare and contrast the way they framed the links with the way I am led to frame them here.

There are three sets of examples to discuss. They concern the way modern theories of economic growth view fertility and natural resources, the way population growth and economic stress in poor countries are studied by environmental and resource economists, and the way development economists accommodate environmental stress in their analysis of contemporary poverty. The examples are discussed in the next three sub-sections. If I grumble, there is cause. Not only have most among those who have been investigating economic growth, poverty, environmental stress, and fertility behaviour gone their own ways, judging by their citations there is little evidence they read beyond their particular fields of interest. One cannot but think that this has impeded progress in our understanding of some of the most complex issues in the social sciences.

### **1.1 Population and Resources in Modern Growth Theories**

For the most part modern theories of economic growth assume population change to be a determining factor of human welfare. A central tenet of the dominant theory is that although population growth doesn't affect the long-run rate of change in living standards in any way, it affects the long-run standard of living adversely (Solow, 1956).

Recent models of economic growth have been more assertive. They lay stress on new ideas as a source of progress. It is mostly supposed that the growth of ideas is capable of circumventing any constraint the natural-resource base may impose on the ability of economies to grow indefinitely. It is noted too that certain forms of investment (e.g., research and development) enjoy cumulative returns because the benefits are durable and can be shared collectively. The models also assume that growth in population leads to an increase in the demand for goods and services. An expansion in the demand and supply of ideas implies that in the long run, equilibrium output per head can be expected to grow at a rate which is itself an increasing function of the rate of growth of population (it is only when population growth is nil that the long run rate of growth of output per head is nil). The models regard indefinite growth in population to be beneficial.<sup>5</sup>

The nature of new products in contemporary growth theory isn't modelled explicitly. One

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<sup>5</sup> Jones (1998) contains a review of contemporary growth models.

can only assume that it imagines future innovations to be of such a character that indefinite growth in output would make no more than a finite additional demand on the natural-resource base. The imagination is questionable (Daily, 1997; Dasgupta, 2000b). In any event, we should be sceptical of a theory which places such enormous burden on an experience not much more than two hundred years old (Fogel, 1994; Johnson, 2000). Extrapolation into the past is a sobering exercise: over the long haul of history (some five thousand years), economic growth even in the currently-rich countries was for most of the time not much above zero. The study of possible feedback loops between poverty, demographic behaviour and the character and performance of both human institutions and the natural-resource base is not yet on the research agenda of modern growth theorists.

## **1.2 Demography and Economic Stress in Environmental and Resource Economics**

In its turn, the environmental and resource economics that has been developed in the United States has not shown much interest in economic stress and population growth in poor countries. Kneese and Sweeney (1985, 1993) and Cropper and Oates (1992) surveyed the economics of environmental resources, but bypassed the subject matter of this article. They were right to do so, for the prevailing literature regards the environmental-resource base as an "amenity". Indeed, it is today a commonplace that, to quote a recent editorial in London's Independent (4 December 1999), "... (economic) growth is good for the environment because countries need to put poverty behind them in order to care", or that, to quote the Economist (4 December, 1999: 17), "... trade improves the environment, because it raises incomes, and the richer people are, the more willing they are to devote resources to cleaning up their living space."

I quote these views only to show that natural resources are widely seen as luxuries. This view is hard to justify when one recalls that our natural environment maintains a genetic library, sustains the processes that preserve and regenerate soil, recycles nutrients, controls floods, filters pollutants, assimilates waste, pollinates crops, operates the hydrological cycle, and maintains the gaseous composition of the atmosphere. Producing as it does a multitude of ecosystem services, the natural-resource base is a necessity.<sup>6</sup> There is a gulf separating the perspective of environmental and resource economists in the North (I am using the term in its current

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<sup>6</sup> 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), who discuss the implications of the fact that destruction of ecosystems are frequently not reversible.

geopolitical sense) from what would appear to be the direct experience of the poor in the South.<sup>7</sup>

### **1.3 Population and Resource Stress in Development Economics**

So then you may think that the population-poverty-resource nexus would be a focus of attention among development economists. If so, you would be wrong. Even in studies on the semi-arid regions of sub-Saharan Africa and the Indian sub-continent (poverty-ridden land masses, inhabited by some 2 billion people and experiencing the largest additions ever known to their population; Tables 1-2), the nexus is largely absent. For example, Birdsall (1988), Kelley (1988) and Schultz (1988) are authoritative surveys by economic demographers on population growth in poor countries. None touches environmental matters. Mainstream demography (as reflected in, say, the journal Population and Development Review) also makes light of environmental stress facing poor communities in sub-Saharan Africa and the Indian sub-continent: the subject is rarely touched upon. Nor does the dominant literature on poverty (e.g., Stern, 1989; Dreze and Sen, 1990; Bardhan, 1996) take population growth and ecological constraints to be prime factors in development possibilities.<sup>8</sup>

This should be a puzzle. Much of the rationale for development economics as a specialization is the thought that poor countries suffer particularly from institutional failures. But institutional failures in great measure manifest themselves as externalities. To ignore population growth and ecological constraints in the study of poor countries would be to suppose that demographic decisions and resource-use there give rise to no externalities of significance, and that externalities arising from institutional failure have a negligible effect on resource-use and demographic behaviour. I know of no body of empirical work which justifies such presumptions.

### **2 Population, Food, and Resources: Why Global Statistics Can Mislead**

How is one to account for these neglects? It seems to me there are four reasons, one internal to the development of the "new household economics", the others arising from limitations in global statistics.

The first has to do with the preoccupation of those who developed the new household

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<sup>7</sup> For moving, first-hand accounts of what it is like to live under the stresses of resource scarcity, see Agarwal (1986, 1989) and Narayan (2000). For various attempts to develop the economics of such conditions, see Dasgupta (1982, 1993, 1995, 1996, 1997a, 1998a, 2000a).

<sup>8</sup> There are exceptions (e.g., Bardhan and Udry, 1999), but they really are exceptions.

economics.<sup>9</sup> For reasons of tractability they studied choices made by isolated, optimizing households. Such predictions of the theory as that increases in women's labour productivity reduce the household demand for children are borne out in cross-country evidence (Schultz, 1997). Nevertheless, the study of isolated households is not a propitious one in which to explore the possibilities of collective failure among households. For example, there have been few attempts to estimate reproductive externalities. One reason is that the theory of demographic interactions in non-market environments is still relatively underdeveloped; and without theory it is hard for the empiricist to know what to look for.<sup>10</sup> In Section 7 I show that there is scattered evidence, drawn from anthropology, demography, economics, and sociology, of pro-natalist externalities among rural households in poor countries. I also try to develop some of the analytical techniques which would be required for identifying such externalities. The directional predictions of the resulting theory are not at odds with those of the new household economics (such as that an increase in women's labour productivity lowers the demand for children); but their predictions differ on the magnitude of household responses.

The second reason for the neglect of the population-poverty-resource nexus is the outcome of an enquiry made more than a decade ago into the economic consequences of population growth (National Research Council, 1986). Drawing on national time-series and cross-regional data, the investigators observed that population size and its growth can have both positive and negative effects. For the purposes of interpreting the data population growth was regarded as a causal factor in the study. The investigators concluded that there was no cause for concern over the high rates of growth being experienced in poor countries.<sup>11</sup>

But regression results depend on what is being regressed on what. So, for example, there

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

<sup>10</sup> 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 behaviour) to understand aggregate developments in a general equilibrium framework. But progress in this field has been slow."

<sup>11</sup> Kelley (1988) contains a review of the findings. See also the survey of empirical growth economics by Temple (1999) in which the author adopts an agnostic view regarding population growth in poor countries.



can be set against National Research Council (1986) more recent cross-country studies by Mauro (1995) and Eastwood and Lipton (1999), who have found a negative correlation between population growth and economic growth and a positive correlation between population growth and the magnitude of absolute poverty. In short, cross-country regressions in which population growth is a determining factor have given us mixed messages. Later in this article I show that even though we may have learnt something from cross-country regressions, they have frequently misdirected us into asking wrong questions on demographic matters.

The third reason stems from a different set of empirical findings. Barring sub-Saharan Africa over the past thirty years or so, gross income per head has grown in nearly all poor regions since the end of the Second World War. In addition, growth in world food production since 1960 has exceeded the world's population growth: by an annual rate of 0.6 percent, approximately. This has been accompanied by improvements in a number of indicators of human welfare, such as the infant survival rate, life expectancy at birth, and literacy. In poor regions each of the latter has occurred in a regime of population growth rates substantially higher than in the past: excepting for East Asia and parts of South and Southeast Asia, modern-day declines in mortality rates have not been matched by reductions in fertility.

Table 3 presents total fertility rates (TFR), gross national product (GNP) per head, and growth in GNP per head in several countries and groups of countries.<sup>12</sup> Between 1980 and 1996 the TFR declined everywhere, but very unevenly. Sub-Saharan Africa has displayed the most acute symptoms of poverty: high fertility rates allied to declining GNP per head in what is a very poor continent. Nevertheless, as Table 2 confirms, the oft-expressed fear that rapid population growth will accompany deteriorations in living standards has not been borne out by experience when judged from the vantage of the world as a whole. It is then tempting to infer from this, as does Johnson (2000) most recently, that in recent decades population growth has not been a serious hindrance to improvements in the circumstances of living.

The fourth reason stems from economic theory and cross-country data on the link between household income and fertility. Imagine that parents regard children to be an end in themselves; that is, assume children to be a "consumption good". If in particular children are a

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<sup>12</sup> Total fertility rate (TFR) is the number of live births a woman would expect to give if she were to live through her child-bearing 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 stabilise.

"normal" consumption good, an increase in unearned income would lead to an increase in the demand for children, other things being the same. This is the "income effect".<sup>13</sup> In his well-known work Becker (1981) argued however that if the increase in household income were due to an increase in wage rates (i.e., an increase in labour productivity), the cost of children would increase, because time is involved in producing and rearing them. But other things being the same, this would lead to a decrease in the demand for children (this is the "substitution effect"). It follows that a rise in income owing to an increase in labour productivity would lead to a decline in fertility if the substitution effect were to dominate the income effect, a likely possibility.

Figure 1, taken from Birdsall (1988), shows that among countries which in the mid-1980s were not poor (viz., income above 1000 US dollars per capita), those that were richer experienced lower fertility rates. A regional breakdown of even the Chinese experience displays the general pattern: fertility is lower in higher-income regions (Birdsall and Jamison, 1983). These are only simple correlations and, so, potentially misleading. Moreover, they don't imply causality. But they suggest that growth in income can be relied upon to reduce population growth.

There are three problems with the above set of reasonings. First, conventional indices of the standard of living pertain to commodity production, not to the natural-resource base on which production depends. Statistics on past movements of world (or regional) income and agricultural production say nothing about this base. They don't say if increases in GNP per head in a country aren't being realized by means of a depletion of natural capital (e.g., ecosystem functioning). It could be, for example, that increases in agricultural production are in part accomplished by "mining" soil and water. In relying on GNP and other current-welfare measures, such as life expectancy at birth, infant survival, and literacy, we run the danger of ignoring the concerns ecologists have voiced about pathways linking population growth, economic activity, and the state of the natural-resource base.<sup>14</sup>

It can be shown that the correct measure of a community's welfare over the long run is its wealth, where wealth is the social worth of the entire bundle of its assets, including manufactured, human, and natural capital (Dasgupta and Mäler, 2000). A community's welfare

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<sup>13</sup> Schultz (1997) confirms this for a pooled set of cross-country data.

<sup>14</sup> For a fuller discussion of this, see Daily et al. (1998).

over the long run would increase if net investment per head in its capital base were positive, not otherwise. In other words, there has to be genuine saving if a community's well-being is to be sustainable. Since it is possible for a country's GNP to increase over an extended period even while her wealth is declining, time series of GNP per head could mislead.<sup>15</sup>

Hamilton and Clemens (1999) have provided estimates of genuine saving in a number of countries.<sup>16</sup> Among the resources that make up natural capital, only forests, oil and minerals, and pollution were included (not included were such vital resources as water). So there is an undercount. Moreover, the accounting prices used to value natural capital were crudely estimated. Nevertheless, one has to start somewhere. The figures imply that sub-Saharan Africa, the Middle East, Pakistan, and Bangladesh have been depleting their capital assets over several decades: they are becoming poorer even if their GNP per capita are increasing.<sup>17</sup> The data are far too crude to indicate if this has been the case as well in regions in India, but the possibility that large parts of India too have been dissaving cannot be ruled out.

The second weakness is that among poor countries there isn't a strong relationship between per capita income and fertility. In Figure 1 countries with GNP per head under 1000 US dollars display pretty much the entire range of fertility rates prevailing in the mid-1980s: 2 to 8. Notice that countries lying above the fitted curve are in sub-Saharan Africa, those below are in Asia. We will seek an explanation for this. Admittedly, Figure 1 displays a bivariate distribution,

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<sup>15</sup> 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 in the text. For some years environmental and resource economists argued that GNP should be replaced by net national product (NNP) as a measure of social well-being so as to accommodate environmental concerns. We were wrong: NNP is not an adequate welfare measure, wealth is.

<sup>16</sup> See also World Bank (1998). Serageldin (1995) was a report on the World Bank's research programme on sustainable development.

<sup>17</sup> For example, Pakistan's genuine saving rate (genuine saving divided by GNP) is estimated by Hamilton and Clemens (1999) to have on average been about 0.04 since the 1970s. If we were to assume that the output-capital ratio is a generously high 0.25 per year, population would have had to grow at a rate less than  $0.04 \times 0.25$  per year (= 1 percent per year) in order for Pakistan to have accumulated wealth on a per capita basis. Pakistan's population has been growing at about 3 percent per year for a long while (Table 1). And these estimates don't account for inequalities in the ownership of assets among the people of Pakistan. If, as ideally one would, use were made of distributional weights in the estimation of accounting prices to value capital assets, the figures would reveal an even greater decumulation of wealth.

which could be misleading for a problem requiring multi-variate analysis. The figure is nonetheless suggestive. It reflects the possibility that among poor households in rural communities the substitution effect isn't large and cancels the income effect. This could be because responsibility for child-rearing is frequently diffused over the extended family (Section 7.1).<sup>18</sup>

The third weakness with global statistics is that they are overly aggregative. They gloss over spatial variations and disguise the fact that even though the world economy as a whole has enjoyed economic growth over the past fifty years or so, large masses of people in particular regions have remained in poverty (Tables 2-3). Economic growth hasn't "trickled down" consistently to the poorest, nor have the poorest been inevitably "pulled up" by it.

### **3 Population, Poverty, and Natural Resources: Local Interactions**

In view of this, a few investigators have studied the interface of population, poverty, and the natural-resource base at a spatially localised level. The ingredients of their work have been around for some time; what is perhaps new is the way they have been put together. I don't suppose the work amounts to a theory, it is more like a new perspective.

Several particular models have been constructed to develop the new perspective. We are still nowhere near to having an overarching model, of the kind economists are used to in the theory of general competitive equilibrium.<sup>19</sup> Some models have as their ingredients large inequalities in land ownership in poor countries and the non-convexities that prevail at the level of the individual person in transforming nutrition intake into nutritional status and, thereby, labour productivity (Dasgupta and Ray, 1986, 1987; Dasgupta, 1993, 1997b). Others are based on the fragility of interpersonal relationships in the face of an expanding labour market and an underdeveloped set of credit and insurance markets (Dasgupta, 1993, 1998a, 1999; Section 7.3). Yet others are built on possible links between fertility behaviour and free-riding on local common-property resources (Dasgupta and Mäler, 1991, 1995; Nerlove, 1991; Cleaver and Schreiber, 1994; Brander and Taylor, 1998; Section 7.4 and Appendix). The models differ in their ingredients. What they have in common is a structure that is becoming increasingly familiar

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<sup>18</sup> Dreze and Murthi (2000) have found no effect of income on fertility in a pooled set of district level data from India.

<sup>19</sup> In this, the literature I am alluding to resembles much contemporary economic theory.

from the theory of locally interacting systems.<sup>20</sup> To put it in contemporary terminology, the new perspective on population, poverty and natural resources sees the social world as self-organizing itself into an inhomogeneous whole, so that, even while parts grow, chunks get left behind; some even shrink. To put it colloquially, these models account for locally-confined "vicious circles".<sup>21</sup>

Later in this article (Sections 7 and 8) I present an outline of this work when seen through one particular lens, namely reproductive and environmental externalities, laying stress on the arguments that have shaped it and on the policy recommendations that have emerged from it. The framework I develop focuses on the vast numbers of small, rural communities in the poorest regions of the world and identifies circumstances in which population growth, poverty, and resource degradation can be expected to feed on one another, cumulatively, over periods of time. What bears stressing is that the account does not regard any of the three to be the prior cause of the other two: over time each of them influences, and is in turn influenced by, the other two. In short, they are all endogenous variables.

It is not assumed that, when subjected to such "forces" of positive feedback, people do not try to find mechanisms with which to cope. The models assume that people do the best they can in the circumstances they face. What the models do is to identify conditions in which this is not enough to lift communities out of the mire. Turner and Ali (1996), for example, have shown that in the face of population pressure in Bangladesh small land-holders have periodically adopted new ways of doing things so as to intensify agricultural production. However, the authors have shown too that this has resulted in an imperceptible improvement in the standard of living and a worsening of the ownership of land, the latter probably owing to the prevalence of distress-sales of land. This is the kind of finding which the new perspective anticipated and was designed to meet.

Economic demographers haven't much explored externalities. An important exception was an attempt by Lee and Miller (1991) at quantifying the magnitude of reproductive externalities in a few developing countries. The magnitude was found to be small. The authors searched for potential sources of externalities in public expenditures on health, education and

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<sup>20</sup> Brock and Durlauf (1999) and Levin (1999) offer fine accounts of that structure in a technical and non-technical manner, respectively.

<sup>21</sup> Myrdal (1944) called such forms of feed-back "cumulative causation".

pensions, financed by proportional taxation. But such taxes are known to be very limited in scale in poor countries. Moreover, the benefits from public expenditure are frequently captured by a small proportion of the population. So perhaps it shouldn't be surprising that the reproductive externalities consequent upon public finance are small in poor countries. The externalities I study here are of a different sort altogether.

As we would expect from experience with models of complex systems, general results are hard to come by. The models that have been studied analytically are only bits and pieces. But they offer strong intuitions. They suggest also that we are unlikely to avoid having to engage in simulation exercises if we are to study models less specialized than the ones that have been explored so far.<sup>22</sup>

This should have been expected. Economic demography can be a most frustrating subject. It would seem that for any theoretical inference, no matter how innocuous, there is some set of data from some part of the world over some period that is not consonant with it.<sup>23</sup> Over 40 years of demographic research have uncovered that the factors underlying fertility behaviour include not only the techniques that are available to households for controlling their size, but also the household demand for children. The latter in particular is influenced by a number of factors (e.g., child mortality rates, level of education of the parents, rules of inheritance) whose relative strengths would be expected to differ across cultures, and over time within a given culture, responsive as they are to changes in income and wealth and the structure of relative prices. Thus, the factors which would influence the drop in the total fertility rate in a society from, say, 7 to 5 should be expected to be different from those which would influence the drop from 5 to 3 in that same society.

Across societies the matter is still more difficult. The springs of human behaviour in an activity at once so personal and social as procreation are complex and inter-connected, and empirical testing of ideas is fraught with difficulty. Data often come without appropriate controls. So, what may appear to be a counter-example to a thesis is not necessarily so. Intuition is often not a good guide. For example, one can reasonably imagine that since religion is a strong driving force in cultural values, it must be a factor in fertility behaviour. Certainly, in some multi-variate analyses (e.g., Dreze and Murthi, 2000, in their work on district-level data from

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<sup>22</sup> Lutz and Scherbov (1990) offer a thoughtful review of why and how.

<sup>23</sup> See Cleland (1996) for a demonstration of this.

India), religion has been found to matter (Muslims are more pro-natalist than Hindus and Christians). But in others (e.g., Iyer, 2000, in her work on household-level data from a group of villages in the state of Karnataka, India), it hasn't been found to matter. Of course, it could be that the difference in their findings is due to the fact that the unit of analysis in one is the district, while that in the other is the household. But such a possibility is itself a reminder that complicated forms of externalities may be at work in fertility decisions (e.g., externalities arising from conformist behaviour; Section 7.2).

#### **4 Education and Birth Control**

Education and reproductive-health programmes taken together are a means for protecting and promoting women's interests. They were the focal points of the 1994 United Nations Conference in Cairo on Population and Development and are today the two pillars upon which public discussion on population is based.<sup>24</sup> Later in this article I show that the "population problem" involves a number of additional features. Here I review what is known about the influence of education and reproductive-health programmes on fertility.

##### **4.1 Women's Education and Fertility Behaviour**

In a classic pair of publications, Cochrane (1979, 1983) studied possible connections between women's education and fertility behaviour. She observed that generally speaking lower levels of education are associated with higher fertility. Table 4, based on the Demographic and Health Surveys undertaken in Africa in the 1980s, displays this for Botswana, Ghana, Uganda and Zimbabwe. The finding has proved so congenial to modern sensibilities and is intuitively so reasonable, that social scientists have attributed causality: from education to reduced fertility.

What are the likely pathways of the causal chain? Here are some:

Education helps mothers to process information more effectively and so enables them to use the various social and community services that may be on offer more intensively. The acquisition of education delays the age of marriage and so lowers fertility. At low levels of education and contraceptive prevalence, literacy and receptiveness to new ideas complement the

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<sup>24</sup> To illustrate almost at random, 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."

efforts of reproductive-health programmes, leading to longer birth-spacing.<sup>25</sup> This in turn reduces infant mortality, which in its turn leads to a decline in fertility.

Turning to a different set of links, higher education increases women's opportunities for paid employment and raises the opportunity cost of their time (the cost of child-rearing is higher for educated mothers). Finally, educated mothers would be expected to value education for their children more highly. They would be more likely to make a conscious trade-off between the "quality" of their children and their numbers (Becker, 1981). And so on.<sup>26</sup>

Yet Cochrane herself was reluctant to attribute causality to her findings, as have investigators studying more recent data (Cohen, 1993; Jolly and Gribble, 1993), for the reason that it is extremely difficult to establish causality. It may well be that women's education reduces fertility. On the other hand, it could be that the initiation of childbearing is a factor in the termination of education. Even when education is made available by the State, households frequently choose not to take up the opportunity: the ability (or willingness) of governments in poor countries to enforce school attendance or make available good education facilities is frequently weak. Economic costs and benefits and the mores of the community to which people belong would influence their decisions. It could then be that the very characteristics of a community (e.g., an absence of associational activities among women, or a lack of communication with the outside world; Section 7.2) which are reflected in low education attainment for women are also those giving rise to high fertility. Demographic theories striving

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<sup>25</sup> Above low levels, however, women's education and family-planning outreach activities appear to be substitutes.

<sup>26</sup> Subsequent to Cochrane's work, studies have found a positive association between maternal education and the well-being 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). Here is an indication of orders of magnitude. The infant mortality rate in households in Thailand where the mother has had no education (resp., has had primary and secondary education) was found to be 122 per 1000 (resp., 39 and 19 per 1000). See World Bank (1991). However, a common weakness of many such empirical studies is their "bivariate" nature.

In a pooled cross-section data-set for poor countries over the decades of the 1970s and '80s, 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), 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.



for generality would regard both women's education and fertility to be endogenous variables. The negative relationship between education and fertility in such theories would be an association, not a causal relationship. The two variables would be interpreted as "moving together" in samples, nothing more. In Section 7.2 I explore a theoretical framework which offers this interpretation.<sup>27</sup>

However, the links between women's education and fertility are not as monotonic as I have reported so far. Set against the positive forces outlined above is a possible effect which runs the other way: taboos against post-partum female sexual activity, where they exist, can be weakened through education. In sub-Saharan Africa, where polygyny is widely practised, post-partum female sexual abstinence can last upto three years after birth. It is also not uncommon for women to practise total abstinence once they have become grandmothers. The evidence, such as they exist, conforms to theory: in Latin America and Asia primary education, when compared to no education, has been found to be associated with lower fertility, but in several parts of sub-Saharan Africa (e.g., Burundi, Kenya and Nigeria) the relationship has been found to be the opposite. Table 5 displays the latter.<sup>28</sup> The conventional wisdom that women's education is a powerful force against pro-natalism needs to be qualified: the level of education can matter.

#### **4.2 Family Planning**

Except under conditions of extreme nutritional stress, nutritional status does not appear to affect fecundity (Bongaarts, 1980). During the 1974 famine in Bangladesh the rural population lost over 1.5 million additional children. The stock was replenished within a year (Bongaarts and Cain, 1981). Of course, undernourishment can still have an effect on sexual reproduction, through its implications for the frequency of still-births, maternal and infant mortality, and a possible reduction in the frequency of sexual intercourse.

An obvious determinant of fertility is the available technology for birth control. Cross-country regressions (e.g., Pritchett, 1994) confirm that the fraction of women of reproductive age who use modern contraceptives is strongly and negatively correlated with total fertility rates. So

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<sup>27</sup> In their careful analysis of district-level data in India over the 1981 and 1991 censuses, Dreze and Murthi (2000) have come closer than any other study I know 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.

<sup>28</sup> Hess (1988) has conducted time-series analysis which attests to there being such an effect in parts of sub-Saharan Africa.

it should not be surprising that family-planning programmes are often seen as a pre-requisite for any population policy. But these regression results mean only that contraception is a proximate determinant of fertility, not a causal determinant. They could mean, for example, that differences in fertility rates across nations reflect differences in fertility goals, and thus differences in contraceptive use. Of course, the causal route could go the other way. It could be that the very existence of family-planning programmes influences the demand for children, as women come to realize that it is reasonable to want a small family (Bongaarts, 1997; Section 7.2).

People in all societies practise some form of birth control: fertility is below the maximum possible in all societies. Extended breast-feeding and post-partum female sexual abstinence have been common practice in Africa. Even in poor countries, fertility is not unresponsive to the relative costs of goods and services. In a study on !Kung San foragers in the Kalahari region, Lee (1972) observed that the nomadic, bush-dwelling women among them had an average birth-spacing of nearly four years, while those settled at cattle-posts gave birth to children at much shorter intervals. From the viewpoint of the individual nomadic !Kung San woman, it is significant that the social custom is for mothers to nurse their children on demand and to carry them during their day-long trips in search of wild food through the children's fourth year of life. Anything less than a four-year birth interval would increase mothers' carrying loads enormously, impose a threat on their own capacity to survive, and reduce their children's prospects of survival. In contrast to bush dwellers, cattle-post women are sedentary and are able to wean their children earlier.

Traditional methods of birth control include abortion, abstinence or rhythm, coitus interruptus, and prolonged breast-feeding.<sup>29</sup> These options are often inhumane and unreliable: modern contraceptives are superior. Nevertheless, successful family-planning programmes have proved more difficult to institute than could have been thought possible at first (Cochrane and Farid, 1989). Barring a few countries, fertility rates in sub-Saharan Africa have not shown significant declines, despite declines in infant mortality rates over the past decades.

In a notable article, Pritchett (1994) analysed data from household surveys conducted by the World Fertility Survey and the Demographic and Health Surveys programmes, which included women's responses to questions regarding both their preferences and their behaviour

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<sup>29</sup> Anthropologists have, however, argued that in parts of western sub-Saharan Africa prolonged breast-feeding is not a birth-control measure, but a means of reducing infant mortality: traditionally, animal milk has been scarce in the region.

on fertility matters. Demographers had earlier derived indicators of the demand for children from these data. One such indicator, the "wanted total fertility rate" (Bongaarts, 1990), can be compared to the actual total fertility rate for the purpose of classifying births or current pregnancies in a country or region as "wanted" or "unwanted". Regressing actual fertility on fertility desires in a sample of 43 countries in Asia, Africa, and Latin America, Pritchett found that about 90 percent of cross-country differences in fertility rates are associated with differences in desired fertility. Moreover, excess fertility was found not to be systematically related to the actual fertility rate, nor to be an important determinant of the rate. The figure 90 percent may prove to be an over-estimate, but it is unlikely to prove to be greatly so.<sup>30</sup> Even in poor households the use of modern contraceptives would involve only a small fraction (1 percent or thereabouts) of income.

Pritchett's is a significant finding, if only because it directs us to ask why the household demand for children differs so much across communities. We turn to this.

## **5 The Household and Gender Relations**

As a concept the household is not without its difficulties. It is often taken to mean a housekeeping or consumption unit. The household in this sense is the eating of meals together by members, or the sharing of meals derived from a common stock of food (Hajnal, 1982). This definition has the merit that it is in accordance with most modern censuses, but there is a problem with it: in rural communities it does not yield exclusive units (Goody, 1996). A household shares a "table" and may, for example, include live-in servants who do not cook for themselves. In many cases some meals are had in common, while others are not; and often raw and cooked food is passed to parents in adjacent cottages, apartments, and even rooms. The boundaries vary with context, especially where food is not consumed together round a table (as in Europe) but in bowls in distinct groups (as in sub-Saharan Africa). In none of these cases is the housekeeping unit the same as the consumption unit, nor is the consumption unit necessarily well-defined.

Economists have brazened through these difficulties and have debated something else. They have taken the household to be a well-defined concept, but have debated if it is best to continue to model it as a unitary entity, in the sense that its choices reflect a unitary view among its members of what constitutes their welfare (the utility maximising model), or if it instead

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<sup>30</sup> I am grateful to John Bongaarts for helpful conversations on this matter.

ought to be modelled as a collective entity, where differences in power (e.g., between men and women) manifest themselves in the allocation of food, work, education, and health-care.

Of course, one cannot conclude that households are not unitary from the mere observation that intra-household allocations are unequal. Poor households would choose to practise some patterns of inequality even if they were unitary. For example, since children differ in their potential, parents in poor households would help develop the most promising of their children even if it were to mean that the remaining ones are marginalised. This is confirmed by both theory and evidence (Becker and Tomes, 1976; Bledsoe, 1994). Daughters are a net drain on parental resources in patrilineal and patrilocal communities, such as those in the northern parts of the Indian sub-continent (dowries can be bankrupting). This goes some way toward explaining the preference parents show for sons there (Sopher, 1980a,b; Dyson and Moore, 1983; Cain, 1984) and why higher-birth-order girls are treated worse than lower-birth-order girls (Das Gupta, 1987). In northern parts of India the sex ratio is biased in favour of men.<sup>31</sup>

However, the magnitude of the inequalities frequently observed is at variance with what would be expected in unitary households. The indirect evidence also suggests that the household is a collective entity, not a unitary one (Alderman *et al.*, 1995). For example, if a household were unitary, its choices would be independent of which member actually does the choosing. But recent findings have revealed, for example, that income in the hands of the mother has a bigger effect on her family's health (e.g., nutritional status of children) than income under the control of the father (Kennedy and Oniang'o, 1990).

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<sup>31</sup> Chen, Huq, and D'Souza (1981) is a pioneering quantitative study on the latter. See Dasgupta (1993) for further references. It should be noted that stopping rules governing fertility behaviour based on sex preference provide a different type of information regarding sex preference than 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 sub-group will now stop and the second sub-group will have another try. And so on. 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 since each couple has exactly one son, couples on average have one son. But as the sex ratio is 1, couples on average have one daughter also. Therefore, the average couple have two children. This means that in equilibrium the size of the population is constant.

Since gender inequities prevail in work, education, food, and health-care allocations, it should not surprise that they prevail over fertility choices as well. Here also women bear the greater cost. To grasp how great the burden can be, consider that in sub-Saharan Africa the total fertility rate has for long been between 6 and 8 (Figure 1; Table 2). Successful procreation involves at least a year and a half of pregnancy and breast-feeding. So in societies where female life expectancy at birth is 50 years and the total fertility rate is 7, women at birth can expect to spend about half their adult lives in pregnancy or nursing. And we have not allowed for unsuccessful pregnancies.

In view of this difference in the costs of bearing children, we would expect men to desire more children than women. Birth rates should be expected to be lower in societies where women are more "empowered". Data on the status of women from 79 so-called Southern countries (Table 6) confirm this and display an unmistakable pattern: high fertility, high rates of female illiteracy, low share of paid employment, and a high percentage working at home for no pay hang together. From the data alone it is difficult to discern which of the measures are causing and which are merely correlated with high fertility. But the findings are consistent with the possibility that a lack of paid employment and education limits women's ability to make decisions. This promotes fertility.

Household decisions would assume strong normative significance if the household were unitary, less so if it were not. The evidence is that the unitary household is especially uncommon when the family is impoverished and the stresses and strains of hunger and illness make themselves felt. Despite these findings I adopt a unitary view of the household in what follows. Because I am concerned here with reproductive and environmental externalities, it helps to simplify the exposition without losing anything essential.

## **6 Motives for Procreation**

One motive for procreation, common to humankind, relates to children as ends in themselves. We are genetically endowed to want and to value them. It has also been said that children are the clearest avenue open to "self-transcendence" (Heyd, 1992). Viewing children as ends ranges from the desire to have offspring because they are playful and enjoyable, to a desire to obey the dictates of tradition and religion. One such injunction emanates from the cult of the ancestor, which, taking religion to be the act of reproducing the lineage, requires women

to bear many children.<sup>32</sup> The latter motivation has been emphasized by Caldwell and Caldwell (1990) to explain why sub-Saharan Africa has proved so resistant to fertility reduction.

The problem with the explanation is that, although it does well to account for high fertility rates in sub-Saharan Africa (Table 2; Figure 1), it does not do so well on why the rates have not responded to declines in infant mortality. The cult of the ancestor may prescribe reproduction of the lineage, but it does not stipulate an invariant fertility rate. Since even in sub-Saharan Africa fertility rates have been below the maximum possible, they should be expected to respond to declines in infant mortality. This is a matter I shall come back to in Section 7.4, where I offer one possible explanation for the resistance that the semi-arid regions of sub-Saharan Africa have shown to fertility reduction.<sup>33</sup>

But for parents children are not only an end, they can also be a means to economic betterment. In the extreme, they can be a means to survival. Children offer two such means. First, in the absence of capital markets and social security, children can be private security in old age. There is evidence that in poor countries children do offer such security (Cain, 1981, 1983; Cox and Jimenez, 1992; Section 7.3 below). It leads to a preference for male offspring if males inherit the bulk of their parents' property and are expected to look after them in their old age.

Secondly, in bio-mass based rural economies children are valuable in household production. Evidence of this is extensive (Section 7.4). Such evidence is, of course, no proof that parents have children in order to obtain additional labour. For example, it could be that people have large numbers of offspring by mistake and put them to work only because they can't afford

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<sup>32</sup> Writing about West Africa, Fortes (1978: 125-6) 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, the educated and uneducated in sub-Saharan Africa have more, and want more, children than their counterparts do in other regions. Thus, even the 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.

<sup>33</sup> 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 something like 150 per 1,000 live births (World Bank, 1989).

not to. Or it could be that large families are desired as an end in themselves, and putting children to work at an early age is the only avenue open for financing that end. However, these conjectures are hard to substantiate directly. The former is in any case difficult to believe, since it suggests an inability to learn on the part of parents in a world where they are known to learn in other spheres of activity, such as cultivation. But as the latter is not at variance with any evidence I know, it is explored in Section 7.2.

Caldwell (1981, 1982) put forward the interesting hypothesis that the intergenerational transfer of resources is from children to their parents in societies experiencing high fertility and high mortality rates, but that it is from parents to their children when fertility and mortality rates are low. Assuming it to be true, the relationship should be interpreted to be an association only. The direction of intergenerational resource transfers would be endogenous in any general theory of demographic behaviour, it would not be a causal factor in fertility transitions.

The historical change in the North in parents' attitudes toward their children (from regarding children as a "means" to economic ends, to regarding them simply as an "end") can seem to pose a deep puzzle, as can differences between the attitudes of parents in the North and South today. I have friends among demographers who have remarked to me that some fundamental shift in adults' "world view" must have been involved in such changes in attitudes, a shift that some have called an "ideational change" (Cleland and Wilson, 1987; Section 7.2.1).

They may be right. On the other hand, not only is the explanation something of a deix ex machina, it is also very difficult to test. A different sort of explanation, one which is testable, is that children cease being regarded as productive assets when they cease being productive assets. When schooling is enforced, children are not available for household and farm chores. If the growth of urban centres makes rural children less reliable as old-age security (children are now be able to leave home and not send remittances), children cease being sound investment for old age.<sup>34</sup> And so on. In the limit, if children were to become relatively unproductive in each of their possible roles as an economic asset, their only remaining value would be as an end. No change in world view would necessarily be involved in this transformation.

The above argument does not rely on economic growth. What it involves is a comparison of the productivity of different forms of capital assets. Children could cease being a sound economic investment even if the economy remained poor.

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<sup>34</sup> Sundstrom and David (1988) apply this reasoning to antebellum America.

## **7 Reproductive and Environmental Externalities**

What cause private and social costs and benefits of reproduction to differ? One source which stands out has to do with the finiteness of space (World Bank, 1984; Harford, 1998). Increased population size implies greater crowding, and households acting on their own would not be expected to "internalize" crowding externalities. The human epidemiological environment becomes more and more precarious as communication and population densities rise. Packed centres of population provide a fertile ground for the spread of viruses; and there are always new strains in the making. Conversely, the spread of infections, such as HIV, would be expected to affect demographic behaviour, although in ways which are not yet obvious (Ezzell, 2000).

Large-scale migrations of populations occasioned by crop failure, war, or other disturbances are an obvious form of externality. But by their very nature they are not of the persistent variety. Of those that are persistent, there are at least four types which come to mind. In the remainder of this section we look into them.

### **7.1 Cost-Sharing**

Fertility behaviour is influenced by the structure of property rights (e.g., rules of inheritance). In his famous analysis of fertility differences between seventeenth- and eighteenth-century Northwest Europe, on the one hand, and modern pre-industrial societies, on the other, Hajnal (1982) drew upon the distinction between "nuclear" and "joint" household systems. He observed that in Northwest Europe marriage normally meant establishing a new household, which implied that the couple had to have, by saving or transfer, sufficient resources to establish and equip the new household. This requirement in turn led to late marriages. It also meant that parents bore the cost of rearing their children. Indeed, fertility rates in England were a low 4 in 1650-1710, long before modern family-planning techniques became available and long before women became literate (Coale, 1969; Wrigley and Schofield, 1981). Hajnal contrasted this with the Asiatic pattern of household formation, which he saw as joint units consisting of more than one couple and their children.

Parental costs of procreation are also lower when the cost of rearing the child is shared among the kinship. In sub-Saharan Africa fosterage within the kinship is a commonplace: children are not raised solely by their parents, the responsibility is more diffuse within the kinship group (Goody, 1976; Bledsoe, 1990; Caldwell and Caldwell, 1990). Fosterage in the African context is not adoption. It is not intended to, nor does it in fact, break ties between parents and children. The institution affords a form of mutual insurance protection in semi-arid



regions. It is possible that, as opportunities for saving are few in the low-productivity agricultural regions of sub-Saharan Africa, fosterage also enables households to smoothen their consumption across time (Serra, 1996).<sup>35</sup> In parts of West Africa upto half the children have been found to be living with their kin at any given time. Nephews and nieces have the same rights of accomodation and support as do biological offspring. There is a sense in which children are seen as a common responsibility. However, the arrangement creates a free-rider problem if the parents' share of the benefits from having children exceeds their share of the costs. From the point of view of parents, taken as a collective, too many children would be produced in these circumstances.<sup>36</sup>

In sub-Saharan Africa, communal land tenure of the lineage social structure has in the past offered further inducement for men to procreate. Moreover, conjugal bonds are frequently weak, so fathers often do not bear the costs of siring children. Anthropologists have observed that the unit of African society is a woman and her children, rather than parents and their children. Frequently there is no common budget for the man and woman. Descent in sub-Saharan Africa is for the most part patrilineal and residence is patrilocal (an exception are the Akan people of Ghana). Patrilineality, weak conjugal bonds, communal land tenure, and a strong kinship support system of children, taken together, have been a broad characteristic of the region (Caldwell and Caldwell, 1990; Caldwell, 1991; Bledsoe and Pison, 1994). They are a source of reproductive externalities which stimulate fertility. Admittedly, patrilineality and patrilocality

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<sup>35</sup> This is a testable hypothesis. The way to test it would be to study the age structure of households that foster out and the age structure of households that foster in.

<sup>36</sup> To see that there is no distortion if the shares were the same, suppose  $c$  is the cost of rearing a child and  $N$  the number of couples within a kinship. For simplicity assume that each child makes available  $y$  units of output (this is the norm) to the entire kinship, which is then shared equally among all couples, say in their old age. 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. (We presently endogenize this.) If  $n$  were to be 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 equalling  $Y=[ny+(N-1)n^*y]/N$ . Denote the couple's aggregate utility function by the form  $U(Y)-K(C)$ , where both  $U(\cdot)$  and  $K(\cdot)$  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 which is met in a society where there is no reproductive free-riding. It is a simple matter to confirm that there is free-riding if the parents' share of the benefits from having children exceeds their share of the costs.

are features of the northern parts of the Indian sub-continent also.<sup>37</sup> But conjugal bonds are substantially greater there. Moreover, as agricultural land is not communally held, large family size leads to fragmentation of landholdings. In contrast, large families in sub-Saharan Africa are (or, at least were, until recently) rewarded by a greater share of land belonging to the lineage or clan.

## 7.2 Conformity and "Contagion"

That children are an end in themselves provides another mechanism by which reasoned fertility decisions at the level of every household can lead to an unsatisfactory outcome from the perspectives of all households. The mechanism arises from the possibility that traditional practice is perpetuated by conformity. Procreation in closely-knit communities is not only a private matter, it is also a social activity, influenced by both family experiences and the cultural milieu. Formally speaking, behaviour is conformist if, other things being the same, every household's most desired family size is the greater, the larger is the average family size in the community (Dasgupta, 1993, Ch. 12). This is a "reduced form" of the concept, and the source of a desire to conform could lie in reasons other than an intrinsic desire to be like others. For example, it could be that similar choices made by households generate mutual positive externalities, say, because people care about their status, and a household's choice of actions signals its predispositions (e.g., their willingness to belong) and so affects its status (Bernheim, 1994; Bongaarts and Watkins, 1996). In a world where people conform, the desire for children is endogenous.

Whatever the basis of conformism, there would be practices encouraging high fertility rates which no household would unilaterally desire to break. Such practice could well have had a rationale in the past, when mortality rates were high, rural population densities were low, the threat of extermination from outside attack was large, and mobility was restricted. But practices can survive even when their original purposes have disappeared. So, it can be that as long as all others follow the practice and aim at large family size, no household on its own wishes to deviate from the practice; however, if all other households were to restrict their fertility rates, each would desire to restrict its fertility rate as well. In short, conformism can be a reason for the existence of multiple reproductive equilibria (Dasgupta, 1993, Ch. \*12). It can even be that they

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<sup>37</sup> Among the prominent Nayyars of the southern state of Kerala, India, descent is matrilineal. Kerala is famous today for being among the poorer of Indian states even while attaining a TFR less than 2.

are Pareto rankable, in which case a community could get stuck at an equilibrium mode of behaviour even though there is another equilibrium mode of behaviour which is better for all.

### 7.2.1 A Model

Figure 2 depicts fertility choices in a stylised community where households are identical and are conformists. We imagine that the government has no population policy in place. The horizontal axis denotes  $\bar{n}$ , which is the average number of children per household. It represents the TFR in the community. The vertical axis denotes  $n^*$ , which is the desired number of children of the representative household.<sup>38</sup> Since households are identical, every household is representative. As  $n^*$  is a function of  $\bar{n}$ , we write it as  $n^*(\bar{n})$ . It is drawn as an increasing function, the distinctive feature of conformism. In Figure 2 it is so drawn that it cuts the 45° line at three points,  $\bar{n}_1$ ,  $\bar{n}_2$ , and  $\bar{n}_3$ . Each is an equilibrium. To confirm this, imagine for example that each household expects all other households to have  $\bar{n}_3$  children. Then  $\bar{n}_3$  will be each household's choice, thus confirming the expectations. And so on for  $\bar{n}_1$  and  $\bar{n}_2$ . Notice as well that  $\bar{n}_1$ ,  $\bar{n}_2$ , and  $\bar{n}_3$  are the only equilibria. Let us assume now that out of equilibrium households expect the TFR in each period to be the previous period's TFR (this is a special form of what are known as "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 interest lies in  $\bar{n}_1$  and  $\bar{n}_3$ .

I haven't offered a micro-foundation for  $n^*(\bar{n})$ . The model is of a reduced form. But it can be that all households are 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.<sup>39</sup> It may be that the optimal TFR lies 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., tax-subsidy policy), of a kind that would sustain equilibrium TFR at  $\hat{n}$ . In Figure 2 the broken curve is the representative household's most desired number of children as a function of the community's TFR when the optimum policy is in place. It cuts the 45° line at  $\hat{n}$ .

These are theoretical possibilities. Testing for multiple equilibria is a most difficult matter. For the moment it is analytical reasoning which tells us that a society could in principle

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<sup>38</sup>  $n^*$  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 for itself as a target.

<sup>39</sup> As households are identical in this stylised model, by a collective optimum I mean a Pareto optimum.

get stuck at a self-sustaining mode of behaviour characterized by high fertility (and low educational attainment), even when there is another, potentially self-sustaining, mode of behaviour characterized by low fertility (and high educational attainment).

This doesn't mean that society would be stuck with high fertility rates forever. External events could lead households to "coordinate" at  $\bar{n}_1$  even although they had earlier "coordinated" at  $\bar{n}_3$ .<sup>40</sup> The external events could, for example, be a programme of public exhortations aimed at altering household expectations about one another's behaviour (e.g., family-planning campaigns run by women). This is a case where the community "tips" from one mode of behaviour to another, even although there has been no underlying change in household attitudes ( $n^*(\bar{n})$  has not changed) to trigger the change in behaviour.

In a well known paper 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 not right to think that ideational change needs to be invoked to explain recent fertility transitions. The tipping phenomenon I have just discussed does not appeal to ideational changes. This said, I know of no evidence that is able to discriminate between the two types of explanation.

### **7.2.2 Application to Demographic Transitions**

The tipping phenomenon can also occur because of changes in the peer group on whose behaviour households base their own behaviour. This amounts to the function  $n^*(\bar{n})$  shifting slowly. Such shifts also may fall short of an ideational change. However, as we see below, 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. There are inevitably those who for one reason or another 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,

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<sup>40</sup> In game theory Figure 2 is called a coordination game.

1987, for a commentary on West Africa). The middle classes can also be the trigger, becoming role models for others.

A possibly even stronger pathway is the influence that newspapers, radio, television, and now the internet play in transmitting information about other life-styles (Freedman, 1995; Bongaarts and Watkins, 1996; Iyer, 2000). The analytical point here is that the media may be a vehicle through which conformism increasingly becomes based on the behaviour of a wider population than the local community: the peer group widens.

Such pathways can give rise to demographic transitions, in that fertility rates display little-to-no trend over extended periods, only to cascade downward over a relatively short interval of time, 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 make the point I wish to make 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 radio 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 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, 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. Now let time pass. The 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 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 a tiny bit more, say to become the curve A"B"E" in Figure 3? Well, now the schedule cuts the 45° line only once, at the stable equilibrium B" (at TFR,  $\bar{n}_1^{**}$ ). But as TFR had only recently been substantially above  $\bar{n}_1^{**}$ , households will display disequilibrium behaviour 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) would be observed again 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 behaviour.

It is worth noting that, in showing how fertility cascades can occur, we have not assumed the flow of outside exposure to be "non-linear". Rather, we have assumed household responses to changes in outside exposure to be non-linear: the shape of  $n^*(\bar{n})$  has the non-linearity built into it.<sup>41</sup>

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 fertility reductions that have been experienced in India and Bangladesh in recent years (Table 2) were due to the wider influence people there have been subjected to via the media or to attitudinal differences arising from improvements in family planning programmes. To be sure, fertility reductions have differed widely across the Indian sub-continent (not much reduction in Pakistan so far), but we should not seek a single explanation for so complex a phenomenon as fertility transition.<sup>42</sup>

### 7.2.3 Evidence

Demographers have made few attempts to discover evidence of behaviour that is guided in part by an attention to others. The two exceptions with which I am familiar 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

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<sup>41</sup> 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).

<sup>42</sup> In this connection, the Indian state Andhra Pradesh offers an interesting example. Female illiteracy there is high 55 percent and some 75 percent of the population have access to radio or television. The fertility rate there is now 2.3.

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 differences in fertility and nuptiality within each country declined. She found that in 1870, before the large-scale declines in marital fertility had begun in most areas of Western Europe, demographic behaviour differed greatly within countries. Provinces (e.g., counties and cantons) within a country differed considerably, even while differences within provinces was low. There were thus spatial clumps within each country, suggesting the importance of the influence of local communities on behaviour. In 1960 differences within each country were less than what they were in 1870. Watkins explained this 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 behaviour was able to spread.

There is one recent finding which could also point to contagious behaviour. Starting in 1977 (when the TFR in Bangladesh was in excess of 6), 70 "treatment" villages were serviced by a massive programme of birth control in Matlab Thana, Bangladesh, while 79 "control" villages were offered no such special service. The contraceptive prevalence in the treatment villages increased from 7 to 33 percent within 18 months, and then 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, even though there had been no difference to begin with (Hill, 1992). If we were to assume that, although influence travels, geographical proximity matters, we could explain why the control villages followed those "under treatment", but did not follow them all the way. Contagion did not spread completely.<sup>43</sup>

### **7.3 Interactions among Institutions**

Externalities are prevalent when market and non-market institutions co-exist. How and why might they affect fertility behaviour? There are a number of pathways (Dasgupta, 1993, 1999). Consider the following:

Long-term relationships in rural communities in poor countries are frequently sustained by social norms, for example, norms of reciprocity. A point of importance about social norms

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<sup>43</sup> I am grateful to Lincoln Chen for a helpful 1996 correspondence on this point.

is that they can be reliably observed only among people who expect to encounter one another in similar situations for an extended period of time.<sup>44</sup>

Consider a community of "far-sighted" people who know one another and who expect to interact with one another for a long time. By a far-sighted person 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 (being far-sighted!) would discount heavily the future benefits of the current costs they incur for the purposes of cooperation.

The basic idea is this: if people are far-sighted and are not individually mobile, a credible threat by all that they would impose sufficiently 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 behaviour were to become personally more profitable. The latter would happen if formal markets develop nearby. As opportunities outside the village improve, those 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. Those 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, non-market institution. It is a reflection of an externality.

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

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<sup>44</sup> This is the setting studied in the theory of repeated games. See Fudenberg and Tirole (1991).



In his well known work Cain (1981, 1983) showed that where capital markets are non-existent and public or communitarian support for the elderly are weak, children provide security in old age. The converse is that if communitarian support systems decline, children become more valuable. But we have just noted that communitarian 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 (Section 6) 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 modelling of the process would enable us to determine which influence dominates under what conditions.

#### **7.4 Household Labour Needs and the Local Commons**

The poorest countries are in great part biomass-based subsistence economies.<sup>45</sup> Much labour is needed even for simple tasks. Moreover, households in great numbers there do not have 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 fuel-wood near at hand when the forests recede. This means that the relative prices of alternative sources of energy and water faced by rural households in poor countries 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 as much as five to six hours a day fetching water and collecting fodder and wood. These are complementary activities. They have to be undertaken on a daily basis if households are to survive. Each is time-consuming. Labour productivity is low not only because capital is scarce, but also because environmental resources are scarce. From about the age of 6 years, children in poor households in the poorest countries mind their siblings and domestic animals, fetch water, and collect fuelwood, dung (in the Indian sub-continent), 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 labour. Children between 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).

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<sup>45</sup> I am thinking of countries in sub-Saharan Africa and the Indian sub-continent. There the agricultural labour force as a proportion of the total labour force is of the order of 60-70 percent, and the share of agricultural-value added in GNP is of the order of 25-30 percent.

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 share such costs with their community. In recent years, mores which 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. Are they extensive? As a proportion of total assets, their presence 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 Narayan, 1989). There is a rationale for this, based on the human desire to reduce risks. Communitarian ownership and control enabled households in semi-arid regions to pool their risks.<sup>46</sup> 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 it is the arid and mountain regions and unirrigated areas which 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) studied evidence from over 80 villages in 21 dry districts in India to conclude that, among poor families, the proportion of income based directly on their local commons is for the most part in the range 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 south-eastern Zimbabwe, Cavendish (1998, 1999) arrived at even larger estimates: the proportion of income based directly on the local commons is 35 percent, the figure for the poorest quintile is 40 percent. Such evidence do not of course prove that the local commons are well-managed, but they suggest that rural households have strong incentives to devise arrangements whereby they would be well-managed.

Howe (1986), Wade (1988), Chopra, Kadekodi, and Murty (1990), Ostrom (1990, 1992), Baland and Platteau (1995) and others have shown that, traditionally, many communities have been able to protect their local commons from overexploitation by relying on social norms, by imposing fines for deviant behaviour, and by other means. I argued in the previous section that the very process of economic development can erode traditional methods of control, the pathway

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<sup>46</sup> 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.

being increased urbanization and mobility. Social norms are endangered also by civil strife and by the usurpation of resources by landowners or the State. For example, resource allocation rules practised at the local level have not infrequently been overturned by central fiat. A number of States in the Sahel imposed rules which in effect destroyed communitarian management practices in the forests. Villages ceased to have authority to enforce sanctions on those who violated locally-instituted rules of use. State authority turned the local commons into free-access resources.<sup>47</sup> Whatever the cause, as social norms degrade, parents pass some of the costs of children on to the community by over-exploiting 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 (Appendix, Sec. A.3). Now, it can certainly be 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 a data set from 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 labour to induce higher demand for children, given the effects that work in the opposite direction. Environmental scarcity there acted as a check on population growth.

However, theoretical considerations suggest that, in certain circumstances, increased resource scarcity induces further population growth and, thereby, triggers a spiralling process. As the community's natural resources are depleted, households find themselves needing more "hands". No doubt additional hands could be obtained by the adults working even harder, but in many cultures it would not do for the men-folk to gather fuel-wood and fetch water for household use.<sup>48</sup> No doubt too that 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 labour become too costly, more children

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<sup>47</sup> See Thomson, Feeny and Oakerson (1986) and Baland and Platteau (1996).

<sup>48</sup> Filmer and Pritchett (1996) summarise empirical findings on time allocation in household activities by children in rural areas in poor countries.

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 would 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, what would happen along this pathway is that poverty, household size, and environmental degradation would reinforce one another in an escalating spiral. By the time some countervailing set of factors were to make the benefits of having further children diminish and, thereby, to stop the spiral, very 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 a set of villages in Karnataka, India; and Heyser (1996) in Malaysia. In a statistical analysis of data from a set of villages in the Sindh region in Pakistan, Filmer and Pritchett (1996) very tentatively reported a positive link between fertility and deterioration of the local natural-resource base.

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 sets prevent investigators from getting closer to the theory.<sup>49</sup> In any event, these studies cannot reveal causal connections, but, barring the study by Loughran and Pritchett (1998), they are not inconsistent 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). The latter connection deserves greater investigation than it has elicited so far.<sup>50</sup>

To be sure, families with greater access to resources would be in a position to limit their

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<sup>49</sup> 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.

<sup>50</sup> Crook (1996) questions the poverty-population link. But as he treats population density and land productivity as exogenous variables, it isn't quite a test of the thesis.

size and propel themselves into still higher income levels. Admittedly, too, people from the poorest of backgrounds have been known to lift themselves out of the mire. Nevertheless, there are forces at work which pull households away from one another in terms of their living standards. Such forces enable extreme poverty to persist despite growth in the well-being for the rest of society.

## **8 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 decisions are made by people. But if policies which 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 sub-continent, 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 isn't over. The size-distribution of the world's population subsequent to the transitions will matter. There is likely to be a world of a difference between a global population of 11 billion and a global population of 5 billion, even if we were to ignore differences in their spatial distributions that would inevitably be implied (Cohen, 1995). In this connection, it is worth stressing that some of the externalities that we have identified in this article operate mainly in time, while others operate mainly through time (economists refer to them 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 did this by trying to connect demographic and environmental concerns. The perspective which 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 would depend on the community in question. Thus while family-planning services (especially when allied to public-health services) and measures which empower women (through both education and improved employment opportunities) are certainly desirable, there are also other

policies which 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, and newspapers), and measures which directly increase the economic security of the poor. A number of these policies wouldn't have come to mind if we had studied demographic problems in isolation.

In any event, the aim should not be to force people to change their reproductive behaviour. Rather, it should be to identify policies and encourage such institutional changes as those which would "internalise" the externalities we have uncovered here. Recent declines in fertility rates in the Indian sub-continent and in parts of sub-Saharan Africa suggest that outside influence, via the media, may have been powerful. Observing life-styles elsewhere can no doubt be unsettling to many, but it can give people ideas that are salutary. To the extent that reproductive behaviour is based on conformism (I have little notion of what that extent is), modern communication channels, linking the village to the outside world, would have a powerful effect. But the media are likely to be hampered in arbitrary ways except in politically open societies. Dasgupta (1990) and Dasgupta and Weale (1992) showed 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 rate. Since then Przeworski and Limongi (1995) have shown that these liberties are negatively correlated with fertility rates. We have therefore 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 we have looked at matters wholly from the perspective of the parents. This is limiting.<sup>51</sup> But developing the welfare economics of population policies has proved to be extremely difficult.<sup>52</sup> Our ethical intuition at best extends to actual and future

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<sup>51</sup> 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.

<sup>52</sup> I have gone into some of the difficulties in Dasgupta (1998b).

people, we do not yet possess a good moral vocabulary for including potential people in the calculus. What I have tried to argue in this essay is that there is much that we can establish even if we were to leave aside such conceptual difficulties. Population policy involves a good deal more than making family-planning centres 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 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.

In Section 7.4 I argued that free-riding on the commons among villagers can impoverish households in such a way as to create an additional need for household labour. 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 labour. Of course, this is only one possibility; another is that the receding commons impoverish 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 enables us to identify parametric conditions under which the various outcomes would be expected to occur. I then compare the non-cooperative village to a cooperative one. The model is timeless. Adjustments over time can then be analysed in terms of comparative statics.

#### A.1 The Single Household

I consider a bio-mass 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. We aggregate inputs and outputs and assume that household production possibilities are such that net income per household member,  $y(n)$ , has the quadratic form,

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

The quadratic form is useful. It enables us to capture certain crucial features of a subsistence economy in a simple way, thereby permitting us to draw conclusions easily. For example, (1) presumes that there are 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 fuel-wood, cooking raw ingredients, and so forth), that



single-member households are not feasible. (1) also presumes that when the household is large, the costs of adding numbers begin to overtake the additional income that is generated. This too is clearly correct.<sup>53</sup>

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

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

and  $\bar{n} = [\beta + \sqrt{(\beta^2 - 4\alpha\gamma)}] / 2\gamma. \quad (2b)$

$\underline{n}$  is the "fixed cost" of maintaining a household, while  $\bar{n}$  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

$$n^* = \beta / 2\gamma \quad (3a)$$

and  $y^* = -\alpha + \beta^2 / 4\gamma. \quad (3b)$

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

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  $\alpha$ ,  $\gamma$ , and  $\alpha/\gamma$  were to increase and  $\beta$  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 4. In short, the increase in resource scarcity shifts the curve ABC to A'B'C'.

Consider instead the case where each of  $\alpha$ ,  $\beta$ , and  $\gamma$  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 4. 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).

## A.2 Social Equilibrium

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<sup>53</sup> The analysis that follows can be developed more generally, without recourse to the quadratic function.

We 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  $\alpha$ ,  $\beta$ , and  $\gamma$  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

$$n^* = \beta(Nn^*)/2\gamma(Nn^*) \quad (4a)$$

$$\text{and } y^* = -\alpha(Nn^*) + [\beta(Nn^*)]^2/4\gamma(Nn^*). \quad (4b)$$

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

### A.3 The Optimum Village

Consider next an optimizing village community. It would choose  $n$  so as to maximize

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

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

$$[\beta(Nn) - 2n\gamma(Nn)] - N[\alpha'(Nn) - n\beta'(Nn) + n^2\gamma'(Nn)] = 0. \quad (6)$$

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

$$-\alpha'(Nn^*) + n^*[\beta'(Nn^*) - n^*\gamma'(Nn^*)] < 0. \quad (7)$$

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

Now (7) certainly holds if

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

But (7) holds also if

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

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

### A.4 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 take it that prior to the shifts inequality (7) holds. The perturbations will be taken to be sufficiently small so that (7) continues to hold in the new equilibrium.

Consider first the case where the perturbation consists of small upward shifts in  $\alpha(M)$  and

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<sup>54</sup> I avoid rigour here and assume (without justification) that the optimum is symmetric in households.

$\gamma(M)$  and a small downward shift in  $\beta(M)$ . Notice that if (8) holds, both  $n^*$  and  $y^*$  would be marginally smaller in 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 (9) holds. Suppose the perturbation consists of small upward shifts in each of the functions  $\alpha(M)$ ,  $\beta(M)$  and  $\gamma(M)$ . We can so set the relative magnitudes of the shifts 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 Section 7.4. Such a feedback, while by no means an inevitable fact of rural life, is a possibility. In this paper I have argued that evidence of the experiences of sub-Saharan Africa and northern Indian sub-continent in recent decades are not inconsistent with it.

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Table 1

Crude birth and death rates per 1000 people

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	B <sup>a</sup>		D <sup>b</sup>		B-D	
	1980	1996	1980	1996	1980	1996
China	18	17	6	7	12	10
Bangladesh	44	28	18	10	26	18
India	35	25	13	9	22	16
Pakistan	47	37	15	8	32	29
Sub-Saharan Africa	47	41	18	14	29	27
(Nigeria)	50	41	18	13	32	28
World	27	22	10	9	17	13

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<sup>a</sup> : crude birth rate per 1000 people<sup>b</sup> : crude death rate per 1000 people

Source: World Bank (1998, Table 2.2)

Table 3

Total fertility rates and GNP per head in a sample of countries

	TFR		GNP per head <sup>a</sup>	average annual % growth of GNP per head <sup>b</sup>
	1980	1996	1996	1965-96
China	2.5	1.9	3,330	6.7
Bangladesh	6.1	3.4	1,010	1.0
India	5.0	3.1	1,580	2.3
Pakistan	7.0	5.1	1,600	2.7
Sub-Saharan Africa	6.6	5.6	1,450	-0.2
(Nigeria)	6.9	5.4	870	0.1
U.S.A.	1.8	2.1	28,020	1.4
World	3.7	2.8	6,200	1.2

<sup>a</sup> Dollars at purchasing power parity.

<sup>b</sup> GNP growth calculated from constant price GNP in national currency units

Source: World Bank (1998, Tables 1.1, 1.4, and 2.15)



Table 2  
Magnitude of poverty (1985)

Region	Extremely Poor <sup>a</sup>			Poor <sup>a</sup>		
	Number (m)	HI (%)	PG (%)	Number (m)	HI (%)	PG (%)
Sub-Saharan Africa	120	30	4	180	47	11
East Asia China	120 (80)	9 8	0.4 1	280 (210)	20 20	1 3
South Asia India	300 (250)	29 33	3 4	520 (420)	51 55	10 12
Middle East & North Africa	40	21	1	60	31	2
Latin America & the Caribbean	50	12	1	70	19	1
All Develop- ing Countries	630	18	1	1,110	33	3

HI - Headcount Index (%)  
PG - Poverty Gap (%)

<sup>a</sup> The poverty line in 1985 PPP dollars is \$275 per capita a year for the extremely poor, and \$370 per capita a year for the poor.

Source: World Bank (1990, table 2.1).

Table 4  
Women's education and fertility rates, 1

country	education level	TFR
Botswana	none	5.8
	1-4 years	5.5
	5-7 years	4.7
	8+ years	3.4
Ghana	none	6.8
	1-4 years	6.6
	5-7 years	6.0
	8+ years	5.5
Uganda	none	7.9
	1-4 years	7.3
	5-7 years	7.0
	8+ years	5.7
Zimbabwe	none	7.2
	1-4 years	6.7
	5-7 years	5.5
	8+ years	3.7

Source Jolly and Gribble (1993, table 3.6).

Table 5

Women's education and fertility rates, 2

Burundi	none	6.9
	1-4 years	7.1
	5-7 years	7.3
	8+ years	5.8
Kenya	none	7.2
	1-4 years	7.7
	5-7 years	7.2
	8+ years	5.0
Nigeria	none	6.5
	1-4 years	7.5
	5-7 years	6.0
	8+ years	4.5

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Source Jolly and Gribble (1993, table 3.6) and Cohen (1993, table 2.4).

Table 6

## Fertility rates and women's status

N	TFR	PE	UE	I
9	>7.0	10.6	46.9	65.7
35	6.1-7.0	16.5	31.7	76.9
10	5.1-6.0	24.5	27.1	46.0
25	<5.0	30.3	18.1	22.6

Key N: number of countries

TFR: total fertility rate

PE: women's share of paid employment (%)

UE: percentage of women working as unpaid family workers

I: women's illiteracy rate (%)

Source IIED/WRI (1987, Table 2.3).