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Assessing Strategies for Reducing Poverty

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The project of global human development is now better defined and organized than ever in human history, not least because goals have become increasingly explicit and focused. An important early statement of goals, in Article 25 of the 1948 United Nations Universal Declaration of Human Rights, was highly qualitative:

> Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing, and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age, or other lack of livelihood in circumstances beyond his control.

Over time human development goals have become more quantitative (and more gender-neutral), but they frequently have been more oriented toward input or process than toward output and goal accomplishment. For instance, in 1974 the UN General Assembly declared support for a New International Economic Order (NIEO). The NIEO called for financial aid at 0.7% of donor GDP, debt relief, industrial strategies, and increased savings.

Yet over time a set of accomplishment-oriented and specific, measurable goals has emerged for the reduction of hunger, of infant mortality, and much else. The global community took an especially large step in September 2000, when at the United Nations Millennium Summit 189 countries committed to the eight Millennium Development Goals (MDGs), the first integrated set of development goals with elaborated targets and quantifiable indicators. For instance, the first goal, targeting reduction of poverty, specifically called for halving by 2015 the proportion of people around the world who live on less than $1/day (relative to levels in 1990).

The pursuit of such goals requires three sets of interacting activities (see Figure 1). First, measuring and assessing current conditions and the trajectory of change provides foundational knowledge concerning the specific targets of intervention and the urgency of action. Goals can only be achieved in a process of constant evaluation of actual, changing conditions. Second, framing strategies for action help to determine the efforts needed by specific actors to accomplish established goals. Third, forecasting of alternative futures, with and without specific actions or interventions, provides a basis for understanding the potential leverage of human effort with respect to the goals.

Each of these three activities is underway in the global project to reduce global poverty. Yet there remains room for improvement, perhaps most significantly with respect to forecasting and its explicit use in the packaging of action strategies. All policy analysis is based at least implicitly on forecasting of

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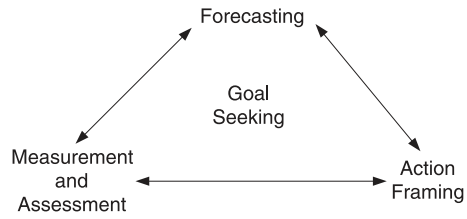


FIG. 1. Framework for Policy Analysis

outcomes with and without action, but very often the forecasting remains implicit and, therefore, underdeveloped. The primary contribution of this essay to the global development project will be to make forecasting more explicit and integrated.[1]

Poverty Reduction and Human Development

The first and in many respects foundational goal of the MDG set is to ''eradicate extreme poverty and hunger.'' Two more specific, quantitative targets accompany the goal:[2]

> Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day.
>
> Halve, between 1990 and 2015, the proportion of people who suffer from hunger.

The apparent clarity of goal, target, and indicators is remarkable and laudatory. It is exactly what is needed for the assessment leg of the assault on poverty. Unfortunately, the clarity is also somewhat more apparent than real. Were it fully realized, there would be no difficulty in answering the following two questions:

> What were the proportions of population globally and in different countries/regions around the world in 1990 that had incomes less than $1/day?
>
> What progress has been made in reducing these proportions since 1990?

The answers to these critical questions are somewhat contested. There is also uncertainty around the measurement of malnutrition, but the larger debates have focused on poverty. The rest of this section explores what we know and do not know about poverty levels.

[1]Support for the project on Patterns of Potential Human Progress has been provided by Frederick S. Pardee. This analysis heavily uses the International Futures (IFs) modeling system. Additional funding for IFs comes from the US National Intelligence Council and the United Nations Environment Programme. Thanks also to TERRA project of the European Commission, the Strategic Assessments Group of the US Central Intelligence Agency, the National Science Foundation, the Cleveland Foundation, the Exxon Education Foundation, the Kettering Family Foundation, the Pacific Cultural Foundation, the United States Institute of Peace, and General Motors for funding that contributed to earlier generations of IFs. None of these institutions bears any responsibility for the analysis presented here. IFs also owes much to the large number of students, instructors, and analysts who have used the system over many years and provided much appreciated advice for enhancement. The project further owes great appreciation to Anwar Hossain, Mohammod Irfan, Jonathan Moyer, and José Solórzano for data, modeling, help system and programming support within the most recent model generation. Haider Khan and Krishna Kumar will be coauthors on the first volume of the series on Patterns of Potential Human Progress.

[2]To assist with assessment of the human condition and progress toward the targets of the MDGs, the UN, International Monetary Fund, World Bank, and Organization for Economic Cooperation and Development have identified quantitative indicators and developed a database.

The World Bank's Foundational Approach

The World Bank has taken the lead in measuring poverty and providing data on change in its level. Montek Ahluwalia, Nicholas Carter, and Hollis Chenery (1979)first identified an international ''extreme poverty'' measure for comparison across countries. In doing so, they used the International Comparison Projects (ICPs) earliest version of purchasing power parity (PPP) data to explore global levels (see Kravis, Heston, and Summers 1978a,1978b). They based the level primarily on data from India. The level chosen was $200 per capita, the 45th percentile of income in India in 1970 ICP dollars, which in 1985 dollars is quite close to the more contemporary $1/day level. That initial specification of poverty level corresponded roughly also with access to 2,250 calories per day, something close to a survival minimum.

Since 1990 the World Bank (see Ravallion, Datt, and van de Walle 1991) has relied upon that head-count measure of poverty. One dollar per day was subsequently converted to $1.08/day at 1993 prices measured at PPP,[3] but the shorthand reference to $1/day remains common. A second international measure of poverty, somewhat further above the basic survival level, is set at $2.15/day at 1993 PPP.

The core of the World Bank's empirical approach to determining how many people earn less than $1/day is the use of country-based surveys. The number of surveys has steadily expanded, reaching 454 across 97 developing countries in the Shaohua Chen and Martin Ravallion (2004) analysis that provided much of the poverty data used by the Millennium Project (2005) in its elaboration of proposals for meeting the MDGs. Such surveys allow the construction of distributions of income or consumption levels across national populations and the specifications of shares associated with various percentiles of population.

The attention of the World Bank to distributions of income and consumption is fundamentally important. For instance, it matters much whether the bulk of those in a country below the extreme poverty line of $1/day cluster just below that level or find themselves significantly below the line. In the latter case the poverty is clearly deeper. The Bank and other analysts, therefore, supplement poverty head counts with measures such as the poverty gap, which increases with the distance of the income of the poor below $1.[4]

All these data and tools are being used in efforts to answer the two questions raised earlier: what are poverty levels and how have they been changing? Table 1 shows the World Bank's most recent answers to these questions. With respect to change, it also provides forecasts through 2030, the most authoritative ones available.

The Great Debates around Poverty Numbers

The numbers and patterns in Table 1 have been challenged; some calculate more rapid poverty reduction than does the World Bank. The fundamental basis for the challenge lies in the use of national account data rather than the Bank's survey data. The national account data suggest on the whole both higher values for income and consumption than do survey data and more rapid growth in them. Therefore they suggest both lower poverty rates and faster reduction. This has led Surjit Bhalla (2002), for example, to argue that the first target of the

[3]Surjit Bhalla (2002) questions whether a price differential of only 8% between 1985 and 1993 is reasonable. Martin Ravallion (2003) has strongly defended it.

[4]J. E. Foster, J. Greer, and E. Thorbecke (1984) created a general index that captures both incidence and intensity of poverty.

TABLE 1. World Bank Data and Forecasts of Poverty

	Leas than $1/day				Less than $2/day			
Region	1990	2003	2015	2030	1990	2003	2015	2030
Millions of persons living on								
East Asia and the Pacific	472	213	57	18	1,116	745	317	148
China	375	179	50	16	325	531	229	108
Rest of East Asia and the Pacific	97	34	7	2	292	213	88	40
Europe and Central Asia	2	9	5	3	23	71	40	26
Latin America and the Caribbean	49	49	38	30	125	134	118	103
Middle East and North Africa	6	5	3	1	51	62	45	31
South Asia	462	472	273	159	958	1,131	1,017	902
Sub-Saharan Africa	227	320	345	337	382	530	613	653
Low- and middle-income countries	1,218	1,068	721	547	2,654	2,671	2,150	15,631
Excluding China	844	889	671	531	1,829	2,140	L921	755
Percent of the population living on								
East Asia and the Pacific	29.6	11.5	2.8	0.8	69.9	40.2	15.5	6.7
China	53.0	13.9	3.6	1.1	72.6	41.2	16.5	7.3
Rest of East Asia and the Pacific	21.1	6.0	1.1	0.2	63.2	37.7	13.5	5.4
Europe and Central Asia	0.5	1.9	1.0	0.6	4.9	15.0	8.4	5.5
Latin America and the Caribbean	11.3	9.1	6.1	4.1	28.4	24.9	18.8	14.2
Middle East and North Africa	2.3	1.7	0.7	0.2	21.4	21.0	12.3	6.5
South Asia	41.3	33.2	16.2	8.1	85.5	79.5	60.2	46.0
Sub-Saharan Africa	44.6	45.0	37.4	29.9	75.0	74.5	66.5	58.0
Low- and middle-income countries	27.9	20.2	11.8	7.8	60.8	50.5	35.1	26.7
Excluding China	26.1	22.2	14.2	9.7	56.6	53.5	40.6	31.9

Source: World Bank 2007.

MDGs, the halving of global poverty rates, was actually already accomplished by 2000 when the goals were enunciated. Some efforts to clarify the issues involved (e.g., Deaton 2004) may ultimately move us toward resolution.

The choice of analysts between data based in surveys or national accounts would not be so problematic if the calculations of the ratios of mean societal consumption of the two were fundamentally constant over time. Then the estimates of poverty might vary across methodologies, but the patterns of change over time would be fundamentally the same. Angus Deaton (2004:12) notes, however, that the rate of growth in surveys is about half that in national accounts.

For the purposes of forecasting, a key question is whether the ratio of survey-based measures of consumption to national accounts-based measures of consumption will continue to decrease. It really makes no sense to expect such ratios to decline indefinitely. The forecasts in this essay begin in 2000 and use estimates of poverty in that year from World Bank sources, thereby accepting the estimates for initial poverty levels from the survey data. The forecasting from 2000, however, uses national accounts to drive poverty computations. It is, of course, impossible to forecast survey data.

The focus of this essay is on income poverty in large part because the first target of the first MDG is expressed in terms of income. It is important, however, not to lose track of the reality that poverty is much more than an income-based phenomenon. As Amartya Sen (2000) has long emphasized, human capabilities and the freedom of action to which they give rise lie at the heart of human development. Income underpins some such capabilities and freedom, but education and health are among the other key pillars. Our larger project does not lose sight of this concept of poverty.

Tools for Forecasting and Analysis of Leverage

Forecasting often begins with simple extrapolation,[5] extending existing trajectories of change and anticipating where they might take us. Forecasting must fairly quickly move beyond extrapolation and into causal analysis, however, if it is to be useful in the evaluation of alternative intervention options. Because the immediate or proximate drivers of poverty levels within societies are average levels and distribution of income plus the size of population, causal analysis is easily begun. Extended causal analysis is not simple, though, because it requires moving beyond proximate drivers to deeper ones and asking what kinds of specific human agency and action might change income, its distribution, or population size.

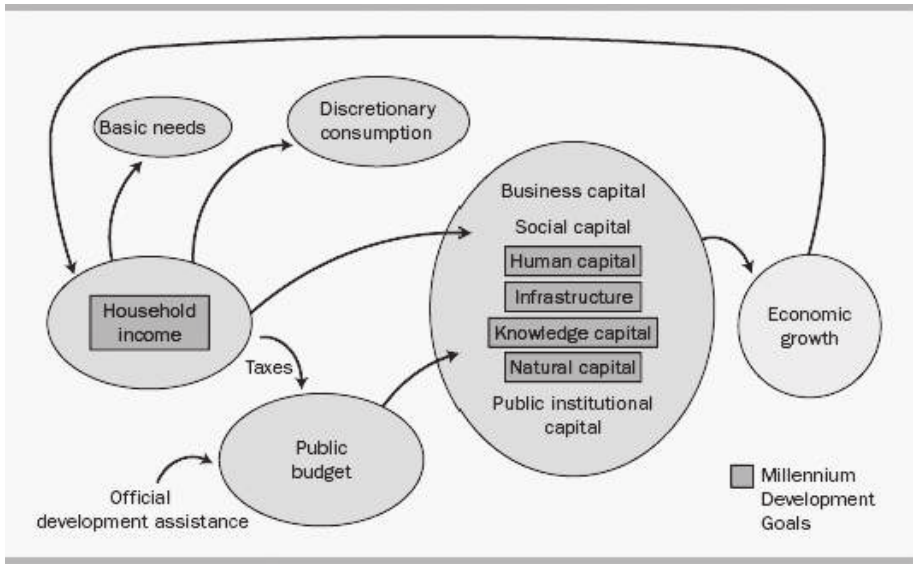
Existing Forecasts

Just as Ahluwalia et al. (1979) were path-breaking in establishing a cross-country measure of poverty, they (Ahluwalia, Carter, and Chenery) were leaders in the forecasting of it. Their work suffered from the absence of information on China. Nonetheless, AAC computed that the portion of populations in other less developed countries living in extreme poverty had fallen from 50.9% in 1960 to 38.0% by 1975. Using population forecasts from the UN 1975 population projections, basing future economic growth prospects on rates between 1960 and 1975, and forecasting income distribution in deciles, they suggested that the number of poor would decline somewhat based on historical trends and even more in their dynamic base case, falling from 38.0% of the population in their country set to 16.3% by 2000. Subsequent numbers from Chen and Ravallion (2004) showed a decline by about one half in the global portion of poor between 1981 and 2001. Although the Chen and Ravallion data included China and doing so considerably influenced the overall rate of decline in developing countries, it is obvious that the AAC forecasts were right not only in direction but in general magnitude.

The forecasting of poverty then essentially ceased for about two decades. The declaration of the MDGs has, however, reinvigorated it. The UNDPs *Human Development Report 2003*, titled *Millennium Development Goals: A Compact among Nations to End Poverty*, undertook simple extrapolation to compare extended trajectories of global regions with the path necessary to accomplish the goals by 2015 (United Nations 2003). Examining the UNDP extrapolations, however, it is unbelievable that the reduction of poverty in East Asia and the Pacific will continue on a straight line to zero in 2015. Progress will become more difficult in pockets within countries throughout the region. On the other hand, given the increased economic growth of recent years in India, the demographic giant of South Asia, it is quite possible that the downward trajectory the UNDP showed in simple extrapolation could accelerate.

In short, more sophisticated forecasts must at least move to the key proximate drivers of poverty reduction, namely economic growth and distributional change. That is the next step that the UN Human Development Report Office took. In support of the *Human Development Report 2005*, Yuri Dikhanov (2005) produced a study of change in global income distribution with forecasts to 2015. In addition, he began to look at scenarios for intervention into the forecasting model, specifically a pro-poor growth scenario.

[5]Especially in economics, forecasting is often reserved to mean obtaining results from multiple regression formulations. In broader forecasting literatures, its methods range from extrapolation through regression formulations and on to complex dynamic simulations, and even further to include a variety of qualitative techniques. Forecasting is used in the broader sense in this essay.



Source: Millennium Project 2005: 29.

Fig. 2. Millennium Project's Conceptual Framework

Attention to proximate drivers is, however, still not sufficient for policy-oriented analysis on poverty reduction. Deeper analysis requires that we turn to deeper drivers. That is what motivated the authors of the Millennium Project (2005), directed by Jeffrey Sachs, to produce Figure 2. To develop and present their ''practical plan'' for achieving the MDGs, they elaborate the causal understanding of change in levels of poverty, hunger, education, and other variables related to the goals. The diagram shows the clear impact of economic growth on household income and therefore on poverty, also suggesting some of the drivers of economic growth. These deeper drivers are ones that most economic production functions recognize.

The authors of *Investing in Development* relied heavily on their causal model in elaboration of their plan. As experts with respect to development, their mental models were, of course, considerably richer than Figure 2. In the course of elaborating their plan, they implicitly made forecasts with respect to the implications of investments in human capital, social capital, knowledge capital, and other factors on economic growth and thought more deeply with respect to the causal implications of official development assistance for public budgets and for such investments in human capital and other drivers of growth.

What they were unable to do was explicitly make forecasts based on their understandings of the global development system. As rich as their mental models were, they were insufficiently well elaborated and formalized to allow such forecasting. When the authors turned to a discussion of the costs and benefits of their proposals for achieving their goals, they were generally able to consider explicitly the costs of individual actions, but not match them directly with benefits. Nor could they systematically investigate trade-offs, synergies, reinforcers, or perverse effects of their proposed interventions. Still another step they did not take was explicitly to address the many differences among the mental models of team members and those between the general approach of the team and other development experts.

Explicit and formal computer models can make contributions to thinking about strategies for poverty reduction, adding to more qualitative and expert-judgment-based analysis. Computer models often benefit from very extensive and up-to-date empirical information. They handle the calculations of secondary and tertiary effects that address trade-offs, synergies, and other concerns. They allow investigation of possible futures with and without interventions, both selected individual ones and strategic packages.

Such models come, however, with great costs and disadvantages of their own. They are extremely time-consuming to create. They suffer from shortages of and inadequacies in data and theoretical understandings. The richer and more complex they are, the more difficult it becomes to understand the precise paths by which interventions give rise to outcomes (one needs a model of the model) and the more subject they are to non-discovery of errors in specification. In short, no one should ever believe the results of a formal, computerized simulation of development processes or the forecasted results of human intervention—just as no one should ever take for granted the forecasts of those who base them on simple or complex, individualized, and implicit mental models. Forecasts should be an aid to thinking and discussion, not a substitute for them.

International Futures

International Futures (IFs) is a large-scale integrated global modeling system. The broad purpose of IFs is to serve as a thinking tool for the analysis of near- through long-term country-specific, regional, and global futures across multiple, interacting issue areas. IFs allow variable time horizons for exploring human leverage with respect to pursuit of key goals in the face of great uncertainty. This section can only very briefly introduce IFs; for more detail see the IFs web site at http://www.ifs.du.edu, which provides both web-based and downloadable versions of the model. Barry Hughes, and Evan Hillebrand (2006) offer an introduction.[6]

Three sets of values and goals frame global initiatives and the structure of IFs. First, humans as individuals should be able to develop their capabilities as fully as possible, attaining literacy, securing nutrition, and health care that allow a reasonable life expectancy, and gaining access to a basic level of economic resources. The broader purposes of these capabilities are to allow individuals substantial freedom of choice in their pursuit of a fulfilling life (Sen 2000). Second, humans in their interactions with one another desire peace and security (Kant 1795) and also basic fairness and justice (Rawls 1971). Third, humans in their interactions with a broader biological and physical environment should be able to live in a sustainable manner so that life styles and choices do not jeopardize the life conditions of their own futures and those of subsequent generations (United Nations/Brundtland Commission 1987). Collectively, these goals have increasingly come to be recognized as the pillars of ''sustainable human development.''

Figure 3 shows the specific modules of IFs and a small selected set of connections among them. The elements of particular utility to this study are those in the upper left, namely the population, economic, and socio-political modules. The IFs modules all represent 182 countries. An extensive database supports model development and use.

[6]The most important source of documentation for the model is its extensive Help system, available with both web-based and downloadable versions. In addition, a substantial set of project reports and working papers sit on the web site at http://www.du.edu/~bhughes/ifswelcome.html.

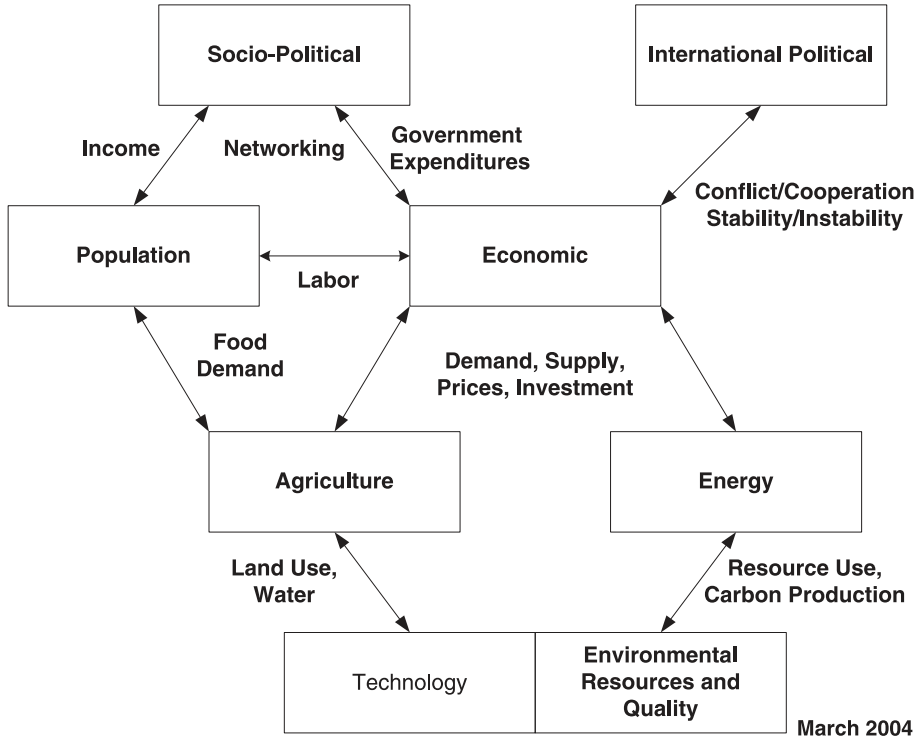


FIG. 3. Modules of International Futures (IFs)

Poverty Reduction Formulations in IFs

International Futures relies on two formulations for forecasting income poverty rates as a function of income and distribution, one based on cross-sectional analysis and one tied to log-normal analysis. Why two forecasting formulations? The cross-sectional formulation serves two purposes. First, it helps estimate poverty levels for countries for which there are no survey data. Second, there is basis on which to question the pure form of the log-normal curve as average income improves (even when aggregate measures like the Gini coefficient change very little). Pockets of poverty are a well-known phenomenon and often persist in remote rural areas, among disadvantaged ethnic groups, and in other subpopulations in spite of the economic advance of the average population. This phenomenon is chronic poverty rather than the transient poverty that results from job loss or other life status change. Thus, there may be a tendency for the left-hand tail of the log-normal distribution to display some inertia with economic transformation, leaving some additional number of people at or below the poverty line. The cross-sectional formulation might be responsive to them.

$$\text{Income LT1CS}_r = 14.514 - 15.196 \times \text{LN}\left(\text{GDPPC2000}_r\right) + 56.17 \times \text{GINI}_r$$

where,

Income LT1CS is the percentage living on less than $1 (cross-sectional); GDPPCP2000 is GDP per capita in 2000$ at PPP; GINI is the Gini coefficient; r is a specific country/region; R^2=.64.

Log-normal formulations are the standard. It is useful to make an initial distinction between methods of representing distributions and methods for summarizing the character of those distributions parametrically. By far the most widely

used method for representing distributions is the Lorenz curve. Any survey data on income or consumption for a society can be shown in Lorenz curve form with essentially complete accuracy. There is a clear relationship between the Lorenz curve and the expression of shares of income held by shares of population. Although it would theoretically be possible simply to project forward the decile, quintile, or even percentile shares of a Lorenz curve to specify future distributions, doing so is impractical if not impossible. It would most likely freeze those distributions that can be highly dynamic.

What we want instead is an analytic representation of the population distribution that can change systematically in form over time in response to both changing average income levels and changing income distributions as represented by something as simple as the Gini coefficient. Moreover, we want a representation from which we can conveniently compute specific deciles or quintiles (thereby generally reconstructing the Lorenz curve) and also compute key poverty measures like the headcount and poverty gap. Fortunately, there are a number of analytic formulations and estimation techniques that allow this to happen. The most widely used is the log-normal formulation. Although not all national income distributions have a log-normal form, something very close to that form is very typical.[7] A log-normal distribution that fully represents the distribution of income in a society can be specified with only two parameters, average income and the standard deviation of it. Usefully for forecasting purposes, the Gini coefficient can substitute for the standard deviation.[8]

$$\text{Income LT1LN}_r = F\left(\text{Log Normal Distribution},\ \text{CperCap}_r,\ \text{GINI}_r,\ \text{NSNARAT}_r\right)$$

where,

$$\text{NSNARAT}_r = f\left(\text{Income LT1LN}_r^{t=1}, \text{CperCap}_r^{t=1}, \text{GINI}_r^{t=1}\right)$$

where, income LT1LN is the percentage living on less than $1 (log-normal); CperCap is household consumption per capita in 2000$; GINI is the Gini coefficient; NSNARAT is the ratio of national survey poverty level to household consumption from national account data, computed in the initial market year (2000); *r* is a specific country/region.

Forecasting Economic Growth

To analyze the leverage of policy interventions, it is necessary to explore the deeper drivers of those proximate drivers, ideally with tools that frame the deeper drivers in terms of something relatively close to action of agent classes: government spending and regulation, household behavior, technical and other assistance by nongovernmental organizations, or decisions by firms.

That holy grail of the assessment-forecasting-action triangle may be as difficult to find as the religious one. In this essay, we make do with the structures that have been developed within the IFs model. The economic module of IFs is a general equilibrium-seeking model that uses inventories as buffer stocks and to provide price signals so that the model chases equilibrium over time. Its production function has Cobb–Douglas form. The IFs specification makes possible attention to many deeper drivers because it has an endogenous representation

[7]Francois Bourguignon (2003:7) noted that a log-normal distribution is ''a standard approximation of empirical distributions in the applied literature.'' He further decomposed the growth and distributional change effects in poverty reduction and explored the interaction between them.

[8]The log-normal is not the only parameterization possible of the income distribution and there are advantages and disadvantages of it and others. Other forms include polynomial functions (used by Dikhanov 2005), a generalized quadratic model (Villasenor and Arnold 1989), and the Beta model (Kakwani 1980). Gaurav Datt (1991) has derived formulations for computing the common aggregate poverty measures from multiple parameterizations of the Lorenz curve. In representing income distribution, it is also possible to use non-parametric techniques, such as the Gaussian kernel density function (Sala-i-Martin 2002).

of multifactor productivity (MFP) as a function of human capital (education and health), social capital (governance quality and policies), physical and natural capital (infrastructure and energy prices), and knowledge development and diffusion (R&D and economic integration with the outside world). The cohort-component demographic model determines size of the labor force, whereas domestic and foreign savings help determine capital investment. A social accounting matrix envelope ties economic production and consumption to intra-actor financial flows, including government taxation and domestic/international transfers. Many of the agent-based policy levers are available in the structure (such as governmental spending and transfers).

$$\mathrm{GDP}_r = \mathrm{MFP} \times K_r^{\alpha} \times \mathrm{LAB}_r^{\beta}$$

where, GDP, gross domestic product; *K*, capital stock; LAB, labor; MFP, multifactor productivity, and MFP is a function of many variables, see Figure 5.

Forecasting Distribution

If the forecasting of economic growth is very difficult, the forecasting of income distribution is even harder. Many users of the IFs model prefer to specify changes in the Gini coefficient over time exogenously rather than to rely on its endogenous computations. Scenarios with respect to distribution-neutral futures versus either more egalitarian or less egalitarian futures should be a mainstay of analysis.

The Worlds of 2050: Framing Uncertainty

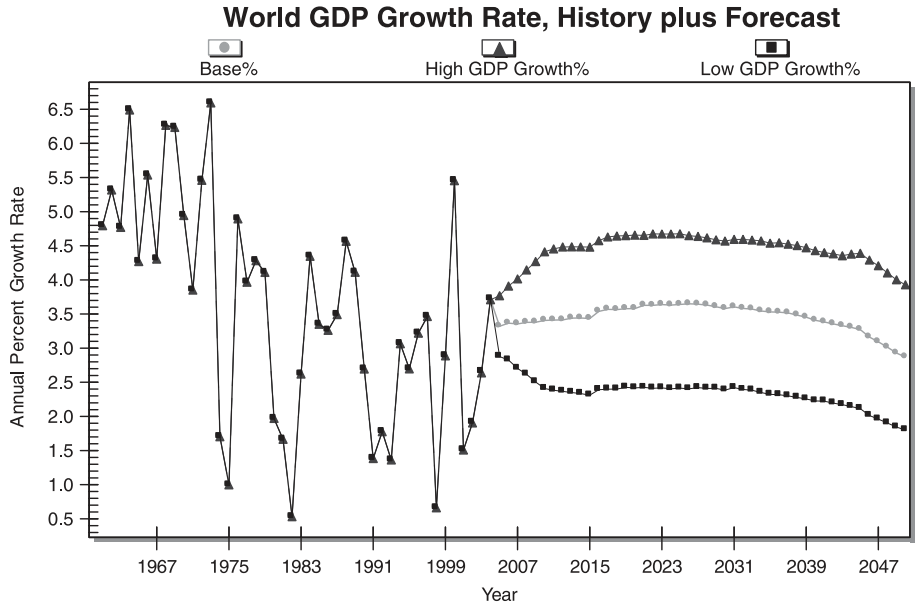
Two general categories of uncertainty affect forecasts of global poverty. The first involves formulations, as described in the last section (what drives poverty levels); the second involves the future of the drivers. This section builds a frame for a picture of possible futures of poverty. It does so by examining across the formulations the likely range of the proximate drivers of poverty and therefore the likely rough borders of change in poverty levels. The next section moves to painting a picture to fit into that frame, honing in on the nature of possible human interventions.

There are three frame-building population forecasts of the IFs model. The middle case is the Base Case of IFs. The Base Case is *not* a ''business as usual'' extrapolation as base or reference cases are sometimes labeled. Instead, it is a full scenario in itself, reflecting the unfolding not just of trends but of dynamic relationships in the model. The interventions made to create the high and low population forecasts were simple variations on the endogenous fertility rate forecasts of the Base Case, scaled so as to create something quite close to the well–known UN population forecasts. To put the forecasts in context, the 2006 Revision of the UN's *World Population Prospects* provided high, medium, and low forecasts with values in 2050 of 10.7 billion, 9.1 billion, and 7.7 billion, respectively. Values from IFs for 2050 are quite close to those (10.5, 9.2, and 7.9).

All three cases show considerable drops in poverty. The variations in rates by 2015 are not great—in all three population forecasts about 10–11% of world citizens still live in poverty using the log-normal formulation. Variations across the three population cases are more substantial by 2050. Using the cross-sectional formulation, the rate of poverty also drops in all three population scenarios, but not nearly as much.

There are also three frame-building forecasts of economic growth (see Figure 4).[9] The middle case is the Base Case of IFs, a global growth rate of

[9]Figure 5 shows GDP at market exchange rates in order to provide a long historic series. IFs also calculates GDP at purchasing power parity (PPP) and uses that for its poverty forecasting.



Source: IFs Version 5.29

Fig. 4. World Economic Growth across Three Scenarios

about 3.3%, which is quite close to World Bank forecasts (see Hughes 2006 for comparison of IFs forecasts with many others and for a more general validation discussion). The interventions made to create the high and low economic forecasts were simple variations on the MFP forecasts of the Base Case, scaled so as to create something close to rates of GDP growth 1% faster or slower than those in the Base Case.

To provide some additional historic context for the long-term forecasts, Angus Maddison (2001:126; see also Maddison 1995) estimated that the world economy grew at a rate of 1.6% from 1820 to 1950, at 3% between 1973 and 1998, and at 4.9% during the ''Golden Age'' for the world economy from 1950 to 1973. In general, the growth rate of the world economy has quite steadily accelerated since the beginning of the industrial revolution. The great surge from 1950 to 1973 and the fall-off thereafter, however, add uncertainty to forecasting in the twenty-first century.

The forecasts in this essay for the first half of the twenty-first century are scenarios for a period in which population growth rates are expected to continue a fairly substantial decline across all scenarios, in contrast to the history of most of the twentieth century, which included a rapid rise, peaking, and then some important initial decline in population growth rates. Economic growth rates like those of the Golden Age, involving catch-up after World War II and global peak population growth rates, fall outside of our forecast range.

Forecasts of income distribution within IFs are not strong enough to carry much weight in the framing analysis of future poverty levels. This is not a criticism of IFs relative to other forecasting efforts, but rather an absolute statement because there simply are not useful forecasts of domestic income distributions on a global basis. Ahluwalia et al. (1979) attempted to create distributional forecasts by relying upon the inverted-U of the Kuznets Curve. Longitudinal analysis and even more recent cross-sectional work have, however, largely discredited that pattern. More recent studies have not found a strong alternative foundation for forecasting of Gini coefficients or other distributional measures.

The Base Case forecast in IFs produces a fairly flat global average of income distributions across the countries of the world, with a very slight increase of inequality in early years because population weighting is used for the global computation and the population grows more rapidly in countries with less equal distributions. In both framing cases, exogenous changes in domestic distributions enter gradually over the entire 50-year period, shifting initial Gini coefficients upward or downward by 15%. As with scenarios around population change and economic growth, the intent is to provide reasonable outer boundaries for expectations in the first half of the century. Alternative scenarios of inequality make about a 3% difference in global poverty rates by 2050, very considerably less than do alternative GDP growth rate scenarios. The size of the pie is more important to extreme poverty in the longer run than is its distribution.

Completing the framing of implications for poverty reduction of the proximate drivers requires attention to the combined impact of the drivers. Two more complex cases were created to allow for that focus. The first is a Worst Case scenario of high population, low economic growth, and deteriorating distribution. The second is a Best Case scenario of low population, high economic growth, and improving distribution.

The Worst Case with the cross-sectional formulation actually increases the absolute number of humans in poverty by mid-century. In the best-case scenario, both cross-sectional and log-normal formulations suggest that extreme poverty could be nearly eliminated by mid-century. Remember that extreme poverty kills through malnutrition and bad health, so that is a remarkable prospect. At the same time, remember that crawling out of that condition requires only an income of $1/day, hardly suggesting that the world's poor would be doing very well in absolute terms.

By 2015 the difference in poverty rates between Best and Worst Cases with the log-normal formulation (see Table 2) is about 7%, approximating the difference between the two formulations in the Base Case in 2015. By 2050 the difference in poverty rates between the two cases is about 16% and the difference in the formulations is much less.

Use of wide ranges of proximate drivers to explore the rough outer limits of poverty futures should help shape our expectations for the more detailed and focused exploration of human leverage in the next section. Among the most important findings of the framing analysis are:

- Forecasting formulation is, indeed, very important. Uncertainties related to formulation are especially critical in the period up to 2015 when the first MDG calls for a 50% reduction in the global poverty rate. Over that period the uncertainties are comparable to what appears to be the outer range of human leverage.

Table 2. Poverty Head Counts and Rates across Combined Framing Scenarios

	Worst case		Base case		Best case	
Non-OECD	2015	2050	2015	2050	2015	2050
Poverty numbers (millions)						
Log-Normal	824	1,500	630	298	362	11
Cross-Sectional	1,135	1,711	1,004	588	786	127
Poverty rates (%)						
Log-Normal	13.6	16.1	10.5	3.8	6.2	0.2
Cross-Sectional	18.7	18.3	16.8	7.4	13.5	1.9

Source: IFs Version 5.29.

- In spite of great uncertainty, there appears to be a considerably higher probability that both numbers in poverty and rates of poverty will fall than that they will rise. The exception to this generalization is Sub-Saharan Africa, where it appears most likely that numbers will rise and rates will fall (results shown in the next section).
- It appears that the reductions in poverty that are likely as a result of population growth, economic growth, and income distribution patterns in the base forecast will reduce poverty globally to something near the poverty target by 2015 and by somewhat less than another factor of two by 2050. Poverty will become progressively harder to reduce.
- It is critical to remember that much of anticipated reduction in the Base Case is a direct result of a wide range of policy initiatives already underway to improve the economies of countries around the world and to target the poorest of the world with education, family planning, health initiatives, micro-credit, and much more. The maintenance of such programs is an essential foundation for additional and accelerated progress.
- Given that each of the proximate drivers identified is subject to considerable human influence via collective and conscious action, humanity does have much incremental discretionary control over poverty levels and rates. Yet, because conscious human action is unlikely to cause swings in the combined proximate drivers nearly as large as the ranges selected for them in this framing discussion, it is likely that human influence on poverty rates will be considerably less.
- Depending on the forecasting formulation and the year, reductions of the poverty rate relative to the Base Case could mean by 2050 the lifting of 280–450 million more people out of extreme poverty, the ''poverty that kills.''

The Worlds of 2050: Strategic Interventions

The last section framed, using proximate drivers, the probable maximum incremental leverage we have in reducing poverty. The purpose of the present section is to explore the choices that might most effectively exercise some or most of that discretionary leverage.

Mapping the Levers

It is useful to divide deeper drivers and levers for action into domestic and international subcategories. Figure 5 illustrates the manner in which the identification of potential drivers was undertaken and tied simultaneously to the structures of IFs for the investigation of those drivers. With respect to the internal drivers of economic growth, the analysis builds on three immediate ones, namely, supplies of labor, production capital, and MFP (see the earlier Cobb–Douglas formulation). The figure elaborates the key MFP term, initially by dividing it into five types of capital (excluding the traditional financial capital category, which is combined with MFP in the Cobb–Douglas production function): human capital, social capital, infrastructure capital, natural capital, and what might be called the stock of knowledge or knowledge capital. They, in turn, have drivers of them, the deeper drivers of interest to us in this analysis.

More general analysis, also looking at the external environment, produced the listings of deeper drivers in Tables 3 and 4. Those by no means exhaust the possible points of intervention in order to accelerate reductions in poverty rates. They do, however, touch on most of those that development experts have

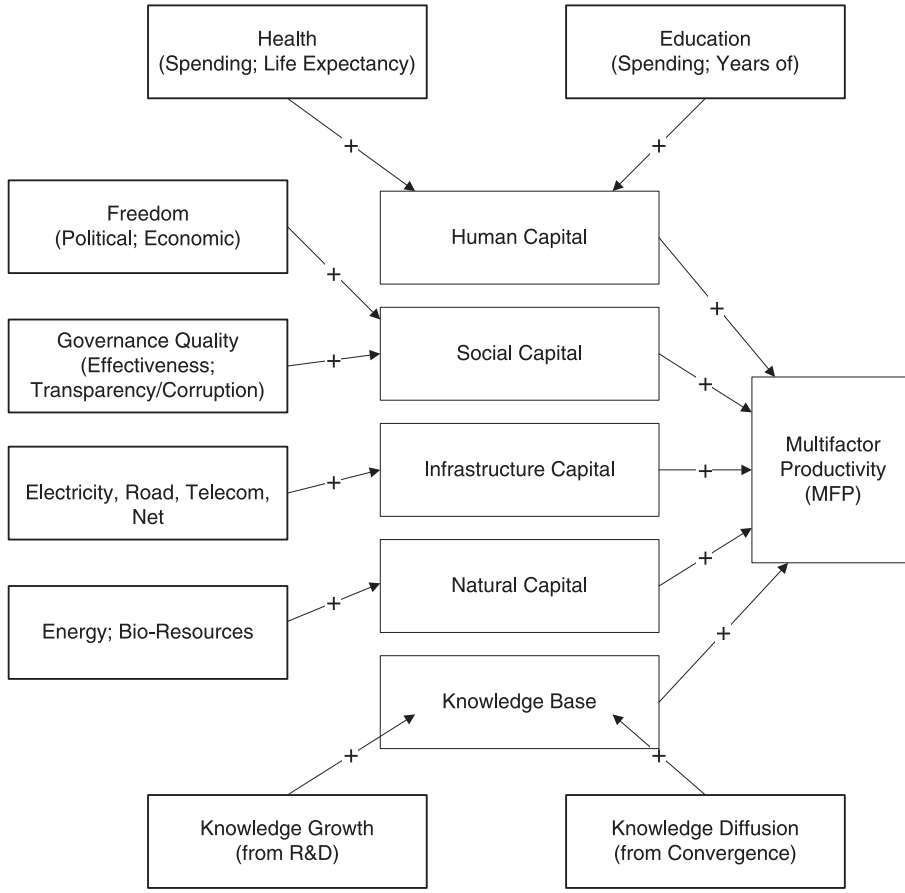


Fig. 5. Deeper Drivers of Economic Productivity in IFs

identified. As Archimedes pointed out long ago, however, not all levers are the same length and some might have the potential to move the world.

Silver Bullets?

In the fight against poverty, there is a search for silver bullets (as world-moving levers are often labeled in policy analysis). Identification of prospective silver bullets changes over time and across philosophical viewpoints. In recent years the two most prominent candidates, in addition to the classic of trade and financial flow liberalization, tend to be (1) improved governance (by which is generally meant some combination of reduction of corruption, protection of property rights, and liberalization of markets) and (2) increased and more effective foreign aid (given considerable attention in the Millennium Project's recommendations for meeting the MDGs).

Table 3 shows the individual impact forecast by IFs of many of these domestic leverage points. The log-normal formulation was used for the table and the Base Case is shown for comparison. The results of the cross-sectional formulation are not shown, but earlier discussion showed that it would provide higher forecasts.

In interpreting Table 3, it is essential to remember once again the first rule of forecasting based on models: always distrust the results. Models are

TABLE 3. Internal Levers Explored: Log-Normal Formulation

Scenarios	Developing 2015	SS Africa 2015	S Asia 2015	Developing 2050	SS Africa 2050	S Asia 2050
Extreme poverty (millions)						
Base Case	633	258	235	298	246	25
Fertility Reduction	627	252	235	221	169	25
High Fem Labor	633	258	235	298	246	24
High Investment	661	273	245	304	258	20
High Education	630	257	234	280	230	23
High Health Exp	632	258	235	289	240	23
High Government Effect	622	256	230	274	230	21
Low Corruption	631	258	234	273	227	22
High Econ Free	630	257	233	283	236	22
High Infrastructure	632	258	235	285	236	24
High Renewable	633	258	235	295	244	24
High R&D	632	258	234	299	248	24
Low Protection	630	258	231	300	252	21
High Transfers	614	243	235	255	207	25
All Domestic Combined	610	248	231	94	74	9
Extreme poverty (%)						
Base Case	10.3	27.9	13.9	3.7	14.0	1.1
Fertility Reduction	10.2	27.7	13.9	2.8	12.0	1.1
High Fem Labor	10.3	27.9	13.9	3.7	14.0	1.1
High Investment	10.7	29.5	14.5	3.7	15.0	0.9
High Education	10.2	27.8	13.9	3.5	13.2	1.0
High Health Exp	10.2	27.9	13.9	3.5	13.6	1.0
High Government Effect	10.1	27.7	13.6	3.4	13.2	0.9
Low Corruption	10.2	27.9	13.9	3.4	13.0	1.0
High Econ Free	10.2	27.8	13.8	3.5	13.5	1.0
High Infrastructure	10.3	27.9	13.9	3.5	13.5	1.0
High Renewable	10.3	27.9	13.9	3.6	13.9	1.1
High R&D	10.2	27.9	13.9	3.7	14.2	1.1
Low Protection	10.2	27.9	13.7	3.7	14.4	0.9
High Transfers	9.9	26.3	13.9	3.1	11.8	1.1
All Domestic Combined	9.9	27.2	13.7	1.2	5.3	0.4

Source: IFs Version 5.29.

oversimplifications of reality, sometimes brutally so. IFs is intended to collect and synthesize a considerable portion of the collective knowledge of a wide range of experts and to tie that knowledge to data and theory. Within these limits the analysis of individual and combined domestic interventions supports several conclusions.

First, the incremental leverage available for poverty reduction by 2015 (relative to the Base Case, which builds in much action already underway) is quite limited. There is, at least when interventions are combined, however, some quite significant leverage for policies by 2050. On a global basis perhaps 200 million fewer people would live in extreme poverty with a combined package of incremental domestic interventions than without such interventions. What this pattern suggests, though, is that as important as the focus of the MDGs on 2015 may be, policy analysis must take a longer time horizon.

Second, there appear to be no silver bullet to reduce poverty among the set of interventions examined. Almost all of the interventions make some contribution to that goal, but the reductions associated with each of them individually are fairly modest.

TABLE 4. External Levers Explored: Log-Normal Formulation

Scenario	Developing 2015	SS Africa 2015	S Asia 2015	Developing 2050	SS Africa 2050	S Asia 2050
Extreme poverty (millions)						
Base Case	633	258	235	298	246	25
High Trade	629	259	232	282	236	21
Export Promotion	628	258	230	296	246	22
High FDI	635	257	237	282	231	24
High Portfolio	633	258	235	298	246	25
High Remittances	629	257	232	287	237	23
High Foreign Aid	621	248	235	234	186	22
High IFI Flows	633	258	235	287	235	24
High Tech Transfer	623	255	230	266	223	20
Combined Intl	605	248	222	160	130	12
Extreme poverty (%)						
Base Case	10.3	27.9	13.9	3.7	14.0	1.1
High Trade	10.2	28.0	13.7	3.5	13.5	0.9
Export Promotion	10.2	27.9	13.6	3.6	14.1	1.0
High FDI	10.3	27.7	14.0	3.5	13.2	1.1
High Portfolio	10.3	27.9	13.9	3.7	14.0	1.1
High Remittances	10.2	27.8	13.8	3.6	13.6	1.0
High Foreign Aid	10.1	26.7	13.9	2.9	10.7	1.0
High IFI Flows	10.3	27.9	13.9	3.5	13.4	1.1
High Tech Transfer	10.1	27.6	13.6	3.3	12.8	0.9
Combined Intl	9.8	26.8	13.1	2.0	7.6	0.5

Source: IFs Version 5.29.

Third, direct transfers to the poor are among the most effective single measures, and perhaps the only one that makes a really significant contribution by 2015. By 2050, however, other interventions are as important or more so. Upon reflection, this temporal pattern makes perfect sense—in the shorter-run it is difficult to change the size of the pie; in the longer-run doing so has a larger effect than does its division. This finding suggests the importance of exploring further the time paths of the effects of interventions. For instance, according to the log-normal formulation, higher saving and investment actually have a detrimental impact, squeezing the consumption of the poor. In analyses of quicker and lesser rises in investment rates, that negative impact turns significantly positive over time. Because the intervention of Table 5 (see below) continues to ramp up investment over a long period, however, such a cross-over pattern does not emerge.

These time-dependent patterns reinforce the argument for a twin-track approach to pursuit of the MDG targets, as was proposed by the UN Food and

TABLE 5. Combined Levers Explored: Log-Normal Formulation

Scenario	Developing 2015	SS Africa 2015	S Asia 2015	Developing 2050	SS Africa 2050	S Asia 2050
Extreme poverty (millions) using log-normal formulation						
Base Case	633	258	235	298	246	25
Domestic and International	573	229	218	50	38	5
Extreme poverty (%) using log-normal formulation						
Base Case	10.3	27.9	13.9	3.7	14.0	1.1
Domestic and International	9.3	25.1	12.9	0.6	2.8	0.2

Source: IFs Version 5.29.

Agricultural Organization and the World Food Program at the 2002 Monterrey conference on development financing (United Nations Food and Agriculture Organization 2005). The first track focuses on growth in the productivity and longer-term income of the poor; the second track creates social safety nets and provides direct food and other basic assistance to the poor. Some external assistance might be useful or necessary in the interim in order to help pay some of the costs of long-term investments of various kinds.

Fourth, in spite of limited geographic differentiation in Table 3, there is some evidence of differential contributions of interventions to different regions. For instance, by 2050 using the log-normal formulation, the high R&D intervention reduces poverty for South Asia, but increases it in Sub-Saharan Africa. Africa may not have the resources to use such a targeted strategy without greater damage elsewhere. Development experts have long known that one size does not fit all with respect to development policies.

As with domestically focused interventions, internationally oriented ones may have important synergies and trade-offs. For instance, there is a logic around the globalization process that says that many interventions are likely to cluster together. Table 4 presents the forecasts for each individual international intervention and their combination, using the log-normal formulation.

An examination of the table leads to conclusions very similar to those drawn from analysis of domestic interventions. First, leverage available for poverty reduction by 2015 is very limited. With the partial exception of higher foreign aid, which provides immediate resources for recipient societies, none of the interventions significantly reduce poverty by 2015. The model may even exaggerate the impact of foreign aid somewhat, because it is not clear how much of such aid would flow to the poorest. The model adds aid to GDP and to income and therefore raises average income and reduces poverty. That model's pass-through to the poor as well as the rich is by no means certain in the real world.

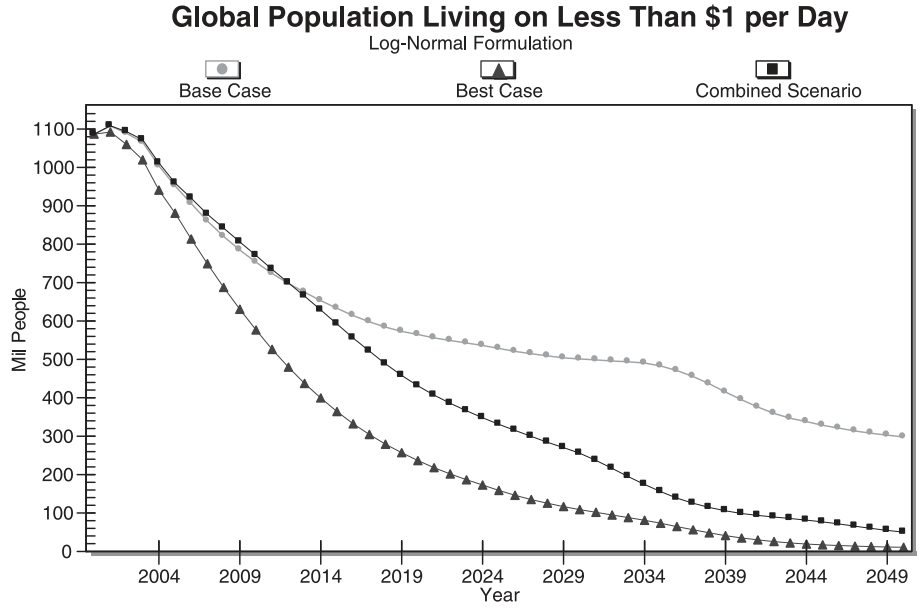
Second, there is again quite significant leverage for policies by 2050. The combined impact could be a reduction in global poverty of about 140 million people.

Third, there still appear to be no silver bullets. In contrast with the domestic interventions, however, there is one clear leader in overall magnitude of impact both by 2015 and in 2050. That is significantly increased foreign aid. And there is a second intervention with very substantial and generally comparable impact by 2050, namely the greater availability of technology. In reality, both fail to be convincing silver bullets—foreign aid because the model does not represent well some of the negative or distorting impacts of it socio-politically (although the model does capture Dutch disease implications); technology because the model does not parcel out its presumed greater availability to the true deeper drivers, such as greater FDI inflows and even the skills that might return with the same temporary immigrants who send home remittances.

Intervention Packages

With a rough map of the impact of individual interventions and of domestic and international packages of them, the next obvious step is to search for more strategic packages that maximize the potential for reducing poverty. The easiest first step is simply to combine the population, domestic, and international interventions explored in the last section. Table 5 does that.

One quite remarkable thing about combining the interventions is that there appear again to be as many or more additive effects (perhaps even some synergies) as trade-offs, particularly in the impact on poverty forecasts for 2015. That is, the reduction in number of poor brought about by the simultaneous introduction of all interventions into the simulation is closer to the sum of the



Source: IFs Version 5.29

FIG. 6. Numbers Living in Extreme Poverty

reductions from individual packages than to even the largest reductions of the individual packages (the latter would imply overlapping effects or trade-offs across interventions).

This finding provides some independent support for the approach advocated by the Millennium Project under the leadership of Jeffrey Sachs. The plan proposed by that large team was not labeled ''Big Push'' by the writers of the report, but it is, in fact, an exemplar of that development strategy and is an aggregation similar in many ways to the Combined Intervention (CI) Scenario.

Why might there be synergies and what are they? The most obvious and important one is that many of the interventions support economic growth. With economic growth relative to the Base Case, almost all interventions are taking place on a higher base. For instance, educational and health expenditures rise with GDP, so an incremental percentage rise in a society already growing faster as a result of FDI or foreign aid will work from a higher base and have even greater effect.

How well does the CI Scenario do in reducing poverty? The last section framed this analysis of poverty by exploring what appear to be the outer limits of human potential to accelerate poverty reduction. It did so by creating a ''Best Case'' scenario (as well as a Worst Case) by direct manipulation of the proximate drivers of poverty. Figure 6 shows the total number living in extreme poverty in the Base Case, the Best Case, and the CI Scenario.

The CI Scenario reduces poverty considerably relative to the Base Case, pulling 300 million people out of extreme poverty by 2035 (250 million by 2050 as the numbers in the Base Case continue to decline). Not surprisingly, the CI Scenario does not do as well as the Best Case, which was framed using costless assumptions about changed economic and population growth and redistributed economic well-being. In contrast, the CI Scenario was built upward from large numbers of individual interventions, many of which do have real costs. As we have seen, for example, increases in savings and investment can actually reduce consumption and increase poverty in the short run. Thus, it is quite impressive

how well the CI Scenario does over the longer term. The intelligent packaging of scenarios does offer the opportunity to tackle poverty forcefully enough to push results toward outer boundaries for reasonable expectations.

Something like the CI Scenario is unlikely, however, for two related reasons. First, the full set of interventions would be very expensive. Although the costs to achieve the scenario would almost certainly be less expensive than the costs of continued poverty and lives lost, costs and benefits are seldom distributed across populations in the same fashion on any policy. No matter how much economists talk about Pareto-superiority after compensatory transfers, those asked to pay on the front end for benefits that quite obviously accrue primarily to others reasonably raise doubts about the contributors ever receiving such compensation. Second, development as a field has always been subject to arguments about the relative merits of various philosophical tendencies, and different strategic orientations have had prominence over time and retained considerable support.

Are there specific proposals that, perhaps by different combinations of the interventions and strategic orientations examined in this essay, could do better than any of them individually and perhaps prove superior to the simple CI Scenario detailed earlier? Almost certainly there are. Experiments have been started, for example, to link the Computer Assisted Reasoning System of RAND and Evolving Logic (Popper, Lempert, and Bankes 2005) with IFs and to explore the space of interventions much more deeply and systematically.

How does the CI Scenario stack up against combinations of proposals already on the table? For example, the Practical Plan of the Millennium Project (2005) identified many of the same interventions that this analysis has explored.[10] There are, however, inherent differences between the structures of such plans and the structure of the analysis undertaken here that make true comparison difficult. With respect to extensive development proposals, many such plans are not fully concrete with respect to the magnitude and timing of the interventions proposed. And a model like IFs necessarily works at a more macro level than proposals that typically come out of extended development analysis. These differences make the two approaches to exploring packages to reduce poverty complementary rather than strictly comparable.

Next Steps

There is a great deal that needs to be done to complete this analysis of strategies to reduce global poverty. Among the most important continuing efforts in the larger project are:

Examining Impact of Interventions on Alternative Poverty Measures

Alternative poverty lines, such as $5/day are likely before long to supplement the current $2/day measure for ''moderate poverty'' and the $1 measure for ''extreme poverty.'' Most important, in the spirit of Sen (2000), capabilities measures such as those of education and health as well as the human development index must be added to the analysis. Most of these alternative measures are available within IFs and will be explored.

[10]There is at least one key intervention that the Millennium Project did not highlight, but that proved important here, especially for absolute numbers of the poor. Family planning and associated population growth reduction can be very important in reducing poverty levels in Sub-Saharan Africa by 2050. *The Practical Plan* did heavily emphasize rebuilding and strengthening networks of public health clinics, in part for the maternal care that does tend to reduce fertility rates. Yet the plan never really emphasized family planning's importance in its own right.

Drilling Down Geographically and Socially

Poverty in East and West Africa are quite different, as are, of course, poverty in India and Pakistan. Further, the interior of China and the coastline vary dramatically, as do rural and urban areas almost everywhere in the world. The larger project intends a country-level analysis with respect to both interventions and results, but will be harder pressed to look inside countries between, say, rural and urban areas because of the limitations in current analysis tools.

Synthesizing Development Strategies

The project has begun to combine the individual interventions explored in this essay into clusters, including (1) domestic self-help, (2) outward, open orientation, and (3) foreign assistance (including access to technology as well as foreign aid). Preliminary analysis suggests that each strategic cluster has positive, but quite different, implications for poverty reduction.

The continuing hope underlying this analysis is that some of the insights can augment efforts like that of the Millennium Project to address the scourge of global poverty.

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