2020 FOCUS BRIEF on the World's Poor and Hungry People

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POVERTY TRAPS
Exploring the Complexity of Causation

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Describing and explaining are two very different engagements, and yet development experts routinely write as though to describe were to explain. If this were not the case, it would be hard to understand why they have found it necessary to repeatedly describe the lives of the world's poorest over the past 30 years. Consider the following sentence constructed from numerous writings—for example, by Banerjee and Duflo, Narayan, the United Nations Development Programme, and the World Bank (see the "For Further Reading" for details)—wherein poverty is defined as a state of affairs where someone has access to very little income:

> In the world of the poor, people don't enjoy food security, don't own many assets, are stunted and wasted, don't live long, can't read or write, don't have access to easy credit, are unable to save much, aren't empowered, can't insure themselves well against crop failure or household calamity, don't have control over their own lives, don't trade with the rest of the world, live in unhealthy surroundings, suffer from "incapabilities," and are poorly governed.

Let's call the above passage *Description*. Although no one would have ever doubted its validity, it offers little guidance for action. It doesn't say what is a cause and what is an effect; it doesn't distinguish between proximate and deep causes; it doesn't say what is a variable and what is a parameter in the environment in which the poor reside; and it doesn't say whether those that are variables can be interpreted in samples to "move" together over time (time-series data) or across parameter values at a given time (cross-sectional data). Above all, the passage doesn't help to identify the pathways that lead to the state of affairs where *Description* holds. And, yet, an enormous literature has drawn on *Description* to arrive directly at policy prescriptions. It seems that even the Millennium Development Goals and the United Nations' plans for meeting them reflect this methodological stance.

Despite its length, *Description* omits at least two items: the sentence should have continued on to say that the poor suffer from a deteriorating natural resource base and high birth rates. These points are kept out of *Description* because neither reproductive behavior nor the local natural resource base has been of much interest to contemporary development experts, an issue that will be discussed later in this brief.

Multiple Causations of Poverty

Theoretical considerations and empirical evidence show that the persistence of poverty in a world of economic progress elsewhere should be traced to socioeconomic, metabolic, and ecological processes involving positive feedback. In mathematically simple systems, the positive feedback may be a reflection of fixed costs. For example, maintenance costs in human metabolic processes are substantial, as are overhead costs in running a household in a world where water cannot be obtained from turning on a tap, where energy is not available at the flick of a switch, and where cooking is a vertically integrated activity, meaning that all the ingredients are in their rawest form. In more complicated systems, positive feedback is a feature of complementarities among the drivers of the processes in question. For example, primary education, nutritional intake, and health care are complementary inputs in child development. Remove one input, and the child does not develop much. The shadow value of a service is negligible if its complements are unavailable. For example, when a child is undernourished, the value of education to her is low, because an under-nourished child is unable to imbibe much knowledge and skills. Of course, fixed costs themselves could be manifestations of complementarities among the drivers of the systems in question, the point being that if you peer into the microfoundations of a process, you may discover that complementarities among the various drivers give rise to those fixed costs.

One implication of positive feedback is that, in the world of the poor, each item in *Description* reinforces the others, implying that the productivity of labor effort, ideas, manufactured capital, and land and natural resources are all very low and remain low. The lives of poor people are filled with problems each day. In contrast, the rich suffer from no such deprivation. People in the rich world face what today are called challenges. An implication of the positive feedback alluded to here is that in the world of the rich, the productivity of labor effort, ideas, manufactured capital, and land and natural resources is all very high and continually increasing. Success in meeting each challenge reinforces the prospects of success in meeting further challenges. Since the aim of this brief is to stimulate discussion, the theory and empirics of poverty traps are not reproduced here. Instead, extrapolating the logic of positive feedback, the discussion shows how some people can get trapped in poverty, while others—not dissimilar to them—are able to escape and prosper. The brief thus follows two parallel expository routes: an informal account and formal modeling approaches presented in Boxes 1 through 3 at the end of the brief.

Even though *Description* suggests the phenomenon of multiple causation, the temptation to seek monocausal explanations for the twin presence of poverty and wealth in our world is so powerful that even development experts have not always been able to overcome it. But the presence of mutual causation (namely, several variables influencing one another over time) has implications for interpreting data. The phenomenon is displayed in a simple deterministic model (Box 1). The model contains several economic variables that influence one another over time. In fact, of course, people's lives involve and feed into many processes. One process, creating metabolic pathways, works at the level of the individual. Those pathways are based on physiological links connecting (a) undernourishment and a person's vulnerability to infectious diseases, (b) nutritional status and work capacity among adults, and (c) nutritional status and physical and mental development among children. The ways those pathways can harbor poverty traps is sketched in the section "Nutrition, Health, and Human Productivity," below, and modeled in Box 2.

A second category of processes, operating at a spatially localized level, is site specific. It involves a combination of ecological and socioeconomic pathways, giving rise to reproductive and environmental externalities. In contrast to modern macroeconomic growth models, these processes are influenced by the local ecology. The theory based on them acknowledges that the economic options open to a poor community in, say, the African savanna are different from those available to people in the Gangetic Plain of India. Although policies and institutions shape the forces people face, the local ecology shapes them too. Among ecological and socioeconomic pathways, some involve positive feedback between poverty, population growth, and degradation of the local natural resource base. However, neither poverty, nor population growth, nor environmental degradation is the prior cause of the others: over time each influences, and is in turn influenced by, the others. The two broad categories of positive feedback are able to coexist in a society because nutritional status doesn't much affect fecundity, or so it has been found, except under conditions of extreme nutritional stress. (During the 1974 famine in Bangladesh, deaths in excess of those that would have occurred under previous nutritional conditions numbered about 1.5 million. The stock was replenished within a year. Of course, undernourishment can still affect sexual reproduction through its implications for the frequency of stillbirths, age at menarche, failure to ovulate, maternal and infant mortality, and the frequency of sexual intercourse.) The interface of poverty, fertility, and the local natural resource base is accounted for in the section "Household Labor Needs and the Local Commons: The Population–Poverty–Resource Nexus," below, and in Box 3.

In speaking of an economy, this is casting a wide net. The economy could be a person, or it could be a household, a village, a district, a province, a nation, or even the whole world. Note, however, that a village could be in the grip of a poverty trap even if the country is not. It is frequently argued that, in such a situation, outside aid is needed if the villagers are to lift themselves out of the mire. (Of course, what form that aid should take is something that can only be identified when the positive feedback mechanism is well understood. *Description* alone doesn't tell us what should be done.) But the context matters. It could be that what is needed more than aid is the creation of (rational) trust among people and (rational) confidence in the external world to honor agreements.

Those who are caught in poverty traps do not necessarily spiral down further. For most, there is little room below to fall into; many are already undernourished and susceptible to diseases. Modern nutrition science has shown that relatively low mortality rates can coexist with a high incidence of undernutrition and morbidity. To be sure, many die owing to causes directly traceable to their poverty. But large numbers continue to live under nutritional and environmental stresses. Moreover, people tend not to accept adverse circumstances lying down. So it is reasonable to assume that they try their best to improve their lot. There are, to be sure, situations where human responses to stress lead to successful outcomes. However, as this brief is about poverty traps, the idea is to identify conditions under which the coping mechanisms people adopt are not enough to lift them out of the mire. For example, one study shows that in the face of population pressure in Bangladesh, small landholders have periodically adopted new ways of doing things so as to intensify agricultural production. This, however, has resulted in only an imperceptible improvement in the standard of living, and a worsening of the ownership of land probably due to the prevalence of distress sales of land. Other researchers have observed that location per se, and not merely the local ecology, can matter. They note, for example, that to be landlocked and surrounded by poor neighbors reduces a country's economic options that much more.

The externalities associated with people's coping strategies can amount to significant differences between private and social returns to various economic activities. Thus, where reproductive behavior is "pro-natalist," the private returns to having large numbers of children are high, in contrast to the social returns. Similarly, where communities degrade their natural resource base, the collective endeavors to maintain the base are unable to withstand the pressure of private malfeasance. And so on.

Box 1—The Idea of Mutual Causation

Mutual causation is at the center of *Description.* In order to formalize mutual causation and to show how cross-sectional data on poverty should be interpreted, consider a system that can be described at any moment of time t by three (scalar) variables $X(t)$, $Y(t)$, and $Z(t)$. We call X, Y, and Z the state variables of the system. A system with three state variables was chosen because the discussion focuses on the possible links between poverty, population size, and the state of the natural resource base.

Imagine that the process driving the system can be described by a triplet of deterministic differential equations:

$$dX(t)/dt = E(X(t),Y(t),Z(t),q), \qquad (1)$$

$$dY(t)/dt = F(X(t),Y(t),Z(t),q), \text{ and} \qquad (2)$$

$$dZ(t)/dt = G(X(t),Y(t),Z(t),q), \qquad (3)$$

where q is a (scalar) parameter and where E, F, and G are continuous functions of X, Y and Z. For simplicity of exposition, assume that X, Y, Z, and q are all observable. Notice first that the causal connection between X, Y, and Z is mutual: equations (1)–(3) say that, over time, each state variable influences the others. Time series of X, Y, and Z enable the econometrician to estimate E, F, and G. Data, however, are frequently cross-sectional (for example, cross household, cross village, cross district, and cross country). It is customary to interpret such data by first assuming that each observation in the sample represents a stationary point of equations (1)–(3). A stationary point is a triplet of numbers ($\underline{X}$, $\underline{Y}$, $\underline{Z}$) for which,

$$E(\underline{X},\underline{Y},\underline{Z},q) = 0, \qquad (4)$$

$$F(\underline{X},\underline{Y},\underline{Z},q) = 0, \text{ and} \qquad (5)$$

$$G(\underline{X},\underline{Y},\underline{Z},q) = 0. \qquad (6)$$

But $\underline{X}$, $\underline{Y}$, and $\underline{Z}$ are functions of q. Write them as $\underline{X}(q)$, $\underline{Y}(q)$, and $\underline{Z}(q)$. If the process defined by equations (1)–(3) has positive feedback, equations (4)–(6) can have multiple solutions for the *same* value of q. So, one possible scenario is that every observation in the data set (say, of size N) is associated with the same value of q but with a different stationary point (see Box 2).

But q is observable. So now suppose that each observation in the data set has a distinct value of q. If N were very large, the sample values of q could be approximated by an interval of numbers. We could plot $\underline{X}(q)$, $\underline{Y}(q)$, and $\underline{Z}(q)$. We would discover that they "move together." We would then say that they are correlated. *Description* involves this form of reasoning.

It may be that $\underline{X}(q)$, $\underline{Y}(q)$, and $\underline{Z}(q)$ do not look like continuous functions. Values of q at which the functions jump are called *bifurcations*. Their presence would point to nonlinearities in the system defined by equations (1)–(3). These equations offer a timeless economic model with microfoundations that can be interpreted in terms of the stationary point (4)–(6).

Nutrition, Health, and Human Productivity

The energy required to maintain each human life is substantial: 60–75 percent of the energy intake of someone in nutrition balance goes toward maintenance, the remaining 40–25 percent is spent on "discretionary" activities (work and leisure activities). Maintenance requirements are like fixed costs. They lead to positive feedback and reflect a nonlinearity inherent in human metabolic pathways. The fixed costs can also be a reason for unequal food distribution within poor households. To illustrate, suppose that in order to balance nutrition, a person requires on average 2,500 kilocalories (kcal) of energy intake each day. A poor household of four, having access to, say, 5,500 kcal per day, would be at serious risk of extinction if food were distributed equally among members. Of course, an unequal distribution would place those receiving well below 2,500 kcal at a terrible risk, but it would offer the household a chance to survive. A rich household, in contrast, has no such dilemma: it can practice equality with impunity. This is an example of how the presence of fixed costs can make poverty a source of inequality.

Why can't the market mechanism be relied on to eliminate undernutrition? The reason is the large energy maintenance requirement for human functioning. It places the undernourished at a severe disadvantage in their ability to obtain food: the quality of work they are able to offer is inadequate for obtaining the food they require, if they are to improve their nutritional status. Notice the circularity in the argument, which is a telling sign that the causation is mutual. Over time undernourishment can be both a cause and consequence of someone falling into a poverty trap. Because undernourishment displays hysteresis (that is, the scars cannot be wiped out), such poverty can be dynastic: once a household falls into a poverty trap, it can prove especially hard for descendents to emerge out of it. It can be shown that assetless people are especially at risk of falling into a poverty trap if the economy is not especially rich and if the distribution of assets is highly unequal. If the distribution of nonhuman assets were made less unequal in the economy, the market for labor would function better. Of course, the key issue is access to nutrition and health care, not so much the distribution of assets. If safety nets are in place, they provide that access when all else fails.

Much international attention has been given to saving lives in times of crises in poor countries. This is as it should be. International agencies have also paid attention to keeping children alive in normal times through public health measures, such as family planning counseling, immunization, and oral rehydration. This too is as it should be. That many poor countries fail to do either is not evidence that these problems are especially hard to solve. In fact, they are among the easier social problems: they can be fielded even though no major modification is made to the prevailing economic system. Much the harder problem, in intellectual design, political commitment, and administration, is to ensure that those who remain alive are healthy. It is also a problem whose solution brings no easily visible benefit. But the persistence of large-scale undernourishment, caused by inadequate diet and lack of sanitation and potable water, is a sure sign of economic backwardness. For example, the stunting of both cognitive and motor capacity is a prime hidden cost of energy deficiency and anemia among children and, at one step removed, among mothers. It affects learning and skill formation and thereby future productivity. The price is paid in later years, but it is paid.

Box 2—Nutrition-Based Poverty Trap

To illustrate positive feedback, consider the following stylized example:

> Denote time by t. The present is $t = 0$. Consider a person whose health (that is, nutritional status) at t is denoted by a scalar index $H(t)$. Let $W(H(t))$ be the flow of well-being enjoyed by the person. Naturally, one would suppose that $dW/dH > 0$. Now let $J(H,q)$ denote a person's income, where q is, as in Box 1, a (scalar) parameter that reflects the person's environment (q is a scalar index of what is a vector of parameters). Assume that the curve J shifts vertically upward with increasing values of q.

What might q reflect? It could reflect (1) factors that are exogenous to the economy, such as rainfall, and factors that are exogenous to the person but are endogenous to the economy, such as the following: (2) the effectiveness of property rights, (3) the extent to which government and communities have effective support programs in place, (4) the degree to which markets are open to the person, and (5) the person's nonlabor assets (including education). To these, add (6) the extent to which the person has reasons to *trust* others, which may be the most important of all.

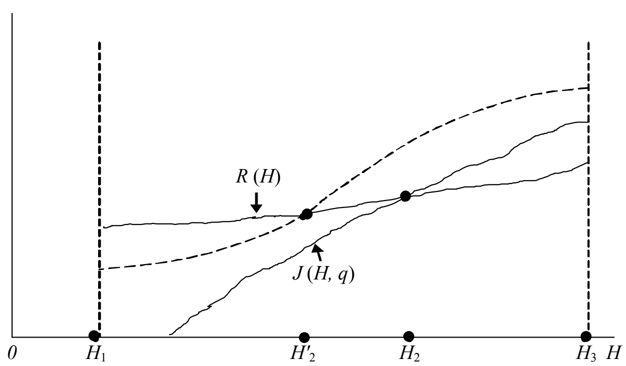
Let $R(H)$ denote the person's nutrition requirement (expressed in units of income). $J(H,q)$ and $R(H)$ are taken to be continuous functions of H. Now imagine that a person's health status, viewed as a stock, obeys the deterministic differential equation,

$$dH(t)/dt = J(H(t),q) - R(H(t)), H_3 > H(t) > H_1, \qquad (7)$$

and if, for any t', $H(t') = H_1$ (resp., H_3), then $H(t) = H_1$ (resp., H_3) for all $t > t'$. ($H = H_1$ and $H = H_3$ are called "absorbing barriers." The constant that preserves dimensionality in equation (7) has been implicitly set equal to unity.

In equation (7), H is the state variable and q is a parameter. In Figure 1, $J(H,q)$ and $R(H)$ have been drawn so that they intersect once, at H_2. (Maintenance costs are reflected in the fact that $R > 0$ even when $H = H_1$.) Equation (7) possesses three stationary points (or *equilibria*): H_1, H_2, and H_3. Of these, H_2 is unstable, while H_1 and H_3 are stable. Notice also that a person whose initial nutritional status, $H(0)$, is slightly in excess of H_2 enjoys growth in well-being, while someone with $H(0)$ slightly less than H_2 is trapped in a deteriorating situation. In short, there are people in the neighborhood of H_2 who are similar but who face widely differing fortunes. Poverty traps give rise to *horizontal inequity*.

Figure 1—Nutrition-Based Poverty Trap



Source: Devised by author.

Suppose q decreases slightly, say, because of deteriorations in any of the six factors listed earlier. In that case the income schedule $J(H,q)$ would experience a slight vertical drop. H_2 would move slightly to the right, meaning that some people who were not facing a poverty trap would now do so. Such people are said to be vulnerable to shocks in q. Suppose instead that q were to increase. The income schedule $J(H,q)$ would rise vertically (as in the broken curve), leading H_2 to move to H_2'. Fewer people would now be prey to the poverty trap. Moreover, if q were to rise sufficiently high, $J(H,q)$ would not intersect $R(H)$. In that case H_3 would become the unique stationary point of the system. Interpretations (2)–(6) for q come into play now. They identify the various pathways by which poverty traps can be and, in some countries have been, eliminated.

Household Labor Needs and the Local Commons: The Population–Poverty–Resource Nexus

Among poor households in rural communities much labor is needed even for simple tasks. Moreover, many households lack access to the sources of domestic energy available to households in advanced industrial countries. Nor do they have water on tap. In semi-arid and arid regions, water supply is often not even close at hand, nor is fuelwood nearby when the forests recede. This means that the relative prices of alternative sources of energy and water faced by 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 several hours a day fetching water and collecting fodder and wood. These complementary activities have to be undertaken on a daily basis if households are to survive. They imply that poor people face large fixed costs in running their households—though econometricians studying rural households rarely model fixed costs (Box 3). Labor productivity is low because manufactured capital and environmental resources are both scarce. From an early age (as early as six years), children in poor households in the poorest countries mind their siblings and domestic animals, fetch water, and collect fuelwood, dung (in the Indian subcontinent), and fodder. Mostly, they do not go to school. Not only are educational facilities in the typical rural school woefully inadequate, but also parents need their children's labor. Children aged 10–15 years have been routinely observed to work at least as many hours as adult males.

The need for many hands can in principle lead to a destructive situation where parents don't have to pay the full price of rearing their children but share such costs with their community. Since time immemorial, rural assets such as village ponds and water holes, threshing grounds, grazing fields, swidden fallows, and local forests and woodlands have typically been owned communally. As a proportion of total assets, the presence of such assets ranges widely across ecological zones. In India the local commons are most prevalent in arid regions, mountain regions, and unirrigated areas; they are least prevalent in humid regions and river valleys. The rationale for this is the human desire to reduce risks. Community ownership and control enable households in semi-arid regions to pool their risks. An almost immediate empirical corollary is that income inequalities are less where common-property resources are more prominent. Aggregate income is a different matter though, and the arid and mountain regions and unirrigated areas are the poorest. As would be expected, dependence on common-property resources even within dry regions would appear to decline with increasing wealth across households.

Box 3—The Village Commons and Household Size

That increases in population put additional pressure on the local natural resource base is, no doubt, a banality; instead consider the reverse influence: the effect of a deterioration of the local natural resource base on desired household size. Villagers free-riding on the commons can impoverish households in such a way as to create an additional need for household labor. This in turn translates into demand for more surviving children, if having more children were the cheapest means of obtaining that additional labor. Of course, this is only one possibility. Another is that the recession of the commons impoverishes households in such a way that, at the margin, children become too costly, with the result that the number of surviving children declines. This box offers a formal account of both possibilities. The model enables us to identify parametric conditions under which the various outcomes would be expected to occur. The noncooperative village (that is, one where villagers free-ride on one another) is then compared with a cooperative one (that is, one where they collectively find ways to avoid free-riding). The model is timeless. Adjustments over time can then be analyzed in terms of comparative statics.

The Single Household

Consider an agriculture-based village economy consisting of N identical households. N is taken to be sufficiently large that the representative household's size does not affect the economy. The model is deterministic. Household size is assumed to be a continuous variable, which is a way of acknowledging that realized household size is not a deterministic function of the size the household sets for itself as a target. Let n be the size of a household. Members contribute to production, but they also consume from household earnings. Inputs and outputs are aggregated, and it is assumed that household production possibilities are such that *net income* per household member, $y(n)$, has the quadratic form

$$y(n) = -a + bn - cn^2, \quad \text{where } a, b, c > 0, \text{ and } b^2 > 4ac. \qquad (8)$$

The quadratic form enables certain crucial features of a subsistence economy to be captured in a simple way, thereby permitting conclusions to be easily drawn. For example, equation (8) 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, collecting fuelwood, cooking raw ingredients, and so forth) that single-member households are not feasible. Equation (8) 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. It follows from equation (8) that $y(n) = 0$ at

$$n^* = [b - (b^2 - 4ac)^{1/2}]/2c, \text{ and} \qquad (9a)$$

Box 3—Continued

$$n^{**} = [b + (b^2 - 4ac)^{1/2}]/2c. \qquad (9b)$$

Note that n^* is the *fixed cost* of maintaining a household, while n^{**} is the environment's *carrying capacity*. It is assumed 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

$$\underline{n} = b/2c \text{ and} \qquad (10a)$$

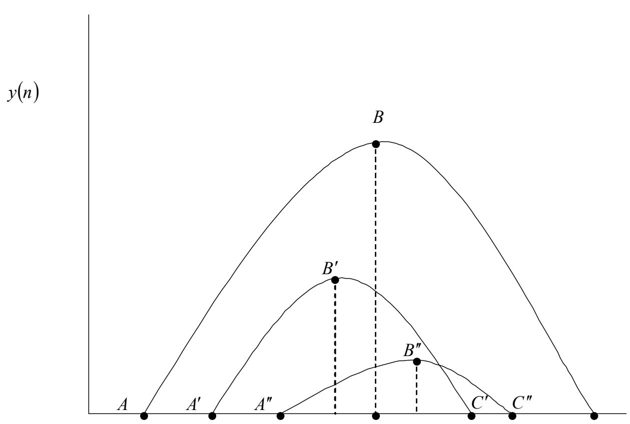
$$\underline{y} = -a + b^2/4c. \qquad (10b)$$

In Figure 2, $y(n)$ is depicted as the curve ABC, where B is the point $(b/2c, -a + b^2/4c)$.

Imagine now that the household faces an increase in resource scarcity, which can be interpreted in terms of receding forests and vanishing waterholes. 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 n^*. But it would typically mean more. For example, equations (9a,b) tell us that the household would face an increase in resource scarcity if a, c, and a/c were to increase and b were to decline in such a way that n^{**} declines. Note too that, in this case, both n and y would decline in equations (10a,b). The resulting $y(n)$ is depicted as the curve $A'B'C'$ in Figure 2. The increase in resource scarcity shifts the curve ABC to $A'B'C'$.

Consider instead the case where a, b, and c each increase, but in such a way that n^* and $\underline{n}$ increase, while n^{**} and $\underline{y}$ 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 though that will make it poorer. The resulting $y(n)$ is depicted as the curve $A''B''C''$ in Figure 2. In short, the increase in resource scarcity shifts the curve ABC to $A''B''C''$.

Figure 2—Household Income per Head as Function of Household Size



Source: Devised by author.

Social Equilibrium

Now to 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, written as M, and a, b, and c in equation (8) are assumed to be functions of M: $a = a(M)$, $b = b(M)$, and $c = c(M)$. A symmetrical equilibrium of the village economy is characterized by $M = N\underline{n}$. That is, n and y are the solutions of

$$n = b(N\underline{n})/2c(N\underline{n}) \text{ and} \qquad (11a)$$

$$y = -a(N\underline{n}) + [b(N\underline{n})]^2/4c(N\underline{n}). \qquad (11b)$$

It is assumed that a solution exists and that $n > 1$.

The Optimum Village

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

$$y(n) = -a(Nn) + b(Nn)n - c(Nn)n^2. \qquad (12)$$

(It is assumed, without justification, that the optimum is symmetric in households.) Let n^{***} be the optimum household size. Then n^{***} is the solution of

$$[b(Nn) - 2nc(Nn)] - N[a'(Nn) - nb'(Nn) + n^2c'(Nn)] = 0. \qquad (13)$$

A comparison of equations (11a) and (13) tells us that $n^{***} < \underline{n}$ if

$$-a'(N\underline{n}) + n[b'(N\underline{n}) - \underline{n}c(N\underline{n})] < 0. \qquad (14)$$

That is, if (14) holds, the village is overpopulated in social equilibrium. An alternative way of thinking about the matter would be to say that an institutional reform that reduces the "freedom of access" to the commons would lower fertility. Now (14) certainly holds if

$$a', c' > 0 \text{ and } b' < 0 \text{ at } n = \underline{n}. \qquad (15)$$

But (14) holds also if

$$a', b', c' > 0, \text{ and } [-a' + (bb'/2c) - (b^2c'/4c^2)] < 0 \text{ at } n = \underline{n}. \qquad (16)$$

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 $a(M)$, $b(M)$, and $c(M)$. It is assumed that prior to the shifts, inequality (14) holds. The perturbations are taken to be sufficiently small so that (14) continues to hold in the new equilibrium. Consider first the case where the perturbation consists of small upward shifts in $a(M)$ and $c(M)$ and a small downward shift in $b(M)$. Notice that if (15) holds, both $\underline{n}$ and $\underline{y}$ would be marginally smaller as a consequence of the perturbation. Intuitively this is what one would expect: a small increase in resource scarcity results in poorer, but smaller, households. Now consider the case where (16) holds. Suppose the perturbation consists of small upward shifts in each of the functions $a(M)$, $b(M)$, and $c(M)$. The relative magnitudes of the shifts can be set so that the small increase in resource scarcity results in poorer, but larger, households; that is, $\underline{y}$ declines marginally but $\underline{n}$ increases marginally. This is the timeless counterpart of the positive feedback mechanism between population size, poverty, and degradation of the natural resource base. Such a feedback, while by no means an inevitable fact of rural life, is a possibility. The experiences of Sub-Saharan Africa and the northern Indian subcontinent in recent decades are not inconsistent with it.

In recent years, social norms that once regulated local resources have changed. The very process of economic development, as exemplified by urbanization and mobility, can erode traditional methods of control. Social norms are endangered also by civil strife and by the usurpation of resources by landowners or the state. For example, resource-allocation rules practiced at the local level have frequently been overturned by central fiat. A number of states in the Sahel imposed rules that in effect destroyed community management practices in the forests. Villages ceased to have authority to enforce sanctions against those who violated locally instituted rules of use. State authority turned the local commons into free-access resources. As social norms degrade, whatever the cause, parents pass some of the costs of children on to the community by overexploiting the commons. This is an 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. It is also true that when households are further impoverished owing to the erosion of the commons, the net cost of children increases (of course, household size continues to remain above what is desirable from the collective viewpoint). A study in Nepal, for example, found that increasing environmental scarcity lowered the demand for children, implying that the households in question perceived resource scarcity as increasing the cost of raising children. Apparently, increasing firewood and water scarcity in the villages in the sample didn't have a strong enough effect on the relative productivity of child labor 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. This statement is qualified because the theory has often been misunderstood to be saying that the negative link between (local) resource availability and fertility is unconditional. Bearing and raising children involve costs, but in some circumstances those costs are outweighed by the benefits of further procreation.

As the community's natural resources are depleted, households find themselves needing more "hands." No doubt additional hands could be obtained if the adults worked even harder, but in many cultures it would not do for the men to gather fuelwood and fetch water for household use. No doubt, too, additional hands could be obtained if children at school were withdrawn and put to work. But, as we have seen, the children mostly don't go to school anyway. In short, when all other sources of additional labor become too costly, more children are produced, thus further damaging the local resource base and, in turn, providing the household with an incentive to enlarge even more. This does not necessarily mean that the fertility rate will increase. If the infant mortality rate were to decline, there would be no need for more births in order for a household to acquire more hands. However, along this pathway, poverty, household size, and environmental degradation could reinforce one another. By the time some countervailing set of factors diminishes the benefits of having further children, many lives may have experienced a worsening of poverty (Box 3). A statistical analysis of evidence from villages in South Africa has found a positive link between fertility increase and environmental degradation, while a weak positive link has been found in the Sindh region in Pakistan. Over time the feedback would be expected to have political effects, as manifested by battles for scarce resources, for example, among competing ethnic groups. The latter connection deserves greater investigation than it has elicited so far.

To be sure, families with greater access to resources would be in a position to limit their size and propel themselves into still higher income levels. Admittedly, too, people from the poorest of backgrounds have been known to improve their circumstances. Nevertheless, positive feedbacks are at work that pull households away from one another. Such forces enable extreme poverty to persist despite growth in the well-being of the rest of society. (For a formal account of the process by means of a timeless model, see Box 2.)

Morals

Poverty traps are a reality. They are symptomatic of essential nonlinearities in metabolic, environmental, and socioeconomic processes. Although poverty traps have no single source, they possess a common structure. A lack of discussion on the pathways leading to poverty traps has been a factor behind many policy failures. Since the purpose here is to stimulate discussion, not to draw policy conclusions, the following observations about poverty alleviation are purposely broad:

1. *Poverty alleviation policies should be site specific.* It is easy enough to say, "One size does not fit all"; it is a lot harder to pin down how the "sizes" should be designed. In some contexts, preventing local institutions from collapsing may be the right object of policy design; in others, the provision of classrooms allied to school meals may be the right immediate investment.

2. *Complementarities matter.* Offering hungry children classrooms (even teachers!) does not help much in creating human capital.

3. *Be aware of mutual causation.* The common belief that unequal distribution of assets is a source of poverty among the unfortunate should be augmented by the recognition that poverty itself can be a cause of inequality.
4. *Be aware of unintended consequences.* Improving market conditions in the neighborhood of villages (surely a good thing) can lead to deterioration of village institutions, which in turn can lead to deterioration in the circumstances of the poorest.
5. *The local natural resource base matters.* National accounts do not include an economy's natural resource base. Policies built on economic models that do not contain natural capital are particularly dangerous because they can harm precisely those who are the objects of concern.

For Further Reading: R. Aggarwal, S. Netanyahu, and C. Romano, "Access to Natural Resources and the Fertility Decision of Women: The Case of South Africa," *Environment and Development Economics* (Vol. 6, No. 2, 2001); A. Banerjee and E. Duflo, "The Economic Lives of the Poor," *Journal of Economic Perspectives* (Vol. 21, No.1, 2007); P. Dasgupta, *An Inquiry into Well-Being and Destitution* (Oxford: Clarendon Press, 1993); P. Dasgupta, "Population, Poverty, and the Natural Environment" in *Handbook of Environmental Economics,* Vol. 1, K.-G. Mäler and Jeffrey Vincent, eds. (Amsterdam: Elsevier Science, 2003); T. E. Homer-Dixon, *Environment, Scarcity, and Violence* (Princeton, NJ: Princeton University Press, 1999); D. Narayan with R. Patel, K. Schafft, A. Rademacher, and S. Koch-Schulte, *Voices of the Poor: Can Anyone Hear Us?* (New York: Oxford University Press, 2000); United Nations Development Programme, *Human Development Report* (New York: United Nations, 1990); World Bank, *World Development Report* (New York: Oxford University Press, 1978 and 2002).

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