5

The IFs Base Case: A Foundation for Analysis

The assumptions that differentiate scenarios should be explicit, whether they concern uncertainties largely beyond human control or uncertainties largely under human control.

The future is uncertain, and our tools for thinking about it are imperfect. These basic truths require us to avoid making predictions about what will happen and explore instead the range of what could happen. Moreover, human choices influence social futures, and our ultimate analytic purpose is to improve those choices in pursuit of human development goals. Thus, analysis of the future prospects for poverty reduction requires scenario analysis, the elaboration of alternative stories about the future. The assumptions that differentiate scenarios from each other should be made explicit, whether they concern uncertainties largely beyond human control, such as the fragility or robustness of natural systems in the face of human action, or whether they concern uncertainties largely under human control, such as the portion of children who attend elementary school.

When a large-scale computer simulation is used in forecasting, however, the assumptions that differentiate the scenarios elaborated in its use are typically a small fraction of the total assumptions made. The model structure and most of its parameters involve assumptions that may be common to the scenarios. Even when documented, complex models are difficult to understand, and examination of their behavior becomes an important part of such understanding. Most often that examination begins by looking at the behavior of a model in the absence of interventions and proceeds only thereafter into scenario analysis. The forecasts of a model without interventions are typically called the base case or reference run (see Box 5.1).

The purpose of this chapter is to explore the base case of the International Futures (IFs) with Pardee model. Our analysis will focus on the behavior of the proximate drivers of poverty (see Chapter 3) and on the unfolding of the base case forecast of poverty itself. We will compare the forecasts to others made of the proximate drivers and of poverty. Typically models are calibrated in their development to such alternative

Box 5.1 The Base Case

The base case of a model like IFs with Pardee is not a simple extrapolation, because it is the nonlinear output of the behavior of a dynamic simulation. Sometimes analysts refer to a base case as a "business as usual" scenario. That is misleading for models like IFs, in which the structure and specification of the model can lead to behavior of actors changing substantially in the course of the simulation (such as countries spending more of GDP on health as they become richer). At the same time, the base case is not a prediction, because no scenario, including the base case forecast, has a high probability of proving correct.

What, then, is a **base case**? It is a scenario portraying a reasonable dynamic evolution of current patterns and trends. That is why a base case forecast of poverty is useful in and of itself and why base cases make good starting points for analyzing other scenarios in which alternative assumptions are introduced.

forecasts because doing so provides some evidence of their credibility.

There is an important point to make about the processes of (1) base case elaboration with (2) subsequent scenario elaboration, because to nonmodelers the steps may seem technical and perhaps even artificial. Specifically, we should develop forecasts based on mental models with the same exacting processes. Foundationally, we should subject the fundamental structure of the mental model to examination in some detail, and the assumptions and relationships of the model should be transparent. Further, we should review the base case forecast of a mental model and compare it to forecasts that others generate. Mental models should also then produce alternative scenarios about the future, as well specified and differentiated as possible. In short, these processes are part not just of thinking about the future with computer models, but much more generally part of thinking about the future.

Population Growth

The forecasts of the UN Population Division are the most widely used and cited of all population forecasts. Therefore, this section will primarily compare the base case forecasts from IFs with the UN's most recent forecasts, those from the 2006 revision.[1] Other institutions that provide population forecasts with global coverage include the U.S. Census Bureau and the International Institute of Applied Systems Analysis (IIASA).[2] Another important information resource for understanding population data and forecasting is the Population Reference Bureau (e.g., O'Neill and Balk 2001).[3]

The IFs base case does not use the forecasts of any other source (except UN forecasts for migration) because the model uniquely generates its own. The most important difference between the forecasts from IFs and other sources is that the demographic module in IFs is integrated with the other modules of the system, including those for economics, education, and sociopolitical systems. That integration has allowed the development of formulations for fertility and mortality driven endogenously by variables such as gross domestic product (GDP) per capita (at purchasing power parity), years of education, and spending on health care. It is this characteristic that will make it possible in subsequent chapters to explore the impact on population, and therefore on numbers in poverty, of interventions such as changes in governance quality.

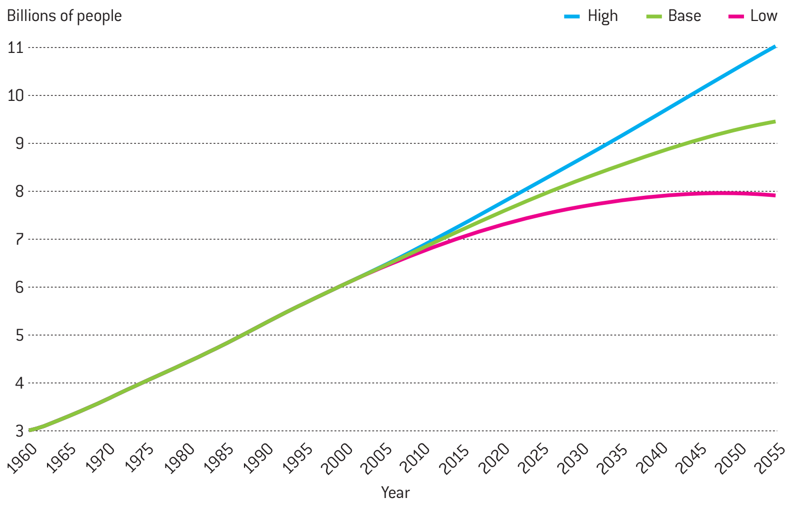
This "broad and deep endogeneity" of IFs also means that the forecasts of IFs, both the base case and the scenarios built around it, will never be identical to the forecasts of any other system. Nonetheless, IFs should generate values in its base case similar to those of experts on their respective issues.

The United Nations produces its well-known medium variant forecast, in combination with high and low variants. Even though global fertility rates are on a steep downward trend, the UN also always shows a constant fertility variant with especially high population growth rates. The IFs project does not normally compute high and low variants, which the UN creates by assuming fertility rates about one-half child above and below the medium variant. Instead, IFs generates scenarios by interventions in deeper drivers, such as those that affect economic growth rates and education levels. To allow some comparison with the alternative UN scenarios, however, Figure 5.1 shows the IFs base case and two scenarios prepared for the analysis of this volume. Chapter 6 will discuss these

We should subject forecasts from mental models to the same exacting analyses of specifications that we apply to thinking about the future with computer models.

Although the "broad and deep endogeneity" of IFs means that its forecasts will differ from others, values from the base case of IFs should be similar to those of experts.

Figure 5.1 Global population: history and forecasts



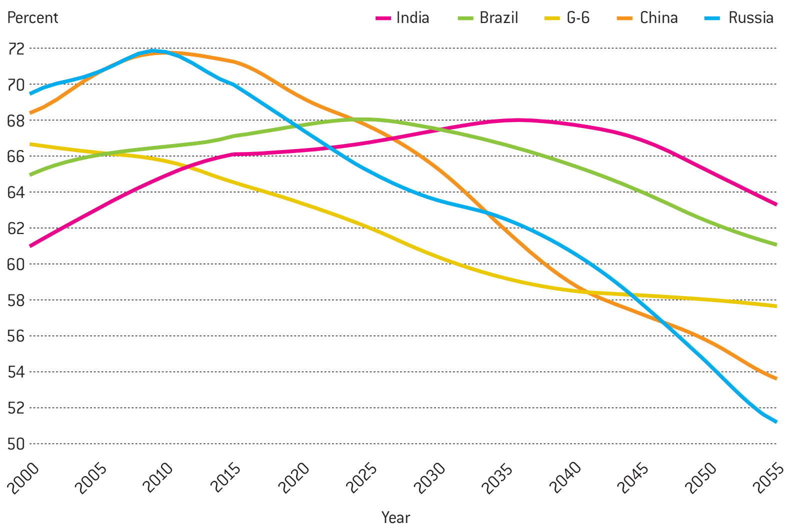
Source: IFs Version 5.47.

Table 5.1 Comparison of United Nations median variant forecasts, 2006 revision, with IFs Base Case

	Population in 2050 (millions)	
	UN	IFs
More Developed (OECD)	1,245	1,262
Less Developed (non-OECD)	7,946	8,016
Oceania	49	45
World Total	***9,191***	***9,279***

Source: UN Population Division (2006), Table 1.1; and IFs Version 5.47.

Figure 5.2 Working age (15–65) population in the BRICs and the G-6



Source: IFs Version 5.47.

IFs high and low population scenarios in more detail. The three scenarios generate populations in 2050 of 10.6, 9.3, and 8.0 million, respectively, compared to values from the UN's 2006 forecast revision of 10.8, 9.2, and 7.8 million in their high, median, and low variants.[4]

For more than a decade the forecasts of IFs (and IIASA) tended to be lower than those of the United Nations, and subsequent UN revisions brought down successive medium variants as it recognized the rapid pace of fertility decline, ultimately bringing its midcentury forecast below that of IFs. There is, however, now some reason to begin questioning whether fertility and growth rates will continue their sharp declines, especially in light of population growth rates that are moving fairly steadily to and below zero in many countries (see Figure 6.1 for the population growth rates corresponding to Figure 5.1). Moreover, AIDS mortality forecasts are declining. The UN median variant forecast for 2050 increased from 9.08 (2004 revision) to 9.19 billion (2006 revision).[5]

Turning to the population in regions of the world, Table 5.1 presents the breakdown by the United Nations of its median variant in comparison with the IFs base case. They are not completely comparable, because the more and less developed regions of the UN have been represented in IFs by members and nonmembers of the Organization for Economic Cooperation and Development (OECD). The regional breakdown, which is identical, shows that IFs forecasts marginally higher populations in Africa and Asia by 2050 than does the United Nations.

A full cohort-component population module, like that of IFs, provides a wide range of numbers that are important to the economic and other modules. Figure 5.2 from the IFs base case shows values for one such linkage, namely the size of the labor force relative to total population in Brazil, Russia, India, and China (the BRICs) and the Group of 6 (the G-7 without Canada). Growth in labor force share constitutes a "demographic dividend" that supports economic growth. The dividends being reaped by the BRICS are clearly evident (compare with the analysis of Goldman Sachs 2003: 8).

Economic Growth

Economic forecasts are more difficult to create than those for population. In the longer term, there can be substantial variation in savings rates, international investment flows, and technological change. Business cycles and financial panics are frequently apparent in short- and midrange economic data.

Because of the great importance of near-term economic forecasts for investors, companies, and governments, there are many forecasting services that create them in spite of the challenges. For instance, Oxford Economics provides forecasts for up to 175 countries, as well as models for use by its clients; the time horizon generally extends up to ten years. Similarly, Goldman Sachs provides forecasts as part of its research service. On occasion its forecasts have been more truly long term, as when they produced a report on the BRICs through 2050. The OECD mostly provides short-term forecasts, such as its semiannual series looking out two years, the *OECD Economic Outlook*.[6] The International Monetary Fund (IMF) also mostly provides short-term forecasts, extending about two years, as in its semiannual *World Economic Outlook*.

The interest of our analysis lies, however, in longer-term economic forecasting. Because of the challenges in creating them, no sets of regular long-term forecasts, like those of the UN and the U.S. Census Bureau for populations of countries, exist for economies.

IFs long-term forecasts

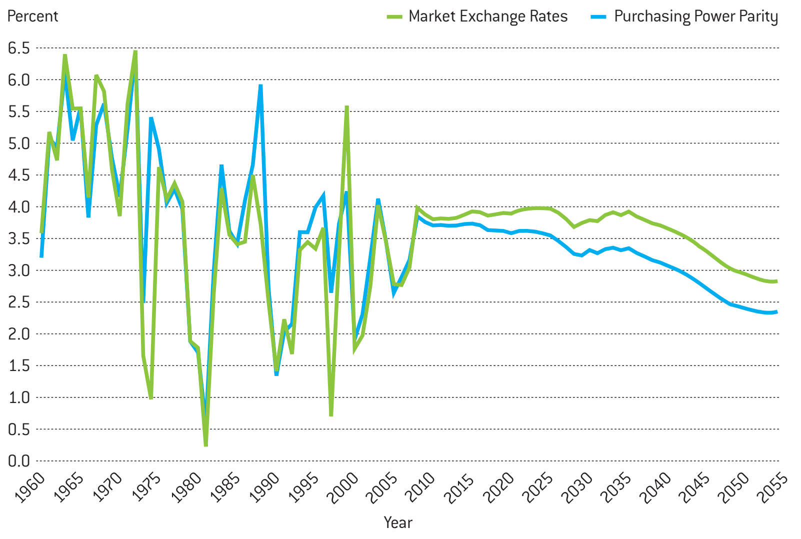
Figure 5.3 provides historical growth rates and IFs forecasts for GDP per capita growth at market exchange rates (MER) and purchasing power parity (PPP). Those figures place the IFs forecasts in the context of historical data, as a prelude to comparison with other forecasts. Because global population growth rates are trending downward and will likely be nearly 2 percent lower by 2050 than they were in 1970, the figure presents GDP per capita values.

It is useful to comment on several aspects of the forecasts of IFs and their relationship to past growth patterns:

- Forecasts are smoother than past patterns, because IFs is a long-term model that makes no attempt to anticipate short-term business cycles or other perturbations. Forecast rates are not completely flat or smooth, however, because many driving forces interact across all the submodels of IFs.
- World economy growth rates were quite a bit higher in the 1960s than in the 1970s and thereafter. Angus Maddison (1995) called the 1950s and 1960s the "Golden Age" of global growth. The per capita rates in IFs forecasts tend to fall somewhat between those of the Golden Age and those of later decades.
- The rise in global growth rates forecast in the early part of this century is in substantial part a result of the continued rapid growth of China and India, which, as their weight in the world economy rises, pushes global rates upward. Conversely, the increasing convergence toward midcentury of GDP per capita levels in middle-income countries with those in rich countries will slow global per capita growth rates, as may the passage of the world through the years of peak oil and gas production.

One aspect of Figure 5.3 merits special comment. The World Bank and Global Insights, whose forecasts the next section will review, anticipate that world GDP will grow faster at purchasing power parity than at market exchange rates. The reason for that expectation is that developing countries have higher GDPs at PPP than at MER; given their higher growth rates, composition

Figure 5.3 Global GDP per capita growth: History and forecasts



Source: IFs Version 5.47.

effects (the increasingly high weight assigned to developing countries in the global average) will, ceteris paribus, give rise to faster global PPP growth. In the World Bank analysis all else is, in fact, equal, because the ratio of GDP at PPP and MER does not change for any country or region; GDP in both cases is considered real GDP and subject to the same growth rate.

In IFs, that composition effect is also present. In addition, however, IFs posits that GDP at PPP and at MER will converge as countries become richer. For instance, the value of China's GDP at PPP is nearly 2.0 times that of its GDP at MER and India's GDP at PPP is 2.5 times its GDP at MER.[7] The values of GDP at PPP and MER for the richest countries of the system seldom differ by more than a factor of 1.5. As China continues to develop, further strengthen its economic ties with the world, and move toward a floating currency, the two measures of its GDP should also converge. That can only happen if GDP at MER grows faster than GDP at PPP. One might argue that forecasting such convergence violates the treatment of GDP at MER and PPP in real terms. We argue here that such convergence is a phenomenon of such importance that analysis should include it.[8] The result is a forecast for global growth at PPP that is slower than that at MER.[9]

Midrange forecasts for comparison

Three sets of forecasts provide the best comparative basis for the base case of IFs. Compared to most organizations, the World Bank tends to take a longer view, and it frequently presents forecasts in its *Global Economic Prospects* series. The 2003–2006 volumes produced global and regional GDP forecasts through 2015 (as well as its forecasts for poverty reduction, reported in Chapter 4). The 2007 volume provided estimates of regional growth rates from 2008 to 2030 and of poverty rates through 2030 (the 2008 volume did not provide a table of long-term forecasts). The International Energy Agency (IEA) uses economic forecasts for its analysis of global energy, most recently through 2030. Global Insight supplies forecasts for the U.S. Department of Energy through 2030 for its annual International Energy Outlook series.[10]

Table 5.2 shows forecasts of the World Bank, the IEA, and Global Insight for growth rate in GDP through 2030, in comparison with those of the IFs base case. The World Bank revised its forecasts downward somewhat in recent volumes as the decade has progressed and the ravages of the financial market collapse and events such as 9/11 took their toll on actual growth. Nonetheless, the bank remains optimistic that growth rates in the developing world will exceed the growth rates of the 1990s. They argue that a variety of economic reforms have positioned many developing countries for acceleration. The forecasts of IFs not only echo that logic but add a bit more optimism for developing countries.

The forecasts of regional growth rates in IFs (at PPP) are very similar to those of the World

Table 5.2 Regional GDP growth rate forecasts from various sources

	GDP growth rate through 2030				
	World Bank	**IEA**	**Global Insight/ Energy Information Agency**	**IFs Base (PPP)**	**IFs Base (MER)**
High-income countries	2.4	2.2	2.6	2.3	2.6
Developing countries	4.0	5.1	5.3	4.6	6.3
East Asia and the Pacific	5.1	5.6	5.8	5.5	8.1
Europe and Central Asia	2.7	3.6	4.3	3.3	4.5
Latin America and the Caribbean	3.0	3.2	3.9	3.3	4.0
Middle East and North Africa	3.6	4.0	4.2	4.6	6.1
South Asia	4.7	5.6	5.8	4.8	6.4
Sub-Saharan Africa	3.3	3.9	4.9	4.0	5.0
World total	***2.9***	***3.6***	***4.1***	***3.4***	***3.6***

Notes: Starting years of forecasts vary somewhat; Global Insight and World Bank forecasts use PPP weights.

Sources: World Bank 2007: 3 (Table 1.1); International Energy Agency 2007: 62 (Table 62); DOE 2007: 10 (Table 2); IFs Version 5.47.

Bank[11] and Global Insights,[12] generally falling between them, with a few exceptions. First, IFs anticipates considerably higher economic growth in the Middle East and North Africa, largely due to the impetus of higher energy prices. The economic model of IFs is connected to an energy module, and 2030 is near the anticipated peak of global oil production, putting upward pressure on prices and import revenues. Second, except for the World Bank, IFs anticipates somewhat lower growth in both East and South Asia (again, in the important PPP terms; the IFs rates at MER are higher in each case). Interestingly, the World Bank (2008: 43–45) significantly revised upward growth expectations for developing countries in its 2008 analysis. Although it did not provide an updated table, the Bank increased expectations for per capita growth in Africa to 3.2–3.4 percent in coming decades; adding population growth averaging more than 2 percent would raise the bank's GDP forecasts from the lowest in Table 5.2 to the highest. Similarly, for developing countries as a whole, the bank's per capita expectations for the next two decades convert into GDP growth rates of nearly 4.5 percent.

Long-range forecasts for comparison

When one looks for economic forecasts beyond 2030, the universe shrinks. Shell International (2001: 60) built its energy scenarios through 2050 on assumptions of growth in global GDP at PPP of 3.2 percent from 2000–2025 and 2.4 percent from 2025–2050. These figures compare with 3.4 percent and 3.1 percent in the IFs base case. One of the key reasons for higher IFs forecasts in out-years is a composition effect—as developing countries become a larger share of global GDP, their higher growth rates raise the global average. IFs posits technological convergence of middle-income developing countries with rich countries, keeping the growth of that country set quite high.

Projects that analyze long-term energy demand/supply and environmental issues, especially greenhouse gas emissions, have created most sets of economic growth scenarios that extend to or beyond 2050.[13] The Special Report on Emissions Scenarios (SRES) of the third and fourth assessment rounds of the Intergovernmental Panel on Climate Change (IPCC) contain perhaps the best-known set of scenarios.[14] Interestingly, three of those four scenarios show some acceleration of global growth in 2020–2050 compared to earlier years in part because, like IFs, they posit increasing North-South convergence.[15] The annual growth rates in the four IPCC scenarios range from 2.26 to 3.38 percent between 1990 and 2020 and from 2.34 to 4.04 percent from 2020 to 2050.

In general, the growth rate of the world economy has quite steadily accelerated since the beginning of the Industrial Revolution, significantly reflecting the cumulative impact of technological development and its diffusion. The great surge from 1950 to 1973 and the falloff thereafter, however, suggest the uncertainty of forecasting in the current century. The convergence of productivity in Europe to levels in the United States was a major driver of growth in the Golden Age, and a possible convergence of larger middle-income country growth rates with OECD rates could similarly now boost global growth through midcentury. On the downside, in addition to possible resource scarcities, it is important to remember that forecasts for the twenty-first century anticipate substantial declines in population growth rates.

It is, of course, ultimately important to consider the position of longer-term base case forecasts of IFs in the broader universe of such forecasts, not just for the world, but for major countries and regions. In this context, it is useful to turn to the numbers produced by Goldman Sachs, which tend to be more optimistic for the BRICs, in particular, than either IFs or the World Bank. In fact, Goldman Sachs concluded that "in less than 40 years, the BRICs economies together could be larger than the G6 in U.S. dollar terms."[16]

Strikingly, the compound growth rates over the first half of this century in the Goldman Sachs analysis are 7.7 percent for China, 8.5 percent for India, and 2.6 percent for the United States.[17] By 2050, China's GDP per capita reaches 90 percent of the level of the United States in 2000, and in that same year Russia's GDP per capita surpasses the value Goldman Sachs anticipates for the United States in 2020. Direct comparison with the IFs base case is possible. In the IFs base, the total GDP of the BRICs reaches about 85 percent of that of the G-6 by 2050, a remarkable increase in the ratio from 12 percent in 2000, but well short of the Goldman Sachs expectation of overtaking the G-6by 2040.[18]

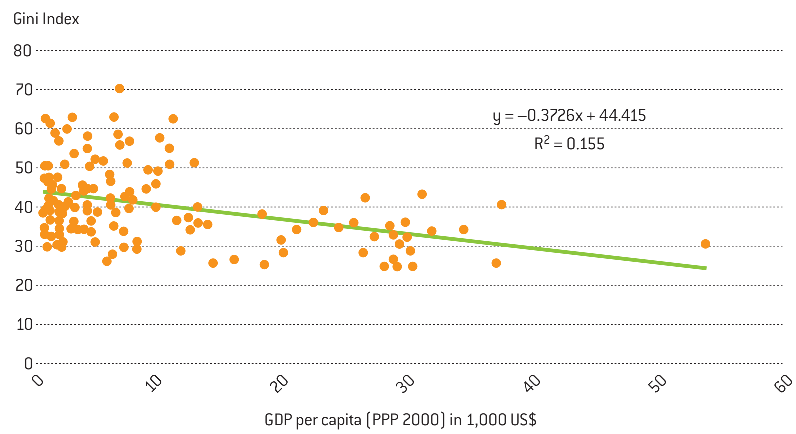
Overall, it bears repeating that there is nothing comparable in the economic arena to the near-consensus about population growth forecasts. Nonetheless, it is clear that IFs falls well within the range of forecasts presented by others.

Economic Distribution

Once upon a time, the Kuznets curve was the primary basis for making forecasts of change in national income distribution. That inverted U-shaped curve nicely portrayed a widely believed story line that countries typically move from heavily agricultural socioeconomic structures in which almost everyone is somewhat equally poor, to less egalitarian industrial structures in which a portion of the population controls most capital and its income, to service structures in which the spread of human capital and government intervention helps society move again toward more equal distribution. Cross-sectional evidence seemed to support the proposition.

Longitudinal data, however, as often contradicted as supported the Kuznets curve within countries over time. Moreover, the slowness of change in income distributions became even clearer than it had been. The most recent cross-sectional plots of the two variables (see Figure 5.4) show a global pattern more like either (1) a downward sloping line suggesting that largely agricultural societies are not so egalitarian as in the story line or (2) two different patterns within groupings of countries separated by GDP per capita of roughly $10,000. It has become common to explain the apparent inverted U of the world in the 1960s in terms of the special position then of Latin American economies as middle-income and persistently inegalitarian (at least in part from the lingering effects of colonial land distribution).

Figure 5.4 Cross-sectional analysis of Gini as a function of GDP per capita



Note: Data are 2004 (Gini), 2005 (GDP per Capita), or most recent available.

Source: IFs Version 5.47

Forecasting domestic inequality

In the face of disillusionment with the Kuznets' curve, there is unfortunately no consensus on any new, much less any simple story with respect to the likely change in income distribution over time. There are, therefore, practically no longer-term forecasts of income distribution within countries around the world. One exception is work reported by Maurizio Bussolo and Denis Medvedev using survey data and microsimulation. They forecast that "more than two-thirds of low- and middle-income countries" will experience a growth in inequality by 2030 (World Bank 2007: 83) and provide estimates by country.

Survey-based microsimulation approaches cannot easily be integrated with larger systems such as IFs. One promising alternative approach is the portrayal of socioeconomic systems in terms of multiple categories of households and other agents (especially firms and governments), each with its own pattern of human capital, accumulated wealth, and income, and all interacting via financial flows. Such social accounting matrixes (SAMs) can be a basis for computing measures of distribution such as the Lorenz curve and Gini coefficient, thereby assisting in their forecasting. As discussed in Chapter 4 (see also Appendix 3), the IFs project generalized a basic SAM structure to all its countries and developed a dynamic forecasting approach. The approach uses data from the Global Trade Analysis Project (GTAP), which unfortunately specify only skilled and unskilled labor categories and limit forecast credibility. The base case forecast produces an essentially flat population-weighted Gini coefficient of non-OECD countries through 2050, but with an increase in Africa of about 0.015 points. Interestingly, the World Bank forecast (2007: 84) similarly anticipates that a large number of African countries will experience increasingly inequality and that none will experience decreases in inequality.

The important conclusion to draw from considering the future of domestic inequality is that there is very weak basis for forecasting. Future chapters rely heavily upon scenarios as a way of treating the variable.

Forecasting global inequality

Although it may seem a digression from the line of discussion in this chapter, the pattern of equality and inequality across the global population as a whole is a very important related topic—remember that Amartya Sen and others have identified inequality as at least a foundation for, if not a manifestation of poverty. The place to begin such a consideration is with a conceptual understanding of global inequality and associated approaches to building a global Lorenz curve and to calculating a global Gini coefficient. Branko Milanovic (2005) very usefully differentiated three concepts of global inequality. Although he regularly referred to them by concept numbers, it is useful to give them names.[19] In each case quantitative assessments normally use GDP per capita at PPP, although they could also build on income or consumption per capita.

Concept 1: Country-based global inequality

Using this approach, China and Barbados have the same weight, obviously a questionable approach to assessing levels of global distribution, but one sometimes used.

Concept 2: Country population–based global inequality

Using this approach, each individual within China is given as much weight as each within Barbados, but the average GDPs per capita or incomes of their countries represent all citizens of each. This approach is frequently used as a basis for measurement of global distribution.

Concept 3: Individual-based global inequality

Now that survey-based data on income or consumption distribution are available for most countries, it is possible to compute a global distribution that effectively captures the human income distribution globally, independent of countries. Milanovic (2002, 2005), Xavier Sala-i-Martin (2002a, 2002b), and others have used this approach.

Milanovic (2005) carefully examined the evolution since 1820 of global distribution with reference to each concept. He found that country-based global inequality rose significantly during the first globalization century, from a Gini of 0.20 in 1820 to 0.37 in 1913. It then fell slightly through the interwar period, rising sharply to the mid-0.40s with the outcomes of World War II, and growing especially in the 1980s and 1990s, ending at 0.54 in 2000.

The pattern for country population–based global inequality was quite different. Although the historical pattern was similar to that for country-based inequality until World War I, with Gini rising from 0.12 in 1820 to 0.37 in 1913, country population–based Gini continued upward to 0.40 in 1938 and then shot up to 0.57 in 1952. The reasons for the dramatic shift have much to do with the economic decline of populous, poor countries like China before and especially during World War II and with the rise of an also populous United States during and after the war. Since 1950, the country population–based Gini has generally trended downward, falling to 0.50 in 2000. The fall has much to do with the economic renaissance of China and would have been greater except for the economic strength of the United States.

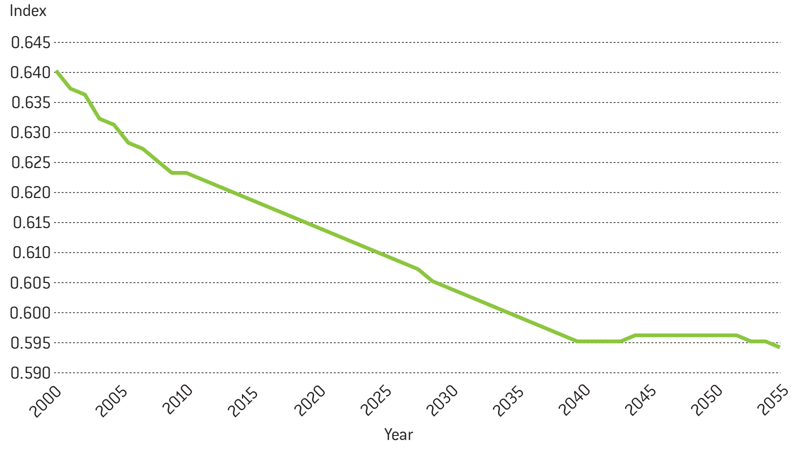
Historical computations for individual-based global inequality are much more difficult and uncertain. The key finding is that at the individual level, global inequality was already very high in 1820, with a Gini of 0.50, attributable to great intracountry inequality at that time, even though intercountry inequality was much less than in later years. The Gini calculated at the individual level continued to rise, to 0.61 in 1913 and 0.64 in 1952. Since then it has been relatively stable.

Individual-based global inequality was already high in 1820 with a Gini of 0.50, but rose to 0.61 in 1913 and 0.64 in 1952; since then it has been relatively stable.

Milanovic concluded that there was a sweeping historical transition between 1820 and 1950 characterized by three elements: “First, rising differences among countries’ mean incomes; second, relative decline of poor and populous countries; and third, diminishing within-country inequalities” (2005: 144). The first two of these forces interacted to give rise to increasing individual-level inequality. Since 1950 the divergence among countries has been less rapid overall, while populous and poor countries (India and especially China) have begun to close the economic gap. Any growth of inequality within countries has been offset by such rise of the populous poor countries, so as to keep global individual-level inequality quite stable.

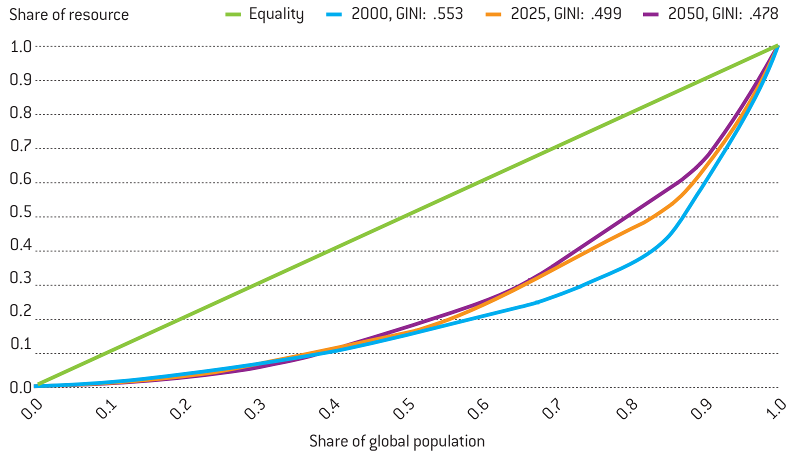
What might be the future of global inequality? On the one hand Milanovic (2005: 148) inveighs against projections because he feels them to be too uncertain, but on the other hand (2005: 162) he concludes that movements toward global community and democracy will lead humanity to reduce economic disparities. Others have been less ambivalent about forecasting. For example, Glenn Firebaugh (2003) argued that the decline in inequality across countries is more than offsetting greater inequality within them, and the trend of reduced individual-based inequality is the "new geography." Sala-i-Martin (2002a) argued that the future of global distribution at the individual human level depends heavily on sub-Saharan Africa. Assuming that the incomes of Africans stagnate, "The main lesson is that world income inequality is expected to fall for a few more years and then, when the Chinese (and Indian) convergence-to-the-rich effect is over, inequality is expected to rise again as the divergence-from-the-poor effects begins [*sic*] to dominate" (2002a: 37).

Figure 5.5 Individual-based global Gini



Source: IFs Version 5.47.

Figure 5.6 Country population-based global Lorenz curves and Gini for GDP at PPP



Note: Values of 1 are equivalent to 100 percent.

Source: IFs Version 5.47.

Figure 5.5 shows the calculation by IFs of individual-based global inequality (Milanovic's Concept 3). Because that forecast requires forecasts of GDP growth and of domestic Gini coefficients, as well as the assumption that income distribution is lognormal, it should be considered cautiously. The pattern does, however, generally support the expectations of Sala-i-Martin, tracing a slow and not very substantial erosion in global inequality over most of the first half of the twenty-first century, followed by a flattening as the convergence effects of China and India play out.

An emerging global middle class

Figure 5.6 shows a representation from IFs of the global Lorenz curve for GDP at PPP in 2000. The Lorenz curve is of country population–based global inequality (Milanovic's Concept 2), not of individual-level inequality. The figure also forecasts the Lorenz curve in 2025 and 2050, using base case forecasts of population and economic growth. It is easy to see the implications of continued rapid economic growth in China, India, and the transition economies in the upper-middle range of the population distribution. That forecast of middle-income growth brings Gini down from 0.549 to 0.515 by 2025. A global middle class is growing, and the number of people globally who have incomes between the average incomes of Brazil and Italy in 2000 ($3,914 and $16,746 at PPP) may grow from 440 million to 1.2 billion by 2025 (Bussolo et al. 2007: 26). It is also possible to see the implications of Sala-i-Martin's analysis in the slowing of change in the distribution and the Gini after 2025, even though the IFs base case does not assume stagnation in African GDP per capita through 2050.

Overall, forecasts of changes in income distributions, both within and across countries, are rare for good reasons: the uncertainty about changes in those distributions is very great. In subsequent chapters of this book, we are attentive to the implications of change in distribution for their impact on poverty, but we also often treat those changes via scenario-based assumptions.

Poverty Levels

Chapter 4 reviewed the approaches and tools that have been used by others (including Dikhanov 2005) to forecast poverty and presented the forecasts that have been made with them. Table 5.3 reproduces the poverty rate forecasts of the World Bank's *Global Economic Prospects 2007*, which are the best-known and most authoritative (see Table 1.1).[20] The table also shows the numbers from IFs with Pardee for the same regional groupings, allowing a direct comparison of base case results from IFs with the forecasts of the World Bank in 2015 and 2030 (and their downward revisions in 2008 of forecasts for 2015).

Most of the numbers for 2015 in the World Bank and IFs lognormal forecasts are quite close, including those for the total developing world at both $1 and $2 per day. There are, however, some important differences between the World Bank and IFs lognormal forecasts, especially for extreme poverty in sub-Saharan Africa. The three variations that might account for such differences occur in drivers, formulations, and initial conditions.

With respect to drivers, we saw earlier that in 2008 the World Bank revised its anticipated economic growth for sub-Saharan Africa

Table 5.3 World Bank and IFs forecasts of poverty rates

	Percentage of population living on less than $1 a day						
	2015				2030		
	WB-07	WB-08	IFs-LN	IFs-CS	WB-07	IFs-LN	IFs-CS
East Asia and the Pacific	2.8	2.0	3.8	7.4	0.8	1.4	1.9
China	3.6	2.1	2.7	6.6	1.1	0.3	0.0
Europe and Central Asia	1.0	0.3	0.6	1.8	0.6	0.3	0.8
Latin America and the Caribbean	6.1	5.5	7.1	8.1	4.1	4.6	5.4
Middle East and North Africa	0.7	0.7	1.3	4.0	0.2	1.5	2.3
South Asia	16.2	15.1	13.7	20.2	8.1	4.5	10.2
India		17.6	16.0	24.0		3.1	9.5
Sub-Saharan Africa	37.4	31.4	29.4	39.4	29.9	20.5	33.3
Total Developing Countries	***11.8***	***10.2***	***11.1***	***16.1***	***7.8***	***6.1***	***10.6***
	Percentage of population living on less than $2 a day						
	2015				**2030**		
	WB-07	**WB-08**	**IFs-LN**	**IFs-CS**	**WB-07**	**IFs-LN**	**IFs-CS**
East Asia and the Pacific	15.5	14.5	16.3	29.4	6.7	7.7	10.2
China	16.5	13.4	10.7	25.2	7.3	2.2	2.5
Europe and Central Asia	8.4	3.4	7.4	11.9	5.5	4.1	5.6
Latin America and the Caribbean	18.8	16.3	19.1	20.7	14.2	14.1	14.2
Middle East and North Africa	12.3	10.3	10.4	21.7	6.5	9.2	14.5
South Asia	60.2	59.0	60.3	54.1	46.0	30.7	35.8
India		62.7	56.4	59.5		23.5	34.7
Sub-Saharan Africa	66.5	61.5	66.6	69.2	58.0	56.0	60.2
Total Developing Countries	***35.1***	***32.9***	***35.0***	***41.1***	***26.7***	***23.0***	***27.8***

Note: LN refers to lognormal formulation; CS, to cross-sectional.

Source: World Bank 2007: 60 (Table 2.3); World Bank 2008: 46 (Table 1.5); IFs Version 5.47.

significantly upward. Prior to that revision, the IFs forecast of extreme poverty for the continent in 2015 was substantially lower than those of the Bank. Now they are quite comparable, although that from IFs for those living on less than $2 per day is now higher than that of the Bank.

IFs also anticipated lower poverty in China than did the Bank, especially at $2 per day. It is likely that the IFs forecast for economic growth in China was higher than that of the World Bank, especially through 2030. The differences with the Bank's values in 2008 are much less. Expected income distribution definitely makes a difference in drivers. IFs endogenously forecasts change in the domestic Gini coefficient. The Gini for China rises in the base case from 0.469 in 2000 to 0.474 in 2015, considerably less than the 10 percent deterioration posited by the Bank.

With respect to formulation, the differences through 2015 between the Bank's approach and the lognormal formulation of IFs are not great; although the Bank uses a three-parameter representation of the Lorenz curve instead of the lognormal representation, the two approaches are analytically very similar. The World Bank and IFs lognormal formulations vary somewhat more in the longer run. The World Bank numbers after 2015 are largely extrapolative, using poverty elasticities with income growth, whereas the IFs numbers reflect the functioning of the full, integrated modeling system. Although the two forecast sets remain quite similar, it is not surprising that they differ more for 2030 than for 2015. Differences in both drivers and formulations explain the increasing divergence.

The IFs cross-sectional forecasts are generally higher than the other two sets, something that Chapter 4 explained in terms of the formulation's potential responsiveness to chronic poverty in disadvantaged groupings. Because neither the Bank's approach nor that of IFs explicitly builds upon the heterogeneity of populations, this characteristic could be useful.

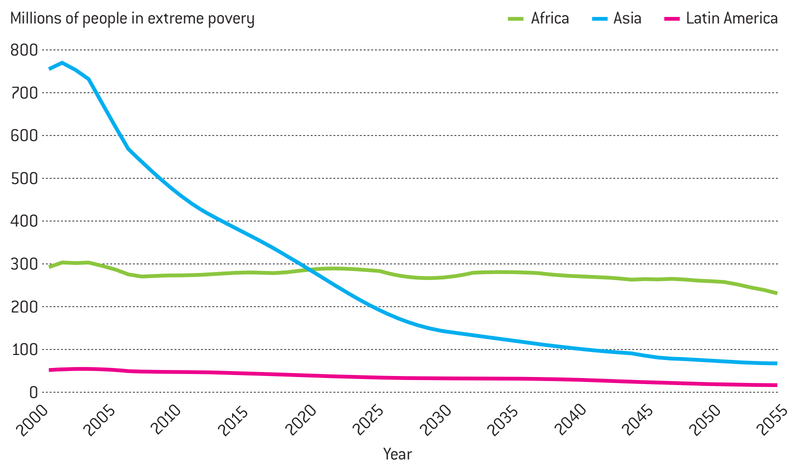
How much difference does the cross-sectional formulation make in baseline forecasts of poverty? Table 5.3 indicates that the magnitude is very substantial. In fact, the cross-sectional formulation suggests that the global goal for extreme poverty reduction will not be met in 2015. Rather, 16 percent of the population of developing countries would still be living on less than $1, in contrast to the 10 percent and 11 percent forecast by the Bank and IFs, respectively, using more traditional approaches.

With respect to initial conditions, the values used by the World Bank will inevitably differ somewhat from those used by IFs, partly because of different procedures for filling the large number of data holes. Only a few countries actually have surveys in any specific year (large countries mount surveys about every third year), so both the World Bank and the IFs project had to use assorted mechanisms, such as interpolation, for filling holes and providing global pictures for any given year. Because there are so many countries in sub-Saharan Africa and a relatively small number of surveys in any given year, it is likely that the largest differences in initial values for the World Bank and IFs would be for that continent, and they are. The World Bank (2007: 60) calculated the extreme poverty level of sub-Saharan Africa in 1990 at 44.6 percent, whereas IFs uses 43.7 percent. This discrepancy is obviously too small to account for the forecast differences but contributes to them.

Overall, the forecasts of poverty from the base case of IFs are not greatly different from those of the World Bank. Moreover, the differences are understandable in terms of variations in driver specification, formulation, and, to a much lesser extent, initial conditions. The basis for further analysis appears solid.

Before moving on to a more extended discussion of poverty, it is important to consider the information presented in Figure 5.7. Using the

Figure 5.7 Regional patterns of poverty in the Base Case



Source: IFs Version 5.47.

lognormal formulation, the IFs base case suggests that by about 2020, the ongoing processes of rapid reduction in poverty throughout much of Asia and considerably less progress in Africa will lead to the latter continent having the greatest number in poverty and by far the highest rates (not shown). The results for the cross-sectional formulation delay the crossover point for Africa and Asia to about 2040, but the implication is the same. As the attention of this book shifts to human intervention, it will need to focus more and more on Africa.

Moving beyond $1 and $2 per day

The world will soon begin to look beyond 2015 and, before many years, also beyond $1 and $2 per day as critical poverty lines. What might poverty rates be through midcentury? And might analysts want to begin focusing more attention on the number of people who live on less than $5, $10, or perhaps even $25 per day (corresponding to roughly $2,000, $4,000, and $9,000 per year)? In an early study of economic and social structure change, Hollis B. Chenery and Moises Syrquin (1975: 19) concluded that “75 to 80 percent of the total structural change takes place within” a range topped by about $1,000 in 1964 dollars at MER, about $7,000–8,000 per year at PPP in 2000 dollars. For instance, when countries reach such levels of average income, the agricultural share of GDP tends to fall below 10 percent, fertility generally drops to replacement levels, life expectancy typically reaches seventy or above, primary education completion normally exceeds 90 percent, access to safe water and improved sanitation nears 100 percent, and much more (Hughes 2001).

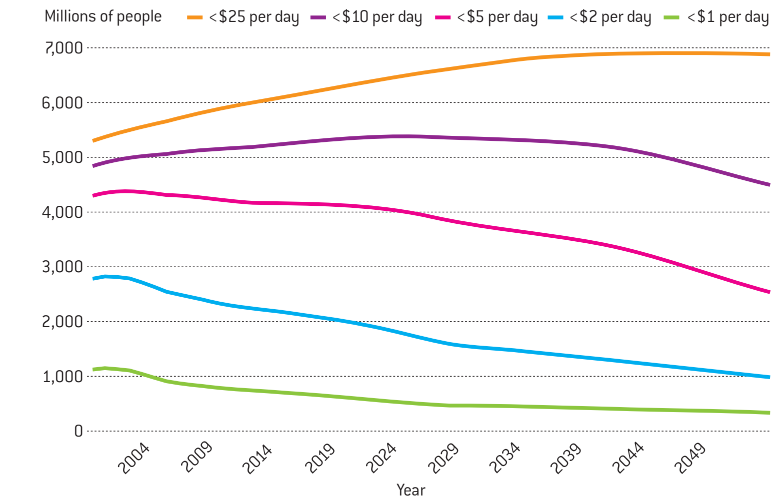
Countries actually accomplish a very large portion of that transformation below a lower level of about $10 per day, roughly the level at which people demonstrate the satisfaction of more basic needs by looking seriously at the purchase of an auto. The definition of entry into the global middle class is marked by reaching an income of about $4,000, or about $11 per day (World Bank 2007: 73). Thus, barring global catastrophes that set back long-term global growth patterns, our desire that humans attain basic capabilities to escape poverty will ultimately require attention to such levels, well above $1 or $2 per day.

Figure 5.8 provides forecasts through midcentury of the number of humans who will be living in poverty defined by five different poverty lines.[21] Hopefully, the world will not increasingly ignore the 350–500 million people who may remain rather persistently in extreme poverty between 2025 and 2055. And it certainly will not be able to turn its eyes from the more than 1 billion people likely to be living on $2 per day or less by midcentury. In fact, it is likely that $2 per day will replace $1 per day as the primary focus of attention. If another line becomes important in discussion of global poverty, it may well be $5 per day. Even by 2055, nearly one-third of humanity is likely to live on less than that amount.

Table 5.4 takes a first cut at exploring in regional detail how the world now looks and how it might appear from the perspective of a poverty line of $5 per day. It suggests that about 70 percent of the global population lived below that level at the beginning of this century and more than 90 percent in both sub-Saharan Africa and South Asia. Given the growth patterns of the base case, those rates could be dramatically lower almost everywhere by midcentury, although the rate in sub-Saharan Africa may still be about 70 percent.

Attention to the emergence of a global middle class requires looking at incomes above $10 per day.

Figure 5.8 Global poverty headcount using multiple poverty lines



	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049
<$1 per Day	1,023	801	707	621	527	446	436	405	376	354
<$2 per Day	2,698	2,379	2,194	2,041	1,830	1,571	1,459	1,347	1,229	13
<$5 per Day	4,349	4,246	4,148	4,122	4,034	3,829	3,648	3,491	3,260	11 2,927
<$10 per Day	5,004	5,120	5,194	5,300	5,366	5,344	5,304	5,246	5,102	4,834
<$25 per Day	5,541	5,810	6,027	6,225	6,431	6,600	6,753	6,847	6,885	6,885

Source: IFs Version 5.47.

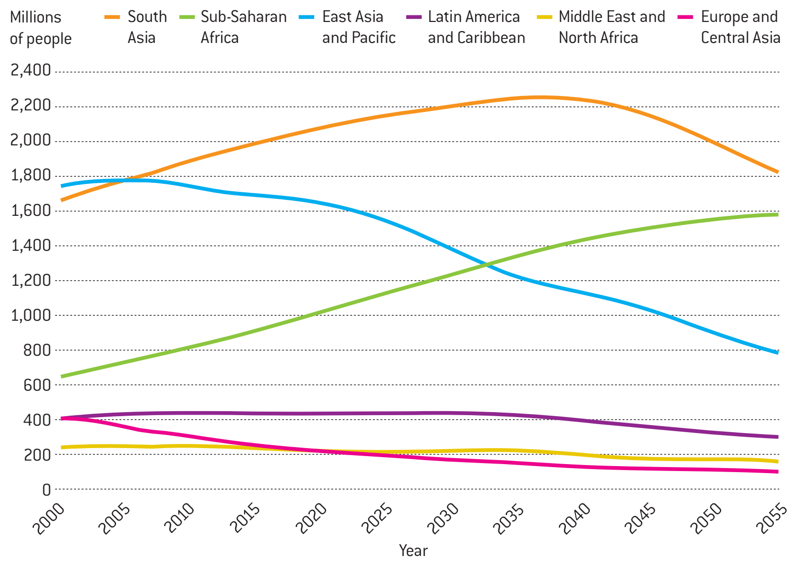
Table 5.4 Forecasts of poverty rates at $5 per day (lognormal formulation)

	Poverty rates at $5 per day		
	2000	2030	2055
World	70.7	46.0	26.6
High-income countries	1.7	0.6	0.1
Developing countries	83.3	52.4	29.8
East Asia and the Pacific	85.6	32.9	12.1
China	84.5	23.3	7.1
Europe and Central Asia	62.2	14.5	6.2
Latin American and the Caribbean	57.4	37.0	19.5
Middle East and North Africa	66.3	31.0	10.3
South Asia	93.7	67.4	29.7
India	98.6	71.0	19.5
Sub-Saharan Africa	94.2	82.0	62.5

Source: IFs Version 5.37.

Moving up one step further in income, on a global basis, IFs calculates that nearly 5.1 billion were living on less than $10 per day in 2000. How might global poverty at that level, roughly the bottom of middle-class status, unfold across the next fifty years? Figure 5.9 shows the IFs base case forecast. Economic and population growth clearly interact in producing that forecast. Because of strong economic and low population growth forecasts, the number in East Asia and the Pacific living on $10 per day or less may decline quite substantially. In contrast, the number below $10 in South Asia will probably continue to grow until about 2035. As the number in South Asia ultimately begins to decline, the number living below $10 per day in Africa may overtake the region. Interestingly, in 2055 the IFs forecast is that about 5.1 billion people globally will still live at or below $10 per day, even though the percentage may decline from 79 percent of global population to 54 percent.

Figure 5.9 Numbers living on less than $10 per day (consumption)



Source: IFs Version 5.47.

This discussion has begun to move from consideration of poverty in absolute terms to exploration of it in relative terms. Figure 5.10 takes another step in doing so. Looking inside each of the world's developing regions, it portrays the number of dollars per day available to the bottom 20 percent, as opposed to the dollars available to those who control more buying power. By midcentury, that line may approach $7 per day in East Asia and in the Middle East and North Africa. Yet in Africa it may still hover around $1 per day, which means that the $1-per-day measure may continue to be very relevant for that region even then.

In the richest countries of the world, such as the original members of the European Union and the United States (not shown in Figure 5.10), the dividing line between the poorest 20 percent of the population and those with higher daily consumption levels is already about $20 per day (2000 dollars at PPP).[22] In relative terms, those societies would consider many or most in that bottom 20 percent to be living in poverty.

Moving beyond income poverty

Chapter 2 emphasized that poverty is a much more complex phenomenon than simple income measures can capture. Thus it is important in this volume that we use a variety of measures, supplementing income ratio and headcount with measures such as the poverty gap, but also looking much more broadly to capabilities-based measures like the noneconomic contributions to the human development index (HDI), as well as the HDI itself.

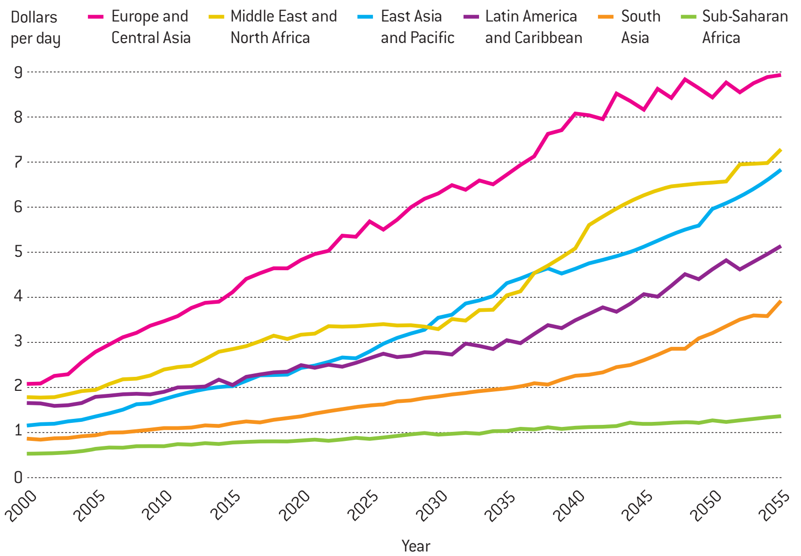
Figure 5.11 shows the average years of education of people twenty-five years of age or older in non-OECD and OECD country groupings (those who wish to see regional and country detail can check the appendixes to this volume). The Robert J. Barro and John Wha Lee (2000) dataset provided the historical data. The forecasts are from the IFs cohort-based model of formal education at primary, secondary, and tertiary levels, developed by Mohammod Irfan. As Sen (1999) has stressed, an increase in educational levels plays a critical part in developing human capabilities that provide the foundation for true freedom. Thus the second volume in this series will focus directly on enhancing educational attainment.

Interestingly, Figure 5.11 could support the same kind of alternative interpretations of global inequality that global GDP per capita often does. Those who see the glass as half empty will likely point to the fact that no significant closure of the nearly four-year gap in educational levels of 1960 between OECD and non-OECD countries has occurred or is anticipated in the base case. At the same time, those who see it as half full will note that the ratio of years of education in the OECD to years of education in non-OECD countries, which has been steady at about 1.9, is forecast to decline below 1.5 by midcentury. Moreover, the average years in school of populations in non-OECD countries will likely reach nine years.

Table 5.5 shows the rise in the human development index for developing regions in the base case forecast of IFs through midcentury. The impact of HIV/AIDS on life expectancy in sub-Saharan Africa, and therefore on HDI, has been substantial. Extending African performance in the 1980s and early 1990s that was already anemic, AIDS has helped cut growth in the HDI for the continent to nearly nothing in the last decade and will help keep it fairly low even through 2030. It appears likely that East Asia and the Pacific will overtake Latin America and the Caribbean within the next two decades, very likely advancing toward the top of the (currently configured) HDI scale by midcentury.

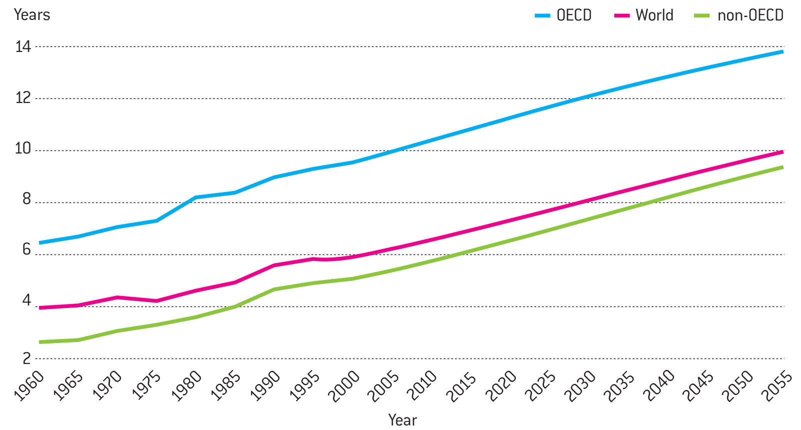
Moving beyond income even in relative terms, Table 5.5 shows two key measures more closely linked to capabilities and functioning. The HDI is fairly well-known: it averages measures of a long and healthy life, knowledge (literacy and educational enrollment) and a decent standard of income. By midcentury the developing world may largely catch up with the current level of countries in the Organization for Economic Cooperation and Development. Some developing regions will be near the top of that index's current range.

Figure 5.10 Consumption level defining the poorest 20 percent



Source: IFs Version 5.47.

Figure 5.11 Education years at age twenty-five: History and forecast



Source: IFs Version 5.47.

Although the HDI tells us much about average capabilities and human development, the first version of the human poverty index (HPI-1) better links functioning and poverty by its attention to deprivation. It focuses on the percentage of a population that fails to attain capabilities and functioning. Specifically, it averages (1) the portion of a population not reaching age forty, (2) the adult illiteracy rate, and (3) a subindex averaging of the portions of population not having sustained access to improved water and the number of underweight children. The HPI-1 paints quite a different picture from the HDI. For

Table 5.5 Human development index (HDI) and human poverty index (HPI)

	Poverty measures related to capabilities and functioning					
	HDI (scale is 0–1)			HPI-1 (scale is 0–100%)		
Developing Regions	**2000**	**2030**	**2055**	**2000**	**2030**	**2055**
East Asia and Pacific	0.74	0.83	0.97	15.0	8.2	2.5
China	0.76	0.86	1.00	13.1	6.3	1.7
Europe and Central Asia	0.79	0.85	0.97	7.4	5.2	2.2
Latin America and the Caribbean	0.78	0.83	0.95	11.5	8.0	2.9
Middle East and North Africa	0.67	0.74	0.91	22.8	16.1	7.1
South Asia	0.58	0.64	0.84	33.1	27.8	17.1
India	0.58	0.64	0.88	34.2	28.6	17.7
Sub-Saharan Africa	0.45	0.52	0.72	41.3	37.5	232.3
Developing world total	***0.66***	***0.72***	***0.89***	***23.2***	***19.0***	***12.3***
Developed world (OECD)	***0.92***	***0.95***	***1.00***	***3.6***	***2.5***	***1.1***

Note: HPI refers to Human Poverty Index.

Source: IFs Version 5.47.

instance, in 2055 the developing world as a whole may still lag considerably behind the developed world's current values.

Remarkably, the scaling of the HPI-1 is such that it corresponds in this decade very closely to $1 per day. In the developing world as a whole in 2000, the IFs calculation of the income level that separates the lowest 23.2 percent (the HPI value in that year) from the rest of society is about $1.04, very nearly the official $1.08. Similarly, the value that separates the lowest 41 percent in sub-Saharan Africa from others is about $1.10, as is the value that separates the lowest 33 percent of South Asians from others. In spite of these similarities in the aggregate, the people who live below $1 would not always be the same as those designated as deprived by the HPI-1.

Although poverty measures are correlated, they tap very different aspects of the phenomenon.

The HDI, HPI-1, and income measures demonstrate, however, quite different patterns when one looks forward—although correlated, they tap very different aspects of poverty and human development. For instance, IFs calculates that the line separating the bottom 12.3 percent of the developing world (the HPI-1 forecast for 2055) from the more well-to-do population will be about $2 per day, not $1.1. That is, deprivation will not decline as quickly as incomes will rise, a phenomenon consistent with the continued persistence of a chronic core of poverty. The stories of poverty now and in the future are very much multifaceted. Forecasts with alternative measures in this volume break new ground (see, especially, the forecast tables at the end of this volume). The development and use of a wide range of measures must continue.

Conclusion

The base case forecasts of IFs with Pardee are generally and purposefully not very different from those of other long-term forecasting models. Those of IFs have the added advantage of representing an integrated system across demographic, economic, sociopolitical and other modules. They also reach beyond the two basic measures of global income poverty. Thus the base case forecasts provide a useful foundation for subsequent chapters, which explore interventions relative to the base.

It is not too strong a statement to say that forecasts of complex human systems are nearly always wrong, whether in the short or long run. Why, then, build anything further on the base case of IFs in subsequent chapters? As we argued in Chapter 1, for those interested in the possibility of actions that might enhance the global human condition, there is no alternative to forecasting. It is necessary to make one's best estimates about that condition, with and without various interventions. In fact, the real value added of forecasting is precisely around such interventions. So, caveats in place, it is time to move forward.

1 Population Division of the UN Department for Economic and Social Affairs. The UN releases revisions of its forecasts biannually under the title *World Population Prospects* (see UN Population Division 2006 concerning the 2004 revision) and http://www.un.org/esa/population/publications/wpp2006/wpp2006.htm for the 2006 revision. The coverage is global, built up from countries. The forecast horizon is normally through 2050, but in late 2003 the UN released forecasts through 2300, under the title World Population in 2300. In addition, the UN has also prepared a database on migration with forecasts through 2050.

2 The U.S. Census Bureau began publishing global forecasts with a 2050 horizon by country in 1985 and does so periodically in its *Global Population Profile* (for the 2002 report, see U.S. Census Bureau 2004). The coverage of IIASA's population forecasting is global, although often with a focus on thirteen global regions and variously through 2050 or 2100 (Lutz, Sanderson, and Scherbov 2004).

3 Although its does not provide global forecasts, the Population Matters program of RAND produces targeted demographic forecasts of importance. See, for instance, Bloom, Canning, and Sevilla, *The Demographic Dividend* (2003) and Cook, Demographic Trends Alter the National Security Scene (2000).

4 For further reference, the Millennium Ecosystem Assessment (MA) (2005: 306) scenarios generate global populations in 2050 that range from a high of 9.6 billion for Order from Strength to a low of 8.1 billion in Global Orchestration. There is no base case in the MA. The MA scenarios were generated by the IIASA population model.

5 The median forecast for 2050 in 1994 was 9.8 billion, in 1996 it was 9.4 billion, in 2000 it was 9.3 billion, and in 2002 it was 8.9 billion. But in 2004 it increased to 9.1 billion. The 2002 revision brought the UN forecasts more in line with those of IIASA in 2001 (as reported in *Nature,* January 9, 2005), namely peaking by 2070 at about 9 billion and declining to 8.4 billion in 2100.

6 The OECD also periodically provides forecasts with a longer range. In 1979 it released *Interfutures: Facing the Future*. In 1991 it published a collection of articles in Long-Term Prospects for the World Economy with some horizons through 2010 and 2015. Sadly, but with importance as a warning to contemporary forecasters, the seeming inability of the United States to shake off low productivity and the great success of Japan in racing ahead appeared for authors at that time to be patterns unlikely to change. By the late 1990s, the OECD (1999) had turned some attention to analyzing the "Long Boom" in a collection of articles looking to 2025 and other horizons, and in 2006–2007 the OECD (2006) undertook a large-scale integrated environmental outlook to 2030 and prepared global economic forecasts in the process.

7 In 2008 the International Comparison Project revised its estimates of GDP at PPP based on new surveys in China and India, greatly narrowing earlier estimates of the gaps between values at PPP and MER; the IFs formulations expect narrowing to continue.

8 Without the representation of convergence, the Chinese growth rates at MER would be unrealistically passed through to PPP and result in many perverse effects, including overly rapid reduction in poverty and unreasonable growth in energy demand. The need to recognize more modest rates of increase in GDP at PPP is one reason some analysts arbitrarily adjust downward Chinese growth at MER.

9 The relationship between MER and PPP accounts is both complicated and controversial (see Castles and Henderson 2003 for some of the controversy). Nordhaus (2005) sorts the relationship out particularly well. Nuxoll (1994) found, similarly to the IFs forecasts, that developing country growth rates at PPP tend to be lower than at MER.

10 In 2011 Data Resources Inc. (DRI) and Wharton Econometric Forecasting Associates (WEFA) merged to become Global Insight.

11 Given the much greater economic weight of other developing regions, the anticipated growth of developing countries as a whole is nonetheless quite similar in the World Bank and IFs forecasts. One surprising element is the considerable difference in world rates. Because the developing countries have a slightly greater GDP throughout most of the forecast horizon, one would expected the weighted average to be somewhat closer to the value of the developing countries, which is not true for the value provided by the World Bank. One possible explanation is that the World Bank may have weighted the global calculation with GDPs only early in the forecast horizon, not with GDPs throughout it.

12 One noteworthy feature of the forecasts of GDP per capita from Global Insights is that the rates for 2015–2030 are consistently lower than those for 2000–2015, in contrast to the forecasts of IFs (see Figure 5.4). Limited explanation of the forecasts is available in the *International Energy Outlook 2006* except for (1) a footnote indicating an analyst-based downward adjustment of rates in India and China and (2) an argument (DOE 2006: 13) that labor force growth rates are anticipated to decline in other non-OECD Asia. In fact, although labor force growth rates are likely to decline in most developing countries, labor force as a share of the total population, normally growth enhancing, is likely to continue rising for many, especially in Africa. Global Insights has also created high and low economic forecasts for the period through 2030. The high-growth scenario assumes OECD and non-OECD growth rates 0.5 and 1.0 percent higher, respectively, with a raise by 1.5 percent in Russia. The low-growth scenario assumes reductions of the same magnitude.

13 Those interested in energy tend to adopt forecast horizons between 2015 and 2050 (e.g., U.S. Department of Energy 2006 and Shell 2001), whereas those interested in climate change have horizons that reach to 2100. With respect to climate change, in 1998 the International Institute for Applied Systems Analysis produced global economic forecasts through 2100 in cooperation with the World Energy Council (WEC) titled *Global Energy Perspectives* (Naki enovi , Grübler, and McDonald 1998). Building in part on IIASA and WEC foundations, the IPCC has needed economic growth forecasts through 2100 as a foundation for its energy and environmental analyses. These are available in the IPCC Third Report Emissions Scenarios (2001). The Millennium Ecosystem Assessment (MEA) in 2005 forecast to 2100, and the UN Environment Programme's Global Environmental Outlook 4 will look out to 2050 (using IFs with Pardee for the economic forecasts).

14 Van Vuuren and O'Neil (2006) have analyzed these numbers and compared them with other economic forecasts, including those of Richels, Manne, and Wigley (2004) who, in working with the Stanford-based Energy Modeling Forum, forecast growth for the twenty-first century between 1.7 and 2.8 percent, with 2.4 percent as the medium case.

15 Another primary source of long economic forecasts is the Millennium Ecosystem Assessment (2005; see Chapter 9, page 309 for tables of forecasts). Its four scenarios come in substantial part from the IMAGE Team (2001) with help in regional disaggregation from procedures developed by Bollen (2004) and the World Scan model. All of the MEA scenarios anticipate higher per capita global economic growth in the 2020–2050 period than in the preceding 25 years, with rates from 1.0–3.0 percent (the IFs base case is at the high end of this range).

16 Goldman Sachs 2003: cover page; for detailed forecasts, see page 9.

17 Methodologically, the Goldman Sachs model is driven substantially by an assumption of 1.5 percent annual convergence of total factor productivity in the BRICs with the United States (Goldman Sachs 2003: 18).

18 The Goldman Sachs analysis attributed about one-third of the gap closure to appreciating currency values of the BRICs. This reflects their recognition that BRICs have relatively higher GDP at PPP than at MER. Our own analysis concurs with their expectation that GDPs at PPP will likely converge with those of the G-6 by midcentury and that, with likely currency appreciation added, GDPs at MER may also do so.

19 The World Bank calls them intercountry, international, and global inequality, respectively.

20 Chapter 4 pointed out that, although initial conditions for Bhalla's forecasts (2002: 170) differ from those of the Bank as a result of different measurement approaches for 2000, the trajectories of his forecasts are very similar to those of the Bank.

21 The lognormal formulation currently allows at least crude estimates of poverty at any specified poverty line. A specialized display form within IFs allows exploration of poverty at different daily consumption levels and consideration the thresholds that divide different percentiles of population from each other.

22 Estimates within IFs of poverty numbers in percentiles of societal distributions and of numbers falling below poverty lines other than \$1 and \$2 do not tie directly to survey data as do initial conditions for poverty at those two standard analysis levels. Instead, they draw upon the lognormal formulation, anchored by average societal consumption levels and the income distribution of Gini coefficients. For consistency, we adjusted the lognormal formulation to \$2-per-day poverty rates from available surveys before calculating higher poverty levels.