



## Tools for Exploring the Future of Global Poverty

If poverty can be reliably defined and measured, and if the historical path of change in the incidence of global poverty can be reliably assessed, there is a basis for attempting to anticipate and then to influence poverty levels in the future. In spite of the debates over concepts, measurement, and analysis sketched in the preceding chapters, we understand the breadth and depth of global poverty and the dynamics of progress in its reduction better now than we did in past decades. Thus, even though a knowledge basis for exploring the future of poverty remains a bit shaky, it exists. In this chapter we review the tools developed for such exploration and the insights generated with them. We also sketch the tools that this volume brings to the effort.

Thinking about the future can and often does begin with a first step of simple **extrapolation**, helping us extend existing trajectories of change and anticipate where they might be taking us. Yet, if it is to be useful in the evaluation of

alternative intervention options, **forecasting** (see Box 4.1) must fairly quickly move beyond univariate extrapolation into causal analysis. Much analysis of poverty has taken this second step into causal analysis, the examination of the dynamics also of the proximate drivers identified in Chapter 3 (economic growth, income distribution, and population) so as to develop more sophisticated econometric forecasts. These forecasts often rely on multivariate equations linking the proximate drivers to the poverty level.

Such forecasts are helpful, but analysts and policy makers want to take still another step, into consideration of the deep drivers of these proximate drivers, so as to come closer to understanding poverty at the level of human agency and in order to examine potential levers for policy intervention. The deep drivers often interact with each other and the proximate drivers in a complex fashion, requiring considerably more elaborate causal modeling. This third step is at the frontier of

● *The concept of, measurement of, and analytical foundations for forecasting poverty have improved considerably.* ●

### Box 4.1 Terminology around forecasting

**Forecasting** is commonly understood to be estimating or calculating something in advance, and in this book we use the term in that sense. Everyday language often uses **prediction** as a synonym for forecast, but we avoid doing so because prediction implies that the predictor believes a specific outcome will be true. In contrast, those who forecast behavior of complex social systems commonly believe that any given forecast has a significant probability of being incorrect. Forecasters instead describe possible outcomes or futures. Forecasters often, for example, talk about alternative **scenarios** or stories of the future, sometimes purely qualitative and sometimes heavily quantitative in character.

Some analysts, especially economists, tend to restrict the meaning of forecasting

to the use of quantitative tools, such as multivariate equations estimated from data and presented with information about the errors of that estimation. That approach means that univariate extrapolations may not be considered forecasts, contradicting common usage. Similarly, economists tend to call the results of large-scale models like IFs “simulations,” limiting the use of the term “forecasts” to results produced with single multivariate equations, again contrary to broader usage.

In this book, we generally make clear the origins of what we label as forecasts, but we also use the term comprehensively in discussing alternative estimates for the future of poverty, whether they come from extrapolation, single multivariate equations, or complex computer simulations.

poverty forecasting and analysis and is the purpose for this book. To accomplish this goal, we use dynamic computer simulation modeling of poverty and poverty reduction. In this chapter we therefore consider the desirable characteristics of such simulation modeling and the tools available to us.

#### Foundational Forecasting

Just as Montek S. Ahluwalia, Nicholas Carter, and Hollis Chenery (1979) were leaders in establishing a measure of poverty linked to purchasing power parity (PPP) and therefore comparable across multiple societies (see Chapter 2), they were pathbreakers in the forecasting of poverty levels. Table 4.1 is from their work. The analysis suffered from the absence of information at that time from China but otherwise covered most of the world’s population.

● Ahluwalia, Carter, and Chenery helped lay a strong foundation for forecasting. ●

**Table 4.1 Forecasts of poverty rates for 2000 produced in 1979**

	ACC	ACC	ACC forecasts for 2000		IFs
	1960 estimates	1975 estimates	Historical trend	Base case	2000 calculations
Low income	61.7	50.7	29.5	22.4	18.7
Middle income	49.2	31.0	11.4	14.2	20.4
High income	24.9	12.6	5.4	4.0	7.7
<b>All LDCs</b>	<b>50.9</b>	<b>38.0</b>	<b>20.2</b>	<b>16.3</b>	<b>16.5</b>

Note: ACC refers to Ahluwalia, Carter, and Chenery; IFs, International Futures; LDCs, less developed countries.

Sources: Ahluwalia, Carter, and Chenery 1979: Table 3; IFs Version 5.4.7.

The authors computed that the portion of populations that they defined as poor in less developed countries other than China had fallen from 50.9 percent in 1960 to 38.0 percent in 1975. Relying only on extrapolation, they foresaw that the poor in their country set would fall to 20.2 percent of population in 2000. 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 (using the then-popular Kuznets curve to anticipate change in distribution), they expected that the number of poor would decline even more in their more dynamic base case, falling to 16.3 percent in 2000.

The forecasts of Ahluwalia, Carter, and Chenery (ACC) for the year 2000 were remarkably prescient, not only in direction of change but even in general order of magnitude. Clearly the poverty measure used by ACC was not identical to the contemporary extreme poverty measure; our analysis estimates their poverty line to have been about \$.81 rather than \$1.08.<sup>1</sup> Using IFs calculations (based on data from the World Bank) for those living on less than \$.81 and looking at the set of countries they examined, the percentage of population at that level in 2000 was 16.5 percent. The forecasts for specific income groups did not prove quite as successful, but still proved remarkably good. Their biggest error was in the middle income category, into which they placed Nigeria. Because of its demographic size and abysmal performance in poverty reduction (Chapter 8 will explore that further), the ACC middle income group actually now has a slightly higher poverty rate than does their low income group.

The ACC study took one additional important analytic step by examining the likely impact on poverty levels of alternative assumptions about their three proximate drivers: population growth rate, mean income, and income distribution. Specifically, they looked at the possible impact of reduced population growth (the low UN estimate for their countries was 1.97 billion, versus 2.21 billion in the base case), of accelerated income growth (1 percent higher than in their base case), and improved income distribution (45 percent higher income for the bottom 60 percent, at a cost of 0.5 percent in overall economic

growth). These changes in assumptions reduced their forecasts of poverty rates in 2000 for all less developed countries to 14.9 percent, 11.5 percent, and 10.5 percent, respectively. They calculated that were all three changes possible, poverty rates would fall to 8.1 percent.

Their alternative forecasts were clearly overly optimistic and contain a lesson for us today: it is not easy to change the underlying trajectory of growth and poverty reduction. Although their simulation methods did not allow ACC to pursue the more extensive, policy lever-based analysis they suggested, the ACC study also identified many of the key deep drivers that are of interest to the current study (see, again, Figure 3.4). Their foundational work was remarkably innovative.

### Contemporary Forecasting and Simulation

Somewhat surprisingly, forecasting of poverty futures was mostly interrupted for two decades

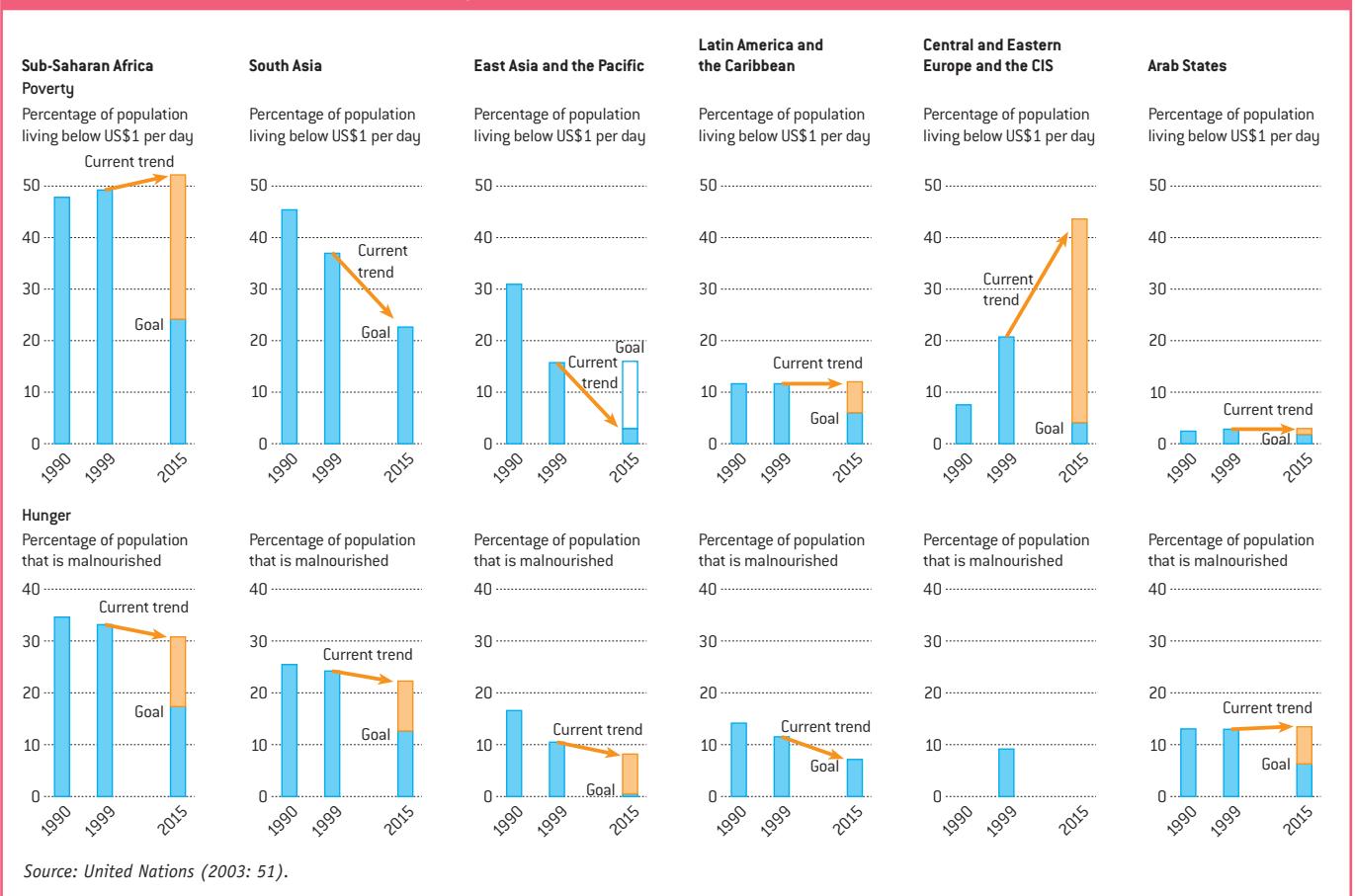
following the work of ACC. In the interim, analysts devoted attention to the refinement of poverty concepts and measures, as described in Chapter 2. Moreover, the UN and the World Bank have resumed forecasting.

### The UN Development Programme (UNDP)

The declaration of the Millennium Development Goals (MDGs) pushed analysts into attempting to anticipate progress toward them. In one of the first recent steps, the UNDP's *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 move toward accomplishing the goals by 2015.<sup>2</sup> Figure 4.1 shows the results with respect to the two most widely used indicators on the first MDG.

Although extrapolations tend to be a best first step in most forecasting, their limitations are obvious. For instance, in Figure 4.1, it is

**Figure 4.1 Simple extrapolations of poverty trends relative to the first MDG**



**Table 4.2 Forecasts of poverty head count in 2015 (millions)**

	Dikhanov values and forecasts				World Bank
	1970	1990	2000	2015	2015
World	1,409	1,355	1,172	689	624
Latin America	43	43	43	37	34
East Asia	784	530	380	95	40
South Asia	427	494	325	92	217
Sub-Saharan Africa	145	267	288	430	290
Eastern and Central Europe	1	0	8	0	2

Note: Dikhanov used \$700 per year in 1999 PPP terms, declaring it to be approximately \$1 per day when adjusted from 1985 to 1999; thus the numbers were meant to be comparable.

Sources: Dikhanov 2005: 34; World Bank 2008: 46.

unbelievable that the reduction of poverty in East Asia and the Pacific will continue on a straight line to zero in 2015. Saturation effects will almost certainly preclude such an outcome. That is, assuming that poverty reduction continues, progress will become more difficult in pockets of chronic poverty within countries throughout the region. This point reinforces the facts that (1) representing the distributional characteristics of income, ideally within different population subgroups, is highly desirable in exploring the future of poverty; and (2) that forecasts should generally go beyond simple extrapolative techniques. Illustrating a different variation of the risks associated with simple extrapolation, given the increased economic growth of recent years, it is quite possible that the downward trajectory shown in Figure 4.1 for South Asia (primarily India) could accelerate. There have also been some signs in recent years of accelerated economic growth in sub-Saharan Africa, which could slow or reverse its upward trend in poverty rates.

In short, more sophisticated analysis must move at least to the key proximate drivers of poverty reduction. The Human Development Report Office has, in fact, done that. 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 manipulate the forecasting model, specifically by creating a pro-poor growth scenario.

Table 4.2 shows the Dikhanov report's 2015 forecast for regional and global poverty using UN population projections to 2015, economic

growth rates mostly at the 1990–2002 rates, and unchanged national income distributions. The economic analysis assumed that growth in Eastern and Central Europe would increase, so as to compensate for the 1990–2002 declines (Dikhanov 2005: 6). Further, the study struggled with many of the issues raised in Chapter 2 about measuring historical poverty levels, and among other decisions, it reduced the economic growth rate of China from official data by nearly 3 percent, using numbers from Angus Maddison (2001).

Table 4.2 also includes forecast values from the World Bank's *Global Economic Prospects 2008*. The global numbers are comparable for 2015, but Dikhanov forecast a much lower headcount for poverty in South Asia and a considerably higher count for Africa.

Dikhanov's pro-poor growth scenario assumed that the incomes of the population below \$700 at PPP would grow at twice the average rate of income growth. The assumption was a blunt manipulation of this proximate driver, clearly not tied to any particular intervention with respect to policy. The analysis calculated that it would take nine years to reduce global poverty to the MDG level in the pro-poor growth (PPG) scenario, compared to fifteen years in the distribution-neutral growth (DNG) scenario. The comparable numbers for Africa alone were twenty-two and more than thirty years. Thus the MDG for poverty would be met by 2015 in either case for the world as a whole, but in neither case for Africa.<sup>3</sup>

### **The World Bank**

Because freeing the world from poverty is central to the World Bank's mission and the Bank collects the data that map progress toward that goal, it is hardly surprising that the Bank has produced most poverty forecasts, beginning with those by ACC. The number of the Bank's forecasts is not large, however, and they do not contain a great deal of geographic detail.

Among the Bank's analyses on poverty and poverty reduction are two World Development Reports titled *Poverty* (1990) and *Attacking Poverty* (2000–2001). Table 4.3 contains poverty forecasts and two social forecasts from the 1990 volume. In each case the table shows data for 1985 (as understood in 1990), a forecast to 2000, and data for 2000.

**Table 4.3 World Bank poverty and social forecasts for 2000 compared with data**

	Number of poor (millions)			Net primary school enrollment Percentage			Under 5 mortality (per thousand)		
	1985	2000	2000 data	1985	2000	2000 data	1985	2000	2000 data
Sub-Saharan Africa	180	265	291	56	86	59	185	136	170
East Asia	280	70	274	96	100	96	54	31	43
China	210	35	209	93	95	99	44	25	41
South Asia	525	365	484	74	88	85	150	98	97
India	420	255	359	81	96	89	148	94	94
Eastern Europe	5	5	21	90	92	88	25	16	32
Middle East, North Africa, Other Europe	60	60	13	75	94	88	119	71	55
Latin America and the Caribbean	75	60	52	92	100	89	75	52	34
<b>Total</b>	<b>1,125</b>	<b>825</b>	<b>1,104</b>	<b>84</b>	<b>91</b>	<b>87</b>	<b>102</b>	<b>67</b>	<b>73</b>

Source: World Bank 1990: 139; IFs Version 5.47 (for data).

The poverty forecast, rooted in a quantitatively informed but primarily qualitative analysis, anticipated that extreme poverty in the developing world would fall to 18 percent in 2000, leaving 825 million living on less than \$1. Building on the most recent World Bank surveys, we calculate the actual rate for the set of countries that the Bank now defines as developing to have been 21.5 percent in 2000, for a total of 1,104 million. The bank's forecast set proved to be somewhat optimistic, suggesting a reason for conservatism with respect to poverty forecasts.

Chapter 2 emphasized, however, that poverty is much more than a matter of income and certainly cannot be captured only by a measure of those living on less than \$1 or \$2 per day. We should look also at capabilities and functioning, using forecasts of education, health, and measures of aggregate well-being such as the human development index to help broaden the perspective.

The World Bank analysis of 1990 also provided forecasts of net primary school enrollment and of under five mortality. The forecast of net primary enrollment also proved optimistic. According to data from the Bank's *World Development Indicators* (WDI), originally from the UN Educational, Scientific, and Cultural Organization (UNESCO), the population-weighted average of net primary enrollment for the same set of countries in 2000 proved to be 87 percent instead of the anticipated 91 percent. The

largest error was clearly for sub-Saharan Africa, where the value in 2000 was 59 percent instead of the forecast of 86 percent. The optimism, or inaccuracy, was partly a result of errors in the 1985 data. The IFs database, using more contemporary UNESCO-based numbers, suggests that the value for Africa in 1985 was actually 47 percent, not 56 percent.

Similarly, Table 4.3 suggests that forecasts for reduction of under five mortality rates were mostly too optimistic, although the error was less substantial than for the other two series. One interesting finding is that the Middle East and North Africa performed relatively well compared to expectations on all three variables, actually doing better than anticipated in two instances, as did Latin America. It clearly was Africa that primarily disappointed expectations.

The World Bank's 2000–2001 report, *Attacking Poverty*, did not forecast the number in poverty, presenting only a figure showing global progress from 1990 through 2000 toward the first seven MDGs in comparison with the paths needed to accomplish the goals. Forecasts are almost inevitably wrong, and the World Bank has understandably been cautious in making them.

Still, the need for forecasts is great. The Bank resumed making and publishing forecasts of global poverty in its annual series, *Global Economic Prospects*. Table 1.1 showed the full set of forecasts from its 2008 volume. Those forecasts suggest that the world as a whole will fairly easily meet the first MDG. The developing



■ **The World Bank's mission is poverty reduction, and it has a solid forecasting capability.** ■

world beyond China may fail to meet the goal, however, because sub-Saharan Africa will be short of the target.

The *Global Economic Prospects* series is annual, making it possible to obtain some sense of the evolution of World Bank forecasting over time (see Table 4.4). The forecasts in the 2000 volume extended only to 2008, so that a comparable forecast series extending through 2015 begins only with the 2001 volume. The table suggests that the World Bank's forecasts have changed relatively little over that seven-year period.<sup>4</sup> The biggest absolute swings have been in the forecasts for sub-Saharan Africa, with higher values forecast in 2003–2004 but lower ones in recent years as economic growth in the region accelerated.

The methodology has evolved somewhat over time.<sup>5</sup> Typically, the LINKAGE model (van der Mensbrugge 2005) provided gross domestic product (GDP) and consumption forecasts based on exogenous assumptions concerning demographics, savings, investment, and technological progress. The World Bank's poverty team combined the economic forecasts with their household surveys (represented by three-parameter Lorenz curves) to compute poverty headcounts for 2015. For the 2007 volume they assumed Gini coefficients to be constant over time, except for India and China; in the case of China they assumed both rural and urban Gini coefficients to

deteriorate 10 percent by 2015, accounting for the higher poverty forecast for China than in the 2006 volume of *Global Economic Prospects*. Forecasts in 2007 for 2030 did not use the same method, turning instead to forecasts of economic growth and income elasticities for poverty.<sup>6</sup>

The Bank's approach has sometimes used alternative scenarios related to specific deep drivers whose effect on the proximate drivers can be estimated. For instance, the theme of the 2006 volume was remittances and migration. Building on analysis of the effect of remittances on GDP, the formulation allowed an estimate of their impact on poverty headcount. The study calculated, for example, that for the countries with the highest remittances and highest poverty headcount, the impact of the remittances on the headcount rate could be as high as 20 percent.

### Weaknesses in Our Tools for Thinking About the Future of Poverty

With the World Bank, in particular, leading the way, the ability to forecast poverty rates has improved considerably. Because the forecasting approaches described above generally rely only on the proximate drivers of poverty, however, they do not facilitate extended policy-oriented analysis of poverty reduction.

The World Bank is hardly alone in struggling with such limitations. Deeper analysis, such as that which motivated the

**Table 4.4 Sequential World Bank forecasts of extreme poverty rates in 2015**

	2001	2002	2003	2004	2005	2006	2007	2008
East Asia and the Pacific	3.1	2.8	3.9	2.3	0.9	0.9	2.8	2.0
China			5.3	3.0	1.2	1.2	3.6	2.1
Rest of East Asia and Pacific	1.3	0.9	1.1	0.5	0.4	0.4	1.1	1.6
Europe and Central Asia	1.3	0.8	1.4	1.3	0.4	0.4	1.0	0.7
Latin America and the Caribbean	6.9	9.7	7.5	7.6	6.9	6.9	6.1	5.5
Middle East and North Africa	1.3	1.5	2.1	1.2	0.9	0.9	0.7	0.7
South Asia	17.7	16.7	15.7	16.4	12.8	12.8	16.2	15.1
Sub-Saharan Africa	39.5	39.3	46.0	42.3	38.4	38.4	37.4	31.4
<b>Total</b>	<b>12.6</b>	<b>12.3</b>	<b>13.3</b>	<b>12.5</b>	<b>10.2</b>	<b>10.2</b>	<b>11.8</b>	<b>10.2</b>
<b>Excluding China</b>	<b>15.0</b>	<b>14.8</b>	<b>15.7</b>	<b>15.4</b>	<b>12.9</b>	<b>14.2</b>	<b>14.2</b>	<b>12.6</b>

Source: World Bank, *Global Economic Prospects* (2008: 46; 2007: 60; 2006a: 9; 2005a: 21; 2004: 46; 2002: 30; 2001: 42). The 2004 volume also included *Global Economic Prospects forecasts for 2003*

authors of the UN Millennium Project (2005b), requires turning to deeper drivers. In order to develop and present *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals*, the authors needed to elaborate the causal drivers of economic growth and to explore leverage with respect to them (see, again, Figure 3.5). They relied heavily on their causal understandings in extended analysis, and as experts with respect to development, their mental models were very rich. In the course of elaborating their plan, they implicitly made forecasts with respect to the magnitude of possible changes in human capital, social capital, governance, knowledge capital, and other productivity-enhancing factors and the collective impact of the changes on economic growth. They also thought deeply about the causal implications of official development assistance for public budgets and for investments in human capital and other drivers of growth.

What the authors of the Millennium Project (2005b) could not do was quantitatively tie analyses of the future of poverty to their understandings of the global development system. As rich as their mental models were, they were not sufficiently well elaborated and formalized to allow detailed analysis. When the authors turned in Part 4 of *Investing in Development* 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 to match costs directly with benefits. They could not systematically investigate trade-offs, synergies, reinforcing, or perverse effects of their proposed interventions, nor could they explicitly address the many differences among the mental models of individual team members or the differences between the general approach of the team and other development experts.

In short, as much progress as the United Nations and the World Bank have made in understanding the foundations of poverty and thinking about alternative futures for it, there are substantial limitations in our forecasting capabilities. It would clearly be useful to have a more extensively elaborated model to serve as a thinking tool for such analysis. What might such a tool look like?

## Desired Model Structure and Capabilities

A simulation tool or toolkit that could be useful in analysis of trends in and options for poverty reduction would allow user manipulation of the three proximate drivers of poverty: economic growth, economic distribution, and population growth. It would be highly desirable, however, if each proximate driver were, in turn, linked explicitly to a substantial number of deep drivers. In the case of economic growth, endogenous growth theory looks not just at labor and capital deepening but at the advance of human capital (such as education and health), the quality of social capital and governance (including such aspects as social trust levels, lack of corruption, the definition and protection of property rights, and the quality of day-to-day policies), the sustainable use of natural capital, and the development and acquisition of knowledge (see, again, Figure 3.6).

In the case of economic distribution, the model should explicitly represent the various social agents, including government, households, firms, and nongovernmental organizations (NGOs). Households vary greatly across dimensions such as rural/urban, levels of education, and employment categories. Households also vary in terms of their membership in various socially excluded groups, sometimes defined in terms of ethnicity and other times in other ways (such as the scheduled castes in India). With respect to population, the ideal tool's endogenization should represent not just the stocks of age- and sex-specific cohorts, but the manner in which fertility and mortality change, in significant part as a result of economic growth and distributional change.

The overall system would rely heavily on data and be deeply rooted in theory. With respect to the latter, the theoretically based economic model would most likely be some form of dynamic general equilibrium model in which interagent flows are represented by a social accounting system to capture many of the distributional elements. The demographic model would be a dynamic cohort-component system. The system would be geographically rich, with separate representation of at least the larger developing countries (and ideally with division of the largest developing countries into

● Forecasting of poverty has overwhelmingly used proximate drivers and has seldom built on analysis of deep drivers. ●

subregions). The system and its data would be accessible to users, and its structures would be both transparent and open to change.

Even if such a tool did exist, analysts should be wary. There would be advantages: rich empirical models can facilitate explicit forecasts and can handle the calculations of secondary and tertiary effects that address trade-offs, synergies, and other effects; they can also 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 suffer from shortages of and inadequacies in data and theoretical understanding. 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 undiscovered errors in specification. In short, no one should ever take at face value the results of a formal, computerized simulation of development processes or the simulated results of human intervention—just as no one should ever take for granted the forecasts of those who base them on individualized and implicit mental models, whether simple or complex.

The motivating assumption behind this volume, however, is that explicit and formal computer models can contribute to thinking about strategies for poverty reduction, adding to and interacting with analyses based on more qualitative and expert judgment. Computer models are usually more explicit than mental models and more easily changed across runs or scenarios. Computer models often benefit from very extensive and up-to-date empirical information. They can enhance the ongoing dialogue about policy options, one in which refinements of mental models is also still an evolving process.

The next two sections will describe the computer simulation called International Futures (IFs), used for the analysis of poverty

reduction in this study. Although a complete system like the ideal one sketched above does not exist, the IFs model has a substantial number of the desired characteristics. The first of the two sections provides general information about IFs, and the second focuses on the manner in which it provides alternative simulations of future poverty levels.

## The International Futures Modeling System

International Futures is a large-scale integrated global modeling system representing 182 countries. Its broad purpose is to serve as a thinking tool for the analysis of near-term through long-term country-specific, regional, and global futures across multiple, interacting issue areas. IFs allows variable time horizons for exploring human leverage with respect to the pursuit of key goals in the face of great uncertainty.

Three sets of values and goals with which few would disagree increasingly frame global initiatives and the structure of IFs (see Table 4.5). 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 1999). Second, humans in their interactions with one another desire peace and security (Kant 1897) 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 lifestyles and choices do not jeopardize the life conditions of their own futures and those of subsequent generations (United Nations 1987). Collectively, these goals have increasingly come to be recognized as the pillars of sustainable human development, the overarching goal or metagoal of most who think about and act to enhance global futures.

The modules within IFs support thinking about and exploration of long-term change and human development with respect to these goals. Figure 4.2 shows the IFs modules and a small, selected set of connections among them.

Richly specified computer models, in spite of their limitations, can complement rich mental models in forecasting poverty.

**Table 4.5 The value and conceptual foundations of IFs**

Humans as individuals	Personal development/Freedom
Humans with each other	Peace and security/Social fairness
Humans with the environment	Sustainable material well-being



Although the elements of particular utility to this study are those in the top half, including the population, economic, education, and sociopolitical modules, the full, integrated system will enhance the analysis.

In quick summary, the modules have the following basic structures:

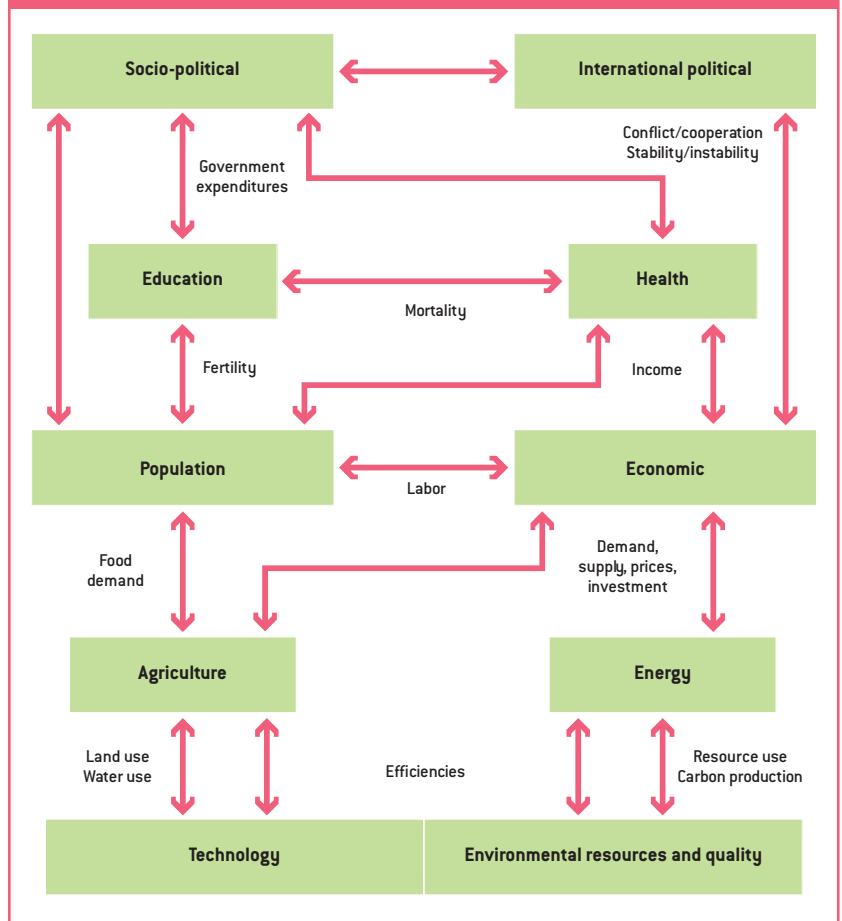
#### The population module

- represents twenty-two age-sex cohorts to age 100+ in a standard cohort-component structure;
- calculates change in cohort-specific fertility of households in response to income, income distribution, education levels, and contraceptive use;
- calculates change in mortality rates in response to income, income distribution, and assumptions about technological change affecting mortality;
- separately represents the evolution of HIV infection rates and deaths from AIDS;
- computes average life expectancy at birth, literacy rate, and overall measures of human development (HDI); and
- represents migration, which ties to the flows of remittances.

#### The economic module

- represents the economy in six sectors: agriculture, materials, energy, industry, services, and information/communications technology or ICT. Other sectors could be configured because the system uses raw data from the Global Trade Analysis Project (GTAP) project with fifty-seven sectors in Release 6;
- computes and uses input-output matrixes that change dynamically with development level;
- is a general equilibrium-seeking model that does not assume exact equilibrium will exist in any given year; rather it uses inventories as buffer stocks and to provide price signals so that the model chases equilibrium over time;
- contains a Cobb-Douglas production function that (following the insights of Robert M. Solow and Paul M. Romer) endogenously represents contributions to growth in multifactor productivity from human capital (education and health), social capital and governance, physical and natural capital (infrastructure and energy

Figure 4.2 The building blocks of IFs



prices), and knowledge development and diffusion (R&D and economic integration with the outside world);

- uses a linear expenditure system to represent changing consumption patterns;
- utilizes a “pooled” rather than bilateral trade approach for international trade; and
- has been imbedded in a social accounting matrix (SAM) envelope that ties economic production and consumption to a very simple representation of intra-actor financial flows (it represents only the skilled and unskilled households of the GTAP project).

#### The education module

- represents formal education across primary, secondary (lower and upper separately), and tertiary levels;
- forecasts intake or transition from lower levels, rates of survival and/or completion, as well as net and/or gross enrollment;

■ *The philosophical foundation of IFs is a broad conceptualization of sustainable human development.* ■

- differentiates males and females;
- is fully linked to population; and
- computes education or human capital stocks by adult age cohort.

*The health module (early in development)*

- differentiates mortality causes by communicable disease, noncommunicable disease, and injuries with multiple subcategories; and
- uses World Health Organization Global Burden of Disease distal driver formulations and introduces assorted proximate drivers for policy intervention.

*The sociopolitical module*

- represents fiscal policy through taxing and spending decisions;
- shows six categories of government spending: military, health, education, R&D, foreign aid, and a residual category;
- represents changes in social conditions of individuals (like fertility rates, literacy levels, or poverty), attitudes of individuals (such as the level of materialism/postmaterialism of a society from the World Values Survey), and the social organization of people (such as the status of women);
- represents the evolution of democracy; and
- represents the prospects of state instability or failure.

*The international political module*

- traces changes in power balances across states and regions, and
- allows exploration of changes in the level of interstate threat.

*The agriculture module*

- represents production, consumption, and trade of crops and meat; it also carries ocean fish catch and aquaculture in less detail;
- maintains land use in crop, grazing, forest, urban, and “other” categories;
- represents demand for food, livestock feed, and industrial use of agricultural products;
- is a partial equilibrium model in which food stocks buffer imbalances between production and consumption and determine price changes; and
- overrides the agricultural sector in the economic module unless the user chooses otherwise.

*The energy module*

- portrays production of six energy types: oil, gas, coal, nuclear, hydroelectric, and other renewable energy forms;
- represents consumption and trade of energy in the aggregate;
- represents known reserves and ultimate resources of fossil fuels;
- portrays changing capital costs of each energy type with technological change as well as with drawdowns of resources;
- is a partial equilibrium model in which energy stocks buffer imbalances between production and consumption and determine price changes; and
- overrides the energy sector in the economic module unless the user chooses otherwise.

*The environmental resources and quality module*

- allows tracking of the remaining supplies of fossil fuels, of the amount of forested land, of water usage, and of atmospheric carbon dioxide emissions.

*The technology module*

- is distributed throughout the overall model;
- allows changes in assumptions about rates of technological advance in agriculture, energy, and the broader economy;
- explicitly represents the extent of electronic networking of individuals in societies;
- is tied to the governmental spending model with respect to R&D spending.

A menu-driven interface facilitates use of the model. Large numbers of intervention points allow access for the user to all parameters (for scenarios) across all the modules. An extensive database supports model development and use.

For detail on the International Futures system beyond this brief introduction, see the IFs website at [www.ifs.du.edu](http://www.ifs.du.edu). That site provides the web version of the full model, as well as a full downloadable version for use on Windows machines. The most important source of documentation for the model is its extensive help system, available with both web-based and downloadable versions. The help system provides assistance with the user interface and also includes flow charts, equations, and complete computer code for

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all sections of the model. Barry B. Hughes and Evan E. Hillebrand (2006) provided a basic introduction to the model with a focus on facilitating its use. In addition, a substantial set of project reports and working papers are on the project website.

Where is the IFs system particularly weak with respect to the poverty analysis goals of this volume? IFs does not represent in any real detail the agents that determine poverty distribution within countries. There are no NGOs and there are only the two types of households (based on skilled and unskilled labor) for which the Global Trade Analysis Project provides data. Household distinctions by rural/urban residence and by work or profession do not exist in the model and would be very helpful for forecasting distributional change and analyzing chronic poverty. More generally, although the IFs model does contain a substantial number of important specifications that tie specific interventions or deep drivers to the proximate drivers and to the calculation of poverty, as with all models it is impossible to be fully confident about many of those. Models are always flawed representations of complex systems, which is why forecasts are inevitably useful only as one element in thinking about the future, not as substitute for such thought.

## **The Foundations in IFs for Poverty Analysis**

This section prepares for the use of IFs in subsequent chapters for analyzing poverty by explaining the formulation(s) linking proximate drivers to poverty and by providing basic information about how the model specifies the linkage of deep drivers and action levers to the proximate drivers.

### ***Initialization of poverty levels***

The IFs model begins its calculations in 2000 and annually updates values for all driver variables and for poverty rates and levels, as well as for the poverty gap and human development index components. Initial poverty rates in the year 2000 and those computed thereafter are country-specific. The processes to set initial values used survey data from the World Bank, specifically from its *World Development Indicators* and the PovcalNet website (which, unlike the WDI, is constantly updated).<sup>7</sup> For

months and countries in which there were no surveys for 2000, linear interpolation across values before and after 2000 was used. When there were no values bracketing 2000 on which to anchor interpolations, extrapolations from values before or (ideally) after 2000 set the value in 2000.<sup>8</sup> For those countries having no surveys to draw upon, a cross-sectional relationship against GDP per capita (at PPP) provided estimates for 2000. Whenever this volume presents poverty rates for groupings of countries, the values are population-weighted averages from the country level.

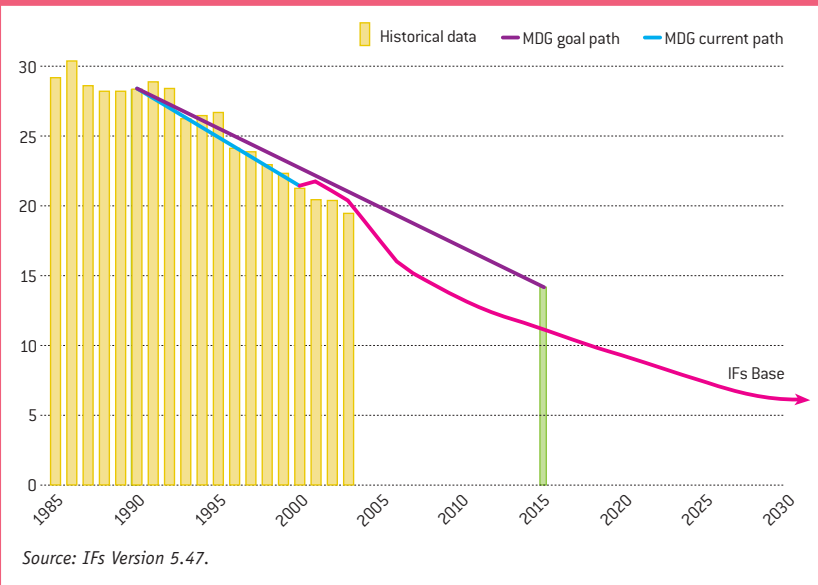
Because the model calculates values in future years for all economic variables in 2000 dollars (both at market exchange rates and at PPP), it would have been ideal to convert the global poverty levels from 1993 dollars to 2000 dollars. Such conversion is, however, as discussed in Chapter 2, a nontrivial and potentially controversial process. Instead of attempting such a process in advance of the World Bank undertaking it again, IFs computes a country-specific scaling factor during the first model year to convert calculations driven by consumption in 2000 dollars to the values initialized as described above. That scaling factor ensures that data in the initial year override calculated values and also scales values calculated in future years.

### ***Income poverty formulations***

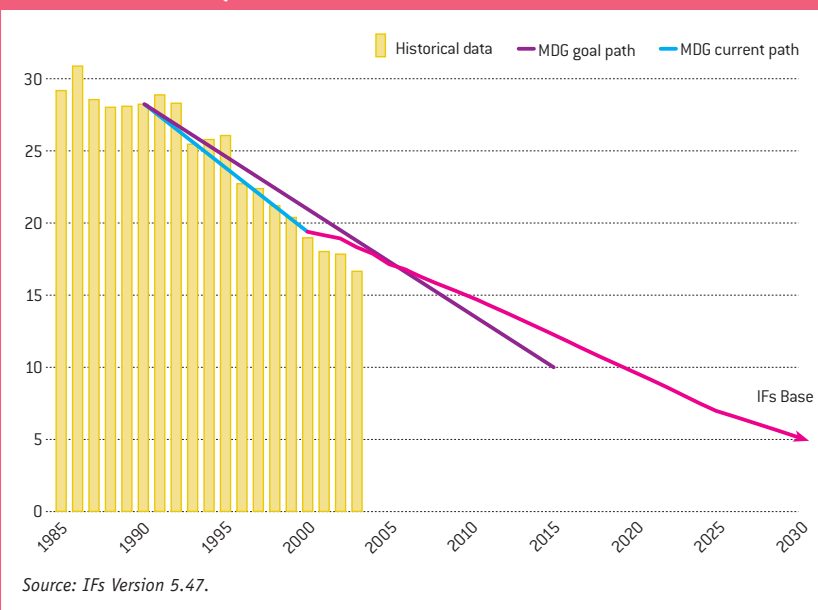
IFs uses two mechanisms to forecast rates of income poverty as a function of income and distribution, one tied to lognormal analysis and one based on cross-sectional analysis. Both formulations rely upon the broader model of IFs to generate driving forecasts of GDP per capita and the consumption share of GDP. They also rely on the IFs economic module or exogenous specification to generate forecasts of the Gini index as a measure of income distribution (with initial conditions for the Gini coefficient coming from the World Bank and therefore tied again to the survey data).

On the surface, it might seem that the clearly superior forecasting formulation would be based on the shifting of the lognormal distribution over time with change in average incomes and the Gini coefficient, as Chapter 3 described. The cross-sectional formulation serves two purposes, however. First, it helps estimate initial poverty

**Figure 4.3 Developing country poverty rate (lognormal formulation forecast)**



**Figure 4.4 Developing country poverty rate (cross-sectional formulation forecast)**



levels for countries for which there are no survey data. That set contains a small number of generally less populous countries, but in global analysis it is desirable to be as comprehensive as possible. Second, there is a logical basis on which to question the persistence of a pure form of the lognormal curve as average income improves (even when aggregate measures like the Gini coefficient change very little). For instance, pockets of chronic poverty are a well-

known phenomenon and often persist among disadvantaged subpopulations in spite of the economic advance of the average population. That is, there may be a tendency for the left-hand tail of the lognormal distribution to display some inertia with economic transformation, leaving some additional number of people at or below the poverty line. Even though the lognormal forecasting formulation may not pick up those pockets of chronic poverty, the cross-sectional formulation may be responsive to them.

In fact, the cross-sectional formulation could potentially be responsive to a number of factors not picked up in the theoretically elegant and simple lognormal approach. Figures 4.3 and 4.4 reinforce this point by showing base year forecasts of global poverty through 2030 with the two formulations. The two figures show, of course, the same historical profile of reduction in rates of global poverty. The bars are built from a combination of survey data and filling of the holes in those data with the cross-sectional formulation.<sup>9</sup> The solid lines represent the path from 1990 values to the MDG goal of reducing 1990 poverty rates by 50 percent by 2015. The marked pink lines are the base case forecasts in IFs.

The cross-sectional formulation shows slower rates of poverty reduction and a clear failure to meet the goal, while the lognormal formulation shows progress of poverty reduction below the goal path. The lognormal forecast is closer to the current conventional wisdom within the development community. In addition to the possible persistence of chronic pockets of poverty, is there any further basis for the more conservative path of the cross-sectional formulation? One basis is in the earlier finding that the 1990 forecasts of poverty for 2000 appear to have overestimated reduction rates.

The key point, however, is to stress the uncertainty with respect to any formulation, which reinforces the desirability of considering multiple ones. Appendix 1 of this volume provides more information on the two formulations. Appendix 3 explains the endogenization of economic growth and income distribution as a function of deep drivers in the model.

## Conclusion

There is a triangle of activities involved in this volume's discussion of the assault on poverty. The first activity, discussed in Chapter 2, is assessment (conceptualization and measurement). Because of the great debates that the chapter sketched, we much better understand the breadth and depth of global poverty and the progress in its reduction than in past decades. The second activity, which Chapter 3 introduced, is framing possible action or intervention.

The third activity of the triangle is exploration of possible futures, with and without interventions. The purpose of this chapter was to describe the foundation for such exploration. Herein we reviewed forecasts of poverty reduction that have emerged to date and the methods behind them. We also sketched the tools that this study brings to the effort and how they will facilitate more extensive analysis. Chapter 5 will take us further down the road of that causal analysis.

Alternative formulations for forecasting poverty can help map the range of uncertainty in our forecasts. ■

- 1 See Chapter 2 for more on the setting of the ACC poverty line based on that of India, further linked to food availability of about 2,250 calories per day. By one estimate, that corresponded to about \$23.14 per month in 1985 relative to the \$31 per month used subsequently by Ravallion as \$1 per day (*Economist*, "Economic Focus: Another day, another \$1.08," April 28, 2007: 90). The ratio of the two suggests that the ACC line was very roughly ( $\$23.14/\$31.00$ ) \* ( $\$1.08/\$1.00$ ) or \$.806.
- 2 A variety of other forecasts for specific regions and countries have similarly relied primarily on extrapolation. See UN ECLAC 2004 and 2005; UN ECAF 2005.
- 3 The UNDP study by Dikhanov produced other results of significance. For instance, it sketched the global distributions of income historically and in the base forecast to 2015. Interestingly, the strongly bimodal character of global income distribution in 1970 had already eroded considerably by 2000 and was forecast to erode further by 2015, beginning to approximate the lognormal form characteristic of most countries. Dikhanov anticipated generally lognormal distributions but used a polynomial estimation approach to fit distributional curves to data.
- 4 As discussed in Chapter 2, it bears repeating that forecasting depends heavily on the measurement

- of initial conditions and the assessment of past patterns. For instance, Bhalla (2002: 170) forecast that in 2015 the portion of the developing world living on less than \$2 per day would be 10.1 percent, about one-third of the percentage that the World Bank (see again Table 1.1) expects to be living at that level. His forecasting method was not dramatically different from that of the World Bank, using assumptions of per capita economic growth averaging 2.5 percent and constant income distribution as key drivers of the forecasts. How, then, could his forecast be so different? Although Bhalla used World Bank data from Deininger and Squire (1996), he imposed his own calculation of the poverty line on them, estimating that in 2000 only 23.3 percent of the developing world lived on less than \$2 per day, rather than the approximately 50 percent value used by the Bank. In fact, Bhalla's estimate for poverty at \$2 per day at the beginning of the century was very close to the Bank's estimate for poverty at \$1 per day, making it no surprise that his forecast for levels at \$2 per day in 2015 were actually quite close to the Bank's forecast at \$1 per day.
- 5 The forecasts of the *Global Economic Prospects* 2006 used a cross-country poverty change model driven by GDP per capita and Gini coefficients (see World Bank 2006: 119 for the specification). For more detail on the technique the Bank used, as illustrated by its

analysis of poverty change in response to different assumptions about remittances, see Annex 5.1, pages 127–129.

- 6 Dominique van der Mensbrugge, in an e-mail from January 2007, explained some of the details of the approach used in the analysis for 2007, supplementing the explanation of the volume (World Bank 2007: 63, footnotes 26 and 27). Chapter 3 of the 2007 volume also explained the processes used to build a global income distribution for 2030 and to explore the emergence of a global middle class. See also Bussolo et al. (2007).
- 7 For countries, such as China and India, and for years in which PovcalNet broke data on poverty rates into urban and rural subsets, national values are weighted sums of those two populations.
- 8 To illustrate, if the nearest survey-based estimate of the World Bank to 2000 was for 2003, that value helped estimate poverty headcount rate for initialization in 2000. A cross-sectional formulation provided the anticipated poverty decrease (or sometimes increase) as a result of difference in GDP per capita in 2000 and 2003, and that difference was used to adjust poverty headcount ratio from 2003 to 2000.
- 9 Surveys for 2004 were only partially available at the time of writing, so the graph omits that year.