



Munich Personal RePEc Archive

## Development Targets and Costs

Christiaensen, Luc and Scott, Christopher and Wodon,  
Quentin

World Bank

April 2002

Online at <https://mpra.ub.uni-muenchen.de/12299/>  
MPRA Paper No. 12299, posted 21 Dec 2008 06:57 UTC

# Chapter 4

## Development Targets and Costs

*Luc Christiaensen, Christopher Scott, and Quentin Wodon*

4.1	Introduction .....	132
4.2	The Political Economy of Target Setting.....	132
4.2.1	The incentive effects of targets .....	132
4.2.2	Selected choices involved in target setting .....	133
4.2.3	Monitoring progress .....	137
4.3	Setting Realistic Targets .....	137
4.3.1	Historical benchmarking.....	137
4.3.2	Macrosimulations.....	139
4.3.3	Microsimulations .....	145
4.4	The Cost and Fiscal Sustainability of Target-Reaching Efforts.....	145
4.4.1	Assessing costs .....	146
4.4.2	Efficiency of public spending .....	149
4.4.3	Fiscal sustainability .....	151
4.5	Conclusion .....	153
	Notes.....	153
	References .....	153

### **Tables**

4.1.	Agricultural Growth in Guinea and Selected Neighboring Countries, 1970–2000 .....	138
4.2.	Gross Primary Enrollment in Guinea and Selected Neighboring Countries, 1960–96 .....	139
4.3.	Required Annual Growth to Halve Poverty over 25 Years in African Countries .....	140
4.4.	Elasticities of Poverty with Respect to Growth and Inequality in Latin America .....	141
4.5.	Structure of SimSIP_Costs for the Education, Health, and Infrastructure Sectors.....	148

### **Figures**

4.1.	The Stages of the Program Cycle.....	135
4.2.	Measuring Efficiency of Input Use.....	150

### **Boxes**

4.1.	Missing the Point? Target Setting in the United Kingdom.....	134
4.2.	Delivery of Basic Services in Uganda: The First Annual PRSP Progress Report.....	136
4.3.	Microsimulations for Child Malnutrition and Maternal Mortality .....	146
4.4.	Progresa: A Successful Means-tested Social Transfer Program in Mexico.....	150
4.5.	Efficiency of Expenditures on Health and Education .....	151

### **Technical Notes (see Annex D, p. 463)**

D.1	SimSIP_Goals: A Simulator for Setting Targets .....	463
D.2	SimSIP_Costs: Estimating the Cost of Reaching Targets .....	465
D.3	Estimating Production Frontiers .....	468

*Acknowledgments:* Jeni Klugman and Norman Hicks provided valuable encouragement and feedback for this paper. The material on SimSIP was developed under poverty assessment and technical assistance tasks for Bolivia and Honduras. Additional support was provided by the Regional Studies Program at the Office of the Chief Economist for Latin America and by the Dutch Trust Fund for PRSP-related activities. In addition to Quentin Wodon, the core team that designed SimSIP included Mohamed Ihsan Ajwad, Bernadette Ryan, Corinne Siaens, and Jean-Philippe Tre. Benedicte de la Briere also contributed, under funding from the Thematic Group on Monitoring and Evaluation. Comments from participants at World Bank seminars on SimSIP were much appreciated. Especially helpful were Gaurav Datt, Martin Ravallion, and Michael Walton. For more details on SimSIP, please contact Quentin Wodon through Anne Pillay at [apillay@worldbank.org](mailto:apillay@worldbank.org).

## 4.1 Introduction

Realistic, quantified development targets are key components of PRSPs, and their establishment is a significant challenge for policymakers. Development targets are intended to help governments focus their resources and hold them accountable for subsequent actions. To serve these purposes, targets must be SMART; that is, they must be Specific, Measurable, Achievable, Relevant, and Time-bound. Experience has shown that most targets developed in the current PRSPs and I-PRSPs fail in several of these dimensions. Most often they are overambitious; they are technically and fiscally unattainable, which defeats their role as effective incentives to action. One example is Tanzania, where some recent informal assessments suggest that the PRSP targets for lowering infant, child, and maternal mortality in this country are unachievable, while other targets—such as those for reducing income poverty, improving access to safe drinking water, and rehabilitating rural roads—will be attained only under the most optimistic assumptions. While this example is particularly striking, it is by no means unique. Similar examples have been reported in other countries. Targets are often also fiscally unattainable. For example, in many countries, the cost of reaching the targets set forward in the Poverty Reduction Strategies largely exceeds the amount of debt relief granted under the Heavily Indebted Poor Countries (HIPC) agreement.

This chapter presents some analytical techniques to help policymakers gauge the technical and fiscal feasibility of their targets. While each of the techniques discussed below has deficiencies, taken together they have proven very useful in providing a sense of realism to target setting. The chapter begins with a review of issues involved in target setting. It then presents three methods for assessing the technical viability of development targets, gradually moving from low data- and skill-intensive to more demanding tools. Next, the chapter discusses two broad sets of techniques for estimating the cost and fiscal feasibility of reaching specific targets, as well as a number of issues to be considered when gauging a country's capacity to implement the related program. The chapter ends with some concluding remarks.

## 4.2 The Political Economy of Target Setting

Targets form a powerful tool to help policymakers focus their efforts and improve their policies' efficiency. Yet this does not follow automatically. Broad political consensus, careful design, and continual monitoring are necessary for targets to be effective. This section elaborates on the different roles targets play (section 4.2.1) and provides some guidance regarding the key choices involved in setting effective targets (section 4.2.2). Monitoring issues are briefly discussed in section 4.2.3.

### 4.2.1 The incentive effects of targets

A target is a pre-determined value of a specific indicator that a country wants to achieve by a particular date. For example, a country may want to reduce the incidence of poverty to one-half its current level by 2015. When countries, agencies, or individuals expect to be evaluated on the basis of whether they have met specific targets, these targets may affect their behavior in at least three ways.

#### ***Resource mobilization***

The setting of targets helps mobilize resources (human and financial) in order to achieve certain goals. Targets represent challenges. They indicate priorities, and they may serve as catalysts to focus the efforts of the various parties involved in reaching the targets. Mobilizing resources is without doubt a primary function of targets set by the international donor community such as the International Development Goals. In domestic settings, as well, targets are frequently used to galvanize support for key initiatives. It is important to set ambitious yet realistic targets, which implies they must be both technically and fiscally feasible. Indeed, if targets are perceived as either too easy or too difficult to attain, mobilization will be weakened. When they are too easy, targets will not be viewed as sufficiently challenging and they will fail to stimulate a response. When they are too difficult, targets will be seen as infeasible and thus unworthy of additional effort.

### **Resource allocation and consensus building**

The process of setting targets helps to prioritize the allocation of resources. Other things being equal, governments and other involved parties will focus their activities on areas where targets have been set rather than on “targetless” areas. The process for setting targets should thus be participatory, in order to galvanize such broad societal support for these targets that governments can and will be held accountable for reaching them. Ideally, progress reports should be fed back into the political debate about choosing proper targets, so that the process becomes iterative, with contributions from specialists, policymakers, and political representatives. Targets indicate priorities for the allocation of public expenditures. It follows that the larger the number of targets, the weaker their role in setting priorities for resource allocation. Having too many targets erodes the significance of any single target. Finally, setting priorities and targets presupposes some knowledge of the relationship between the targets and the inputs (and the associated costs) necessary to reach them. While it is clearly impossible in practice to obtain perfect knowledge of this relationship, such precision is not required to foster a culture of accountability and performance orientation in the budgetary system, the third key objective of setting targets.

### **Performance evaluation**

Targets introduce accountability. They provide benchmarks against which the performance of the responsible actors can be judged. Performance is judged as good if targets are met, and bad if they are not. The effectiveness of targets as performance benchmarks depends on the consequences for the different actors (the government, the private sector, and/or civil society) of meeting or not meeting targets. For example, if bad performance may ultimately result in replacement, or if failure to meet targets may affect the release of (additional) funds by a lender or donor, there will be powerful incentives to reach the targets. In this situation, setting targets becomes an integral part of the conditionality framework. Yet, in order for targets to act as credible benchmarks for performance evaluation, they must be realistic, they must carry broad societal support, and it must be possible to disentangle the effects of poor performance by the implementing actors from the effects of external shocks. Also, there is typically more than one benchmark, and failure according to one criterion may be balanced by success according to another. It is thus essential to take a balanced and comprehensive view in evaluating a government's performance in reaching targets. For example, when evaluating the implementation of its PRSP, a country may find that it reduced income poverty over a three-year period, thereby demonstrating “success” when compared to a poverty baseline. But it still may have missed its poverty reduction targets due to unforeseen external shocks, such as a drought or a sudden change in its terms of trade, thereby exhibiting “failure.” Furthermore, as was the case in Uganda (see box 4.2 below), success in reaching certain outcome targets, such as gross school enrollment rates, may occur at the expense of deteriorating quality, as revealed by lower teacher-pupil and textbook-pupil ratios.

While it is clear that setting targets has, in principle, positive incentive effects for public mobilization, resource allocation, and performance benchmarking, it is also clear that this does not follow automatically. Great care must be taken in the design, implementation, and evaluation of targets. As in the case of the United Kingdom, illustrated in box 4.1, there is always a risk that targets may not convey appropriate priorities, could be too complex or numerous, or might stifle innovation in the field due to bureaucratic pressure from the center to meet the targets. When these things happen, targets may lead to suboptimal behavior and unintended consequences. It is therefore important to make the right choices in setting targets and look for targets that are SMART, i.e., targets that are Specific, Measurable, Achievable, Relevant, and Time-bound. In the next section we will review some key issues in setting SMART targets.

#### **4.2.2 Selected choices involved in target setting**

Many choices are involved in setting targets, and those choices critically determine the effectiveness of targets or incentive mechanisms. In this section, we review such key issues as whether to set targets for inputs, outputs, outcomes, or impact; whether to set point targets or target ranges; whether to set targets only at an aggregate level or also at a disaggregate level; and whether to set targets for the short run or for the long run.

#### Box 4.1. Missing the Point? Target Setting in the United Kingdom

If targets are to be useful, they should have the characteristics highlighted below. In the United Kingdom, many targets seem to lack these qualities, calling into question the effectiveness of target setting in that country.

**Simplicity.** Targets need to be simple to be useful as a management tool. Yet public services are often trying to fulfill many objectives. In the United Kingdom, government departments are currently striving to meet around 600 targets. How successful are the public services in meeting these targets? There is no simple answer to that question. The information is not only scattered across reports issued by individual departments, but it is also difficult to interpret. “The target regime is virtually impossible to follow,” says Tony Travers of the London School of Economics. “The government has engineered an incredibly complex world where targets and indicators change and it is very difficult even for experts to keep a grip on what they are and to understand whether they are being achieved.” The government has accepted that its first set of targets (in 1999) was problematic. Supposedly SMART—Specific, Measurable, Achievable, Relevant, and Time-bound—they turned out to be anything but. A new set of targets has sought to address the earlier weaknesses, through closer focus on outcomes and a drastic cut in the number of “high-level” performance targets, from around 300 to 160. But are the new targets any better? A report from the National Audit Office (NAO) revealed nervousness on this point within the government. The NAO surveyed 17 departments and found the biggest worry is a lack of incentives for workers to meet targets. Another concern is the difficulty in identifying “high-level quantifiable measures of the intended outcomes”—even though departments had spent a year laboriously negotiating just those. Departments were also worried about their ability to influence final outcomes.

**Incentive effects.** If public servants are asked to focus on one measure, they will ignore the others. So when the government set a target for reducing class sizes within primary schools, these duly fell—and secondary school class sizes rose. And when the government set a target for raising literacy and numeracy, children became more literate and numerate—but at the cost of squeezing out other beneficial activities such as sport. At worst, targets create “perverse incentives,” when workers find ingenious, and not necessarily desirable, ways to meet their targets. That is why, for example, the government’s commitment to reduce the hospital waiting list is now widely discredited. The target, cutting the number of people waiting for treatment by 100,000, has been met. But the number of people waiting to see a specialist—waiting to be put on the waiting list, in other words—increased. The target has distorted clinical priorities; minor disorders can be dealt with more swiftly than serious illnesses, so managers have been putting pressure on surgeons to give smaller problems priority over larger ones. To give another example, when the government set local authorities a target for collecting recyclable waste, it seemed a good idea. Even better, the local authorities persuaded residents to take the trouble to separate the stuff that was worth recycling from all the rest—and met their target. There was only one snag. The target was for collecting recyclable waste, not for recycling it. As a result, some local authorities put the rubbish that had been so carefully separated back in with the rest of their garbage and incinerated the lot.

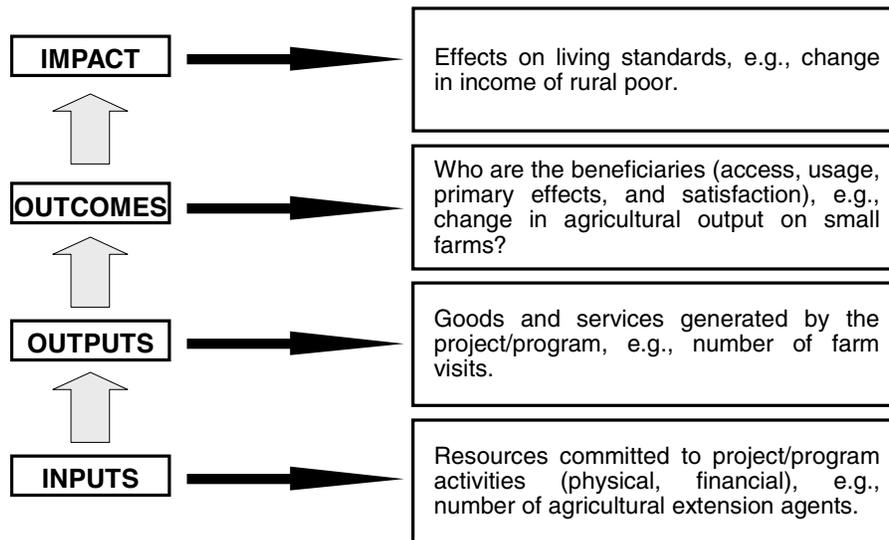
**Innovation.** Britain’s new targets linked to spending plans for 2001–04 break new ground in their focus on the outcomes of public spending. Whereas an output target might be the number of police officers, an outcome target is a reduction in crime. Some of these stretch a long way into the future. For example, there are precise numerical commitments to reductions in mortality rates from heart disease and cancer by 2010. Yet targets risk promoting the illusion that the center can drive change, while improvements in public services generally come from individuals and teams finding better ways to work. Targets also risk encouraging bureaucracy, thereby stifling initiative on the ground. One risk arises because, in general, it is easier to measure outcomes than to determine who is responsible for them, so the target regime could degenerate into something that is farcical and useless. There are worries that the focus on outcomes that can be quantified comes at the expense of others that cannot so easily be measured. Even if the targets are achieved, it may be at the cost of worse performance in another area. For instance, literacy and numeracy may easily be targeted, but improvements in schools in those areas may be at the expense of less measurable virtues, such as creativity.

Source: Adapted from *The Economist*, April 28–May 4, 2001, pp. 22 and 53–54

#### Targets for inputs and outputs, or for outcomes and impact?

In principle, targets may be set at each of the four stages of the program or policy cycle: inputs, outputs, outcomes, and impact (see figure 4.1 and chapter 3, “Monitoring and Evaluation,” for a definition of these terms). The first two stages in the cycle—inputs and outputs—cover implementation of the program or policy, while the last two stages—outcomes and impact—seek to capture the program’s results. Since the PRSP process will be judged primarily on its results, the most important targets will refer to outcomes and impact. Nevertheless, there are good reasons for including input and output targets as well. First, at least over short periods of time, input indicators are likely to play as important a role in poverty monitoring as outcome indicators, because the effects of poverty-reducing policies materialize only after a time lag. Second, given that policymakers do not control all the factors that convert inputs into outcomes, input indicators such as the actual disbursement of public expenditures for poverty reduction purposes can be a valuable guide to a government’s ex ante seriousness of purpose in reaching certain outcomes such as poverty reduction.

However, if targets for inputs and outputs are included together with targets for outcomes and impact, then the targets for results should be checked for consistency with the targets for implementation, i.e., they should be vertically consistent. For example, a target for increasing agricultural production (a result target) may entail a target for the number of farm visits by agricultural extension staff during the

**Figure 4.1. The Stages of the Program Cycle**

next year (an output target). This in turn implies a set of targets for the number of extension agents and vehicles (input targets), for a given level of public sector technical efficiency. The importance of consistency among result and implementation targets is clearly illustrated by the recent experience in Uganda (see box 4.2). Consistency among targets can be checked either by examining how indicators of outcomes have varied with indicators of inputs and outputs in the country's past, or through comparing the input-output-outcome relationship implicitly assumed in a country's PRSP with international evidence (see section 4.3.1). Since outcomes in different areas of well-being are often interdependent (for example, both the incidence of income poverty and infant mortality may be affected by female educational attainment), the consistency of outcome targets for different dimensions of well-being should also be checked. That is, in addition to being vertically consistent, targets should be horizontally consistent. Finally, when targets are set for each stage of the program cycle for each of the different dimensions of well-being, they quickly become too numerous, which in turn undermines their individual strength (see box 4.1). The marginal benefits of yet another target in terms of increased incentives and accountability will have to be traded off against increasing marginal costs of implementing and monitoring this additional target.

### ***Point targets or target ranges?***

In many cases, countries lack reliable information on the input-output relationship at the sector level. There is also some level of uncertainty over the elasticity or responsiveness of poverty and human development indicators with respect to growth and other macroeconomic variables, as well as a high degree of vulnerability of many PRSP countries to shocks such as low rainfall, adverse movements in commodity prices, or natural disasters. All this suggests that target *ranges*, rather than point targets, may be more appropriate for outcomes and impact. In the case of income poverty, for example, a target range's lower bound might be that the aggregate poverty incidence, as measured by the headcount ratio, should not increase between 2000 (the assumed start date of the PRSP) and 2003. Its upper bound could be a given reduction in the headcount ratio using realistic growth and urbanization projections, and the related poverty elasticities (see section 4.3.2 below). On the other hand, point targets may be more appropriate for input and output delivery, as governments typically exert more control over these measurable elements.

### ***Aggregate or disaggregate targets?***

Different targets for different regions or for different population groups (identified, say, by gender or ethnicity) provide a powerful instrument to ensure equal treatment of marginalized groups. Setting

**Box 4.2. Delivery of Basic Services in Uganda: The First Annual PRSP Progress Report**

Evaluation of the delivery of basic services in Uganda, one year after PRSP implementation, indicates that even though the performance of the basic public services—education, health, water, and sanitation—has improved, progress has not been as fast and comprehensive as envisioned in the PRSP. This can largely be ascribed to a discrepancy between the results and implementation targets.

For example, access to education by all income groups and gross enrollment rates have drastically improved. Yet, the quality of education has suffered substantially in the process, with about one in four pupils failing to pass final examinations in primary school. While gross primary enrollment rates were higher than anticipated, targets for average pupil-textbook ratios and average pupil-classroom ratios were not met, partly due to continued delays in teacher recruitment and placement, resulting in a substantial decline in the quality of education. Teacher recruitment has been constrained by a number of factors, including a shortage of qualified teachers in the country. Low pay and payroll delays have also discouraged the entry of new teachers.

In health, the DPT3 immunization target set forward in the PRSP was not achieved. A decrease in vaccinators, and problems with Uganda's aging and inadequate refrigeration systems, hindered the country's efforts. An acute shortage of qualified staff in the health sector was a general constraint to reaching the health targets. In both education and health, discrepancies between result and implementation targets prevented policymakers from reaching their targets. The discrepancies may also have engendered undesirable side effects, such as a decline in the quality of the services provided.

Source: Uganda Ministry of Finance, Planning, and Economic Development 2001.

separate targets to protect marginalized population groups or regions may thus be fully justified on equity considerations, even if it comes at the expense of efficiency. For example, it might be much cheaper to reach national targets for access to health and sanitation services by increasing coverage among the urban population rather than by expanding access to services for those citizens who live dispersed in remote rural areas. Yet, access to services among the rural poor might have been much lower to start with and it would thus be unfair to focus all additional efforts on the urban areas, even though it is more efficient. Budgetary and efficiency considerations are bound to lead governments to ignore the interests of marginalized groups in the absence of disaggregate targets. Considerations of equity and efficiency will have to be traded off against each other. Second, following the process of public sector decentralization combined with the establishment of participatory mechanisms for civil society under the PRSP, there will be an increasing demand for local and regional targets, in addition to national targets.

While considerations of equity and decentralization provide powerful ethical and political arguments to set disaggregated targets, care must be taken, as they may induce behavior making it more likely that sector targets will be attained at the expense of overall national targets. For example, if separate poverty targets are set for the rural and urban populations, the Ministry of Agriculture might lobby to introduce a support price for the main food crop sold by small farmers in order to reduce rural poverty. In the absence of a food subsidy to net consumers of the food crop, this price intervention is likely to raise urban poverty and possibly overall poverty. Hence, while it is useful to *monitor* indicators at disaggregate levels to be able to trace where potential problems lie, this does not necessarily imply disaggregate targets are always needed. Also, if all targets are set at disaggregated levels, the number of targets in a country rapidly grows, reducing their effectiveness in fostering accountability. In conclusion, equity considerations provide a powerful argument to set separate targets to protect disenfranchised population groups and regions, but a proliferation of targets must be avoided and the possibility of perverse incentives must be minimized.

**Short-run or long-run targets?**

Targets can be set for different dates in the future. While annual PRSP progress reports on implementation are important to ensure accountability, this does not imply that annual *targets* should be set, but rather that progress toward these targets should be monitored annually. In theory, the relevant decision rule for the timing of, say, poverty reduction, is that the (discounted) marginal cost of poverty reduction should be equated across time periods. One could ask whether a country's short- and long-run targets are consistent with this rule. In practice, this theoretical principle is not easy to implement. Furthermore, many countries have already committed themselves to long-run poverty reduction and other targets, such as the International Development Goals (IDGs), or to country-specific targets, such as those embodied in the Kyrgyz National Vision for 2010. Still, any targets set within, say, the first three- to five-year time horizon of the PRSP should be consistent with longer-term objectives. Consistency means that

some thought has to be given to the appropriate time path for achieving the target. For example, two countries may share the same long-run target for reducing poverty, such as achieving a decline in the headcount ratio of 25 percentage points by 2010. However, country A, which enjoys good governance and a high growth rate, may opt for a more rapid decline in poverty in the early years than in the later years of the time horizon. This scenario could reflect rising marginal costs of absolute poverty reduction. By contrast, country B, which adopts its first PRSP just after the end of a civil war, or in the immediate aftermath of some other major exogenous shock, may choose a slower decline in poverty in the early years than in the later years of the time horizon because the marginal cost of absolute poverty reduction may fall in the future.

### **4.2.3 Monitoring progress**

For targets to serve as an incentive for government and civil society to mobilize and allocate scarce resources, in order to attain priority social goals, progress toward attaining these targets must be closely monitored. This is a challenge of institutional design. Those working within the information systems used to support the PRSP process need incentives to collect and record information accurately, and in a timely fashion. In addition, once these data are stored, incentives are needed to reveal this information truthfully, whether to an administrative superior, to policymakers, or to other users in civil society. The most fundamental incentive for monitoring progress toward the attainment of PRSP targets is a democratic political process by means of which citizens demand transparency and accountability in policymaking. Further discussion of this issue may be found in chapter 5, “Strengthening Statistical Systems,” while examples of the institutional frameworks used to monitor the PRSP in Uganda and Tanzania may be found in the technical notes to chapter 3, “Monitoring and Evaluation.”

## **4.3 Setting Realistic Targets**

This section presents three analytical techniques that can help policymakers gauge the technical feasibility of reaching their targets: historical benchmarking, macrosimulations, and microsimulations. Under the historical benchmarking approach (section 4.3.1), we assess the evolution of development outcomes such as poverty, literacy, or longevity based on the historical evolution of these indicators within a given country and/or in similar countries. Under the macro- and microsimulation approaches (sections 4.3.2 and 4.3.3), we evaluate the feasibility of targets by the likelihood that another set of targets for key variables affecting the indicators for which the original targets were set, will be achieved. That is, by establishing an empirical relation between the PRSP targets and their correlates, the feasibility of the PRSP targets is evaluated according to the feasibility of the required growth path of their correlates. The empirical relation between the original targets and their correlates can be established using macro- or microeconomic data and models. Within a macroeconomic context, the simplest way to analyze the determinants of poverty and other indicators consists of looking at the effect on poverty of changes in mean income (i.e., economic growth) on the one hand, and changes in inequality on the other hand, possibly also taking migration and urbanization into account. Within a microeconomic context, the simplest way to analyze the determinants of poverty and other indicators is to analyze the effects of various household and community characteristics, while holding all other household and community characteristics constant.

### **4.3.1 Historical benchmarking**

Historical benchmarking provides a simple and useful first step toward introducing some realism into target setting. It is neither time- nor skill-intensive, and the data needed to make historical comparisons can be readily obtained from the World Development Indicators (available on CD-ROM) or from country-specific sources. Furthermore, historical benchmarking can be readily applied to most targets. Thus, at a minimum, each country should gauge its PRSP targets by historical experience. Under this approach, the change in the indicator implied by the target (say, GDP growth or access to safe water), will be compared with the historical evolution of that indicator within the country. This information can be complemented with the examination of the historical evolution of the same indicator in similar countries. These data,

together with an overview of the economic and sectoral policies in place in the past, should help establish the broad feasibility of PRSP targets.

Even though simple, historical benchmarking is nonetheless quite informative, as will be shown with an illustration from Guinea. In its interim PRSP the government of Guinea set itself as objectives—amongst others—to increase the annual agricultural growth rate from 5.3 percent during 1997–99 to 10 percent in 2010, and to enhance the gross primary school enrollment rate from 53.5 percent in 1998–99 to 100 percent in 2007. To determine if these targets are realistic, we can inspect the recent evolution of the indicators in Guinea and selected neighboring countries.

### **Growth in agricultural GDP**

Table 4.1 gives three-year average growth rates for agricultural GDP (we use average rates to control for temporary fluctuations resulting from weather vagaries). For 1989–2000, the moving average for Guinea is 4.2 percent. Guinea's performance is better and less volatile than that of its neighbors, suggesting that the country may already be approaching its production possibilities frontier. Agricultural growth never reached 10 percent in Guinea over the past dozen years. Over the past three decades, agricultural growth reached 10 percent only three times in Mali and two times in Senegal, typically due to rebounds after droughts. If agricultural growth were to accelerate according to its projected linear trend, it would reach 7.3 percent by 2010 in Guinea, the largest projected growth rate among all neighbors but one. Historical benchmarking suggests that a target for agricultural growth of 10 percent per year is unrealistic. A sustainable agricultural growth rate between 6 percent and 7 percent may be attainable, though it would still be ambitious given the efforts already undertaken in Guinea over the past decade to boost agricultural growth and the fact that over extended periods of time most countries experience one or more years with negative agricultural growth, due to bad weather.

### **Gross primary school enrollment**

Guinea also committed to reaching 100 percent gross primary enrollment by 2007. This implies an increase of 46.5 percentage points over a period of only seven years, i.e., an increase of about 7 percentage points per year. Comparative and historical analysis again suggests that this objective is too ambitious. From table 4.2 we see that it took Guinea 36 years to increase gross primary enrollment by 22.6 percentage points, from 30 percent in 1960 to 52.6 percent in 1996. While this rate of increase is relatively low compared to the neighboring countries, gross primary enrollment rose by less than 40 percentage points in the majority of the developing countries over the period 1960–95 (not reported here). Furthermore, the experience in Côte d'Ivoire and Ghana suggests that growth in gross (versus net) enrollment decelerates as enrollment rises. While Guinea's target for 2007 is too ambitious, an increase by 20 or 25 percentage points may be feasible.

**Table 4.1. Agricultural Growth in Guinea and Selected Neighboring Countries, 1970–2000**

<i>3-year moving average</i>	<i>Guinea</i>	<i>Côte d'Ivoire</i>	<i>Ghana</i>	<i>Mali</i>	<i>Senegal</i>
<b>1987–2000</b>					
mean	4.2	3.2	3.0	4.0	1.3
standard deviation	1.1	1.7	1.4	2.4	2.5
<b>Frequency 1970–2000<sup>a</sup></b>					
Moving average >10 %	0	0	0	3	2
Moving average < 0 %	0	6	6	6	8
<b>Projected growth in 2010 from linear trend over</b>					
1987–2000	7.3	2.8	7.8	0.4	4.8
1970–2000	–	2.6	3.3	4.8	1.4

a. Period for Guinea is 1987–2000.

Source: World Development Indicators, World Bank (various years).

**Table 4.2. Gross Primary Enrollment in Guinea and Selected Neighboring Countries, 1960–96**

	% gross primary enrollment			Change (% points)	
	1960	1980	1996 <sup>a</sup>	1960-1996 <sup>a</sup>	1980-1996 <sup>a</sup>
Côte d'Ivoire	46	75.0	71.3	25.3	-3.7
Ghana <sup>a</sup>	38	79.4	78.7	40.7	-0.7
Mali	10	26.3	45.1	35.1	18.8
Senegal	27	46.3	68.2	41.2	21.9
Guinea	30	36.4	52.6	22.6	16.2

a. Reference year for Ghana is 1994

Source: World Development Indicators, World Bank (various years).

These examples show that historical benchmarking provides a useful first step in the evaluation of the technical feasibility of development targets. In the next section, we review methods to set targets based on simple macroeconomic models. In the case of Latin America, these models have been integrated into SimSIP, a user-friendly simulator whose name stands for “Simulations for Social Indicators and Poverty.” Historical benchmarking is also used in SimSIP. Country-specific historical trends are provided for social indicators in education, health, and basic infrastructure. For each indicator, a country-specific historical trend and several projections into the future based on econometric models are provided. The country-specific historical trend carried into the future is generated using one of the following four models: linear trend, logarithmic trend, exponential trend, and power trend (see technical note D.1). It is worth noting that for many indicators, the historical trends that best fit the data are based on logarithmic specifications, which suggests that simply using linear projections may not yield appropriate results. Also, projected trends are sensitive to the choice of the base years from which they are projected.

### 4.3.2 Macrosimulations

One of the most important factors in reduction of poverty and improvement of social indicators is economic growth. Other variables are also important, including level of urbanization, because it is typically easier and cheaper to provide access to education, health, and infrastructure services in urban areas than in rural areas. The feasibility of poverty and social development targets can in first approximation be evaluated by the feasibility of their implicit economic growth, urbanization, and other requirements. Specifically, estimates of the relation between growth, urbanization, and social indicators can be obtained by applying multivariate regression techniques to aggregate cross-country data available in the World Development Indicators. While it may not be practical for government staff in PRSP countries to undertake such analysis themselves, several studies have recently examined the empirical relationship between poverty, social indicators, and their correlates.

In this section we describe the underlying principles and present some empirical results. This provides a first and readily applicable set of tools to help policymakers gauge the feasibility of their development targets. Over time, however, more comprehensive and more accurate data will become available and more sophisticated estimation techniques will be developed. The reader is encouraged to periodically search the literature for updates of the empirical results presented below.

#### **Targets for poverty**

As discussed in chapter 1, “Poverty Measurement and Analysis,” poverty measures are fully determined by the mean level of, in this example, per capita income or consumption in a country, and the inequality in per capita income or consumption. Using estimates of both growth and inequality’s effect on poverty, it is thus feasible to simulate future poverty measures as functions of the expected level of GDP growth (which can be used as a proxy for the increase in mean income or consumption) and the expected change in inequality over the planning horizon.

Two main methods are used in practice to simulate future poverty levels. The first method is very simple. Assume that in a given country, real per capita GDP growth is expected to increase at a rate of 4

percent per year for 10 years. If per capita GDP growth is taken as a proxy for the growth in per capita disposable income or consumption, this will translate into an increase in mean income of 48 percent after 10 years. If inequality is assumed to remain unchanged, all households will benefit from the increase in mean income in the same proportional terms. Hence, in the latest household survey available for the country under review, one can multiply the per capita income or consumption of all households by 1.48, and use the same poverty line in real terms in order to estimate the new level of poverty. The difference between the simulation and the original poverty measures provides the target. Using the same method, it is feasible to estimate the required level of distribution-neutral growth over a given period necessary to achieve a certain level of poverty reduction. Adjustments can be made to this method, for example, to take into account the fact that per capita disposable income or per capita consumption may not be perfectly correlated to per capita GDP growth. The simulations can also be made in terms of GDP growth rather than per capita GDP growth, in which case assumptions must be made regarding population growth over the planning horizon.

Ravallion and Chen (1999) use this method to calculate the per capita growth rates required to reduce the incidence of poverty in selected African countries by half over a 25-year period, from 1990 to 2015. The results are provided in table 4.3. The majority of countries need per capita consumption growth of around 2 percent per year to halve the incidence of poverty in their country (at \$1/day in purchasing power parity [PPP]). But there are some (Guinea-Bissau, Lesotho, and Zambia) where significantly higher growth rates are called for. This reflects the sheer magnitude of poverty in these countries. And there are others (Côte d'Ivoire and South Africa, for example) where the task is less challenging. In most countries, however, recent growth experience is not encouraging. Only Botswana, Mauritania, and Uganda have experienced the sort of private consumption growth that would halve their poverty incidence (again at PPP \$1/day). These examples show that the goal can be achieved. But for most of Africa, the most likely and challenging reality could be increasing absolute numbers of those individuals living in poverty.

The second method is slightly more complex, but simulation tools are available to facilitate its use. The idea is to rely on a simple set of elasticities of poverty reduction and inequality to growth. The

**Table 4.3. Required Annual Growth to Halve Poverty over 25 Years in African Countries**

Country	Required growth rate to halve poverty over 25 years (per capita per year)		Historical growth rates: 1990-98 (per capita per year)	
	At \$1/day (85 ppp \$)	At \$2/day (85 ppp \$)	Private consumption	GDP
Botswana	1.97	3.09	3.45	2.07
Côte d'Ivoire	1.05	1.89	-1.79	2.01
Ethiopia	1.24	2.81	0.52	1.05
Guinea	2.65	3.17	1.21	2.50
Guinea-Bissau	5.37	7.83	0.25	-0.32
Kenya	2.42	3.85	-1.17	-2.28
Lesotho	2.90	4.13	-0.08	1.52
Madagascar	2.63	6.81	-1.09	0.53
Mauritania	2.11	2.56	2.82	-1.06
Niger	1.78	5.59	-0.18	-0.90
Nigeria	2.18	2.95	-0.73	-1.01
Rwanda	1.14	2.88	0.05	-1.11
Senegal	2.79	4.23	0.14	-1.17
South Africa	1.36	2.65	0.24	-0.46
Uganda	2.34	4.44	3.04	3.75
Zambia	4.94	7.13	-3.23	1.52
Zimbabwe	1.87	3.46	-0.31	-1.47

ppp = purchasing power parity

Source: Ravallion and Chen (1999), based on Africa Live Data Base, World Bank

elasticities are typically estimated using a panel of poverty, mean income, and inequality measures for countries within a given region, or for provinces or states within a given country. Three elasticities must be estimated empirically, in order to obtain the net impact of growth on poverty; the fourth is obtained as a function of these three (see Wodon and others 2000). The elasticities are:

- **Gross elasticity of poverty reduction to growth.** This is the percentage reduction in poverty obtained with a 1 percent growth rate in per capita income, holding inequality constant.
- **Elasticity of inequality to growth.** This is the percentage change in inequality obtained with a 1 percent growth rate in per capita income. The sign of this elasticity is not clear a priori. If there is no systematic correlation between growth and inequality, this elasticity is zero.
- **Elasticity of poverty to inequality.** This is the percentage increase in poverty associated with an increase in inequality, holding mean income constant. This elasticity is positive.
- **Net elasticity of poverty to growth.** This elasticity is obtained as a function of the three other elasticities. Denoting by  $\gamma$  and  $\lambda$  the gross and net elasticities of poverty to growth respectively, by  $\beta$  the elasticity of inequality to growth, and by  $\delta$  the elasticity of poverty to inequality controlling for growth,  $\lambda = \gamma + \beta\delta$ . For example, if growth is associated with an increase in inequality (if  $\beta$  is positive and statistically significant), part of the effect of growth on poverty will be “lost” due to the increase in inequality and the impact that this has on poverty.

Table 4.4 gives the above elasticities for the headcount index, poverty gap, and squared poverty gap in Latin America, as obtained from a data set of 12 Latin American countries with five years of data on poverty, inequality, and income growth measures per country. Both poverty (not being able to meet one’s basic needs) and extreme poverty (not being able to meet one’s basic food needs) are considered. Note that these estimated elasticities are not country-specific. Consider the example of the headcount index of poverty. Without changes in inequality (as measured by the Gini index), a 1 percent increase in per capita income results at the regional level in a -0.93 percent decline in the headcount index of poverty (second row in the table). With a regional headcount for poverty at 36.74 percent in 1996 in Latin America, this represents a one-third of a percentage point decline in the share of the population in poverty ( $36.74 * (-)0.0093 = -0.34$ ). This is the “gross” impact of growth on the headcount index of poverty. The net impact of growth on poverty once inequality is allowed to change with growth is similar, because the elasticity of inequality to growth is almost zero (and not statistically significant).

Note also that the elasticities of poverty to inequality are larger for the poverty gap and squared poverty gap than for the headcount index, because these poverty measures are more sensitive to the inequality among the poor (this applies especially to the squared poverty gap).

The use of elasticities has both advantages and disadvantages. One advantage is that the elasticities take into account the potential correlation between growth and inequality. For example, if growth is associated with rising inequality, part of the poverty-reducing effect from growth will be offset by the negative effect of rising inequality. Under such circumstances, neglect of the growth-inequality relationship would lead to overestimates of the poverty-to-growth elasticity. At the same time, the use of elasticities provides an estimation only of future poverty, while the method based on the survey data

**Table 4.4. Elasticities of Poverty with Respect to Growth and Inequality in Latin America**

	<i>Poverty</i>			<i>Extreme poverty</i>		
	<i>Headcount</i>	<i>Poverty gap</i>	<i>Squared poverty gap</i>	<i>Headcount</i>	<i>Poverty gap</i>	<i>Squared poverty gap</i>
Net elasticity of poverty to growth (1)	-0.94	-1.11	-1.19	-1.30	-1.32	-1.33
Gross elasticity of poverty to growth (2)	-0.93	-1.09	-1.16	-1.27	-1.28	-1.29
Elasticity of poverty to inequality (3)	0.74	1.22	1.61	1.46	2.11	2.41
Elasticity of inequality to growth (4)	NS	NS	NS	NS	NS	NS

*Note:* The net elasticity (1) = (2) + (3)\*(4). NS denotes an elasticity not statistically significantly different from zero at the 5 percent level (the estimate of the elasticity of inequality to growth is -0.02).

*Source:* Wodon and others (2000).

itself is more “exact.” For example, if one wants to simulate the impact of distribution-neutral growth using the latest survey data, multiplying all incomes in the data by a constant will yield the “exact” new poverty measures corresponding to the scenario, while using the elasticities approach would only yield a forecast based in part on experience. Both methods can be implemented with user-friendly Excel-based software programs (SimSIP\_Goals and SimSIP\_Poverty), which have been created to facilitate the analysis of the sensitivity of poverty forecasts to assumptions for GDP growth, urbanization growth, and population growth (see technical note D.1). These programs are available free of charge on the World Bank’s website.

A few additional features of the SimSIP simulation software are worth mentioning:

- The models underlying the simulators’ poverty forecasts account for the effect of urbanization on poverty. That is, poverty forecasts are done at the urban and rural levels separately. The rate of urbanization is then used in order to compute the final national poverty measure. This has the advantage of providing information on the contribution of migration, or more generally urbanization, to the decrease in poverty over time.
- Instead of predicting the growth in GDP per capita, real GDP growth and population growth can be entered separately in the simulators, which enables the user to estimate the contribution of the reduction in the rate of population growth to the reduction of poverty.
- The simulators have a number of additional features that can be useful. One such feature is the ability to compute the change in the Gini index needed to reach the poverty goal set by the user, once the other variables (time horizon, percentage poverty reduction, real GDP growth rate, population growth, and urbanization growth) have been specified. Another feature is the ability to compute the share of GDP or mean income that would be needed to eradicate poverty under perfectly targeted income transfers. The user can also compute the increase in the taxation rate on the nonpoor that would be needed to eradicate poverty, or the increase in social public spending, or in public spending targeted to the poor.

It should be emphasized, however, that the methods presented above are simple accounting frameworks, useful for estimating the feasibility of targets, but without any explanatory power regarding the size of the elasticities or the reasons behind the growth-inequality linkages. The methods also rely on several assumptions. First, if per capita GDP growth is used as a proxy for growth in disposable income or private consumption, it is implicitly assumed that GDP growth translates directly into household income or consumption. Similarly, when sectoral decompositions are used to analyze the poverty reduction effect of growth in various parts of the economy, the simulations typically assume that sectoral growth rates translate directly into household consumption and income growth rates in the same sectors. Finally, the secondary effects of policies are typically assumed absent. Despite these limitations, the tools are proving useful in setting targets. They indicate the economic growth needed to achieve specific targets, and the feasibility of such growth rates can be readily assessed based on historical experience.

### **Targets for social indicators**

Higher economic growth and lower population growth are not only significant for poverty reduction; they are also crucial for improving nonmonetary indicators of well-being. Urbanization also matters, because it is often easier and cheaper to provide access to public and private services for education, health, and basic infrastructure in urban areas than in rural areas. Technological progress, often proxied by a time variable, is important as well—simply recall the effect of vaccine development on infant mortality. The level and allocation of public social spending per capita may also have a substantial effect, but comparable information about these variables over time is difficult to obtain for many countries.

In order to integrate forecasts for nonmonetary indicators of well-being into SimSIP\_Goals, Wodon and others (2001) have estimated the elasticities of education, health, and basic infrastructure indicators to real per capita GDP growth, urbanization, and time using worldwide panel data sets, including both industrial and developing countries. The regressions were performed on gross primary, secondary, and tertiary enrollment rates; net primary and secondary enrollment rates; the rate of illiteracy among the

adult population; infant mortality rate, under-five mortality rate, life expectancy, and under-five malnutrition rate; access to safe water and sanitation; and the number of telephone main lines per 100 inhabitants (details are available in technical note D.1). Two different econometric models were estimated. As expected, economic growth was found to have positive effects on a wide range of social indicators including infant mortality, enrollment in secondary education, illiteracy, access to safe water, and life expectancy. For example, for the countries with the lowest level of real per capita GDP (less than \$1,000 in 1985 prices), a 1 percentage point in growth is expected to result in a 0.314 percentage point increase in net primary enrollment in the first of the two models. The impact of growth on net primary enrollment decreases as the level of GDP increases, up to the level of a per capita GDP above \$10,000 (in 1985 prices), at which no more gains in net primary enrollment are obtained. While the magnitudes of the elasticities in each of the two models depend on the social indicator and level of development, there is no doubt that economic growth is associated with strong nonmonetary benefits in terms of education and health performance, as well as access to safe water and sanitation, among others.

In the simulations, the predicted values for the social indicators using both models are calculated by applying to the latest actual data point the estimated elasticity and the projected rate of change of the relevant indicators (GDP per capita growth rate, rate of urbanization, and time trend). As for the simulations on poverty, the per capita GDP growth rate is itself a function of the assumptions for real GDP growth and population growth. Where feasible, the projections for up to 1999 are based on actual GDP growth, urbanization, and population growth rates available in the World Development Indicators database. The growth rates selected by the user are thus applied from 1999 onward. Only statistically significant estimates for elasticities are used in the calculations. That is, if the elasticities are not statistically different from zero at the 10 percent level of significance, a coefficient of zero is assumed. The predictions are also bound by the following restrictions: mortality and illiteracy rates must be greater than or equal to zero, gross school enrollment rates must be less than or equal to 130 percent, and access to safe water and sanitation must be less than or equal to 100 percent. The predictions obtained with the two econometric models, and the projection into the future based on the historical trend with the best fit, provide the user three different estimates for future targets, and thus a range for what might be reasonably expected.

### ***Sensitivity of targets to the choice of elasticities***

The simulations for poverty and social indicators based on the elasticities used in SimSIP\_Goals provide a good first step toward gauging the realism of development targets. Yet the simulations are sensitive to the underlying regression specification. Re-estimation of the econometric models used in SimSIP\_Goals is not a viable option for most development practitioners or government officials. However, SimSIP\_Goals has an option that enables the user to override the elasticities used as default, so that the user may specify his own elasticities. In other words, the user may rely on the existing literature for assessing the effect of income growth and other variables on poverty and social indicators. Such an exercise can be useful for triangulation, i.e., for checking the robustness of the results obtained in SimSIP\_Goals to alternative assumptions. We provide two illustrations below for health indicators.

#### **Under-five mortality**

Demery and Walton (1999) review the empirical literature on the elasticity of under-five child mortality to GDP growth per capita and conclude that it lies between -0.2 (Pritchett and Summers 1996) and -0.6 (Filmer and Pritchett 1997, Pritchett 1997). They decide to use an elasticity of -0.4. In SimSIP\_Goals, the elasticities in the first econometric model estimated by Wodon and others (2001) vary from zero to -0.47, depending on the level of economic development of the country. A user wishing to rely on Demery and Walton's suggestion could override the elasticities in SimSIP\_Goals and use instead a value of -0.4, which in most cases would yield forecasts for child mortality that are slightly more optimistic.

#### **Child malnutrition**

Alderman and others (2000) examine the effect of (log) GDP per capita and female secondary school enrollment on the prevalence of malnutrition (i.e., the proportion of children under five whose weight-

for-age ratio falls more than 2 standard deviations below the median for their sex and age group in the reference population), while controlling for time effects. They use a country-fixed-effect model with data on 63 developing countries spanning the period 1970–95. The marginal effect of the logarithm of per capita GDP on malnutrition is statistically significant and estimated at -8.02. This estimate can be used to compute the income growth needed to reach a given malnutrition target by a certain date. For example, if the prevalence of preschool child malnutrition in 1990 is estimated at 30 percent in a given country, GDP per capita would have to grow by 7.8 percent per year—holding everything else constant—in order to reduce the child malnutrition rate by half by 2015<sup>1</sup>. This would correspond to an elasticity of child malnutrition to growth of -0.09. Compared to the SimSIP elasticities of child malnutrition to economic growth, which vary from zero to -1.1 depending on the country's level of economic development and the econometric model, with a mean of -0.23, this elasticity is relatively low. This is related to the fact that the model underpinning the SimSIP elasticities does not include other important determinants of child malnutrition, such as educational achievement and access to sanitation. To the extent that growth is correlated with those and other omitted variables that affect child malnutrition independently, their effect will be captured by the growth elasticities. A user wishing to rely on Alderman's estimates could always override SimSIP\_Goals's elasticities, which will yield less optimistic forecasts for child malnutrition.

Before closing this section, it must be emphasized that factors other than those taken into account in SimSIP\_Goals and other similar models may help achieve international development goals. For example, as emphasized by Alderman and others (2000), more ambitious goals for reduction of malnutrition could be achieved if direct nutrition interventions were put in place. Income growth is often needed, but direct nutrition interventions ranging from community-based programs focused at changing behavior (e.g., child growth monitoring programs) to national campaigns for immunization and micronutrient supplementation are equally necessary. The results of growth-based simulations are only indicative. They should be interpreted within the broader context of other intervening factors, whose effects are often not explicitly estimated by macroeconometric models (see section 4.3.3 on microsimulations).

### **Forecasting economic growth**

In SimSIP, the targets for social indicators are based on (1) the latest point of data available for any given countries, and (2) the estimated elasticity of the indicator under review to economic growth and urbanization. To set targets, assumptions for future per capita GDP growth and urbanization must be made. Estimating future per capita GDP growth itself requires estimates of future population growth and GDP growth. Estimates for future population growth and urbanization rates are available from the United Nations. But in order to estimate real future GDP growth, one may want to rely on economic models as well. Indeed, while the likely accuracy of projected GDP growth rates can be judged by their historical basis, past growth rates are not necessarily a reliable guide to the future. For some countries, high past growth rates may have resulted from favorable temporary external shocks (improvement in terms of trade or external transfers) or unsustainable fiscal or monetary policies. For others, recent growth rates may be unusually low because of unfavorable shocks, or the effects of policy reform changes.

There are a number of papers in the literature that can be used to forecast economic growth. We review only one of them here. To examine the growth potential of countries, Demery and Walton (1999) use growth predictions derived from an empirical growth model estimated by Sachs and Warner (1995). This model relates per capita growth to initial conditions such as GDP, educational attainment, the price of investment, and the country's economic and political stance, as well as concurrent factors such as government consumption spending, political and social unrest, and investment. The initial economic policy stance in each country is simply classified as good or poor, and represented in the regression analysis by a good/bad dummy. Although this approach is rudimentary, Demery and Walton argue that it might still be informative for target-setting purposes. By substituting current levels of these variables in Sachs and Warner's estimated regression equation, Demery and Walton predict each country's GDP per capita growth into the future. They subsequently switch the good/bad economic policy dummy from 0 to 1 to distinguish between low- and high-income growth scenarios.

Demery and Walton find, for example, that per capita GDP growth in Kenya is predicted at 1.7 percent under the bad policy/lower income growth scenario and 3.5 percent under the good policy/higher

income growth scenario. Even the latter is well below the level likely needed to reach various objectives, such as Kenya’s child mortality reduction target for 2015. While additional direct child mortality interventions could help reach the child mortality reduction target, it is unlikely that their effect would be sufficient to close the gap between the estimated growth requirements and predicted growth.

Growth predictions are only as precise as their underlying assumptions. Their accuracy depends on a host of factors, such as the model used being a correct reflection of the underlying determinants of growth; stability of the estimated coefficients over time; and an unchanging investment-to-GDP ratio. Given the complexity of the economic growth phenomenon, no single model will be able to correctly predict future growth rates. Thus, economic growth rate projections based on a single model should be used in conjunction with insights and predictions from other growth models, as well as with the country’s growth performance in the past. Together, these various pieces of the puzzle should provide a benchmark for reasonable growth expectations.

### 4.3.3 Microsimulations

The results and models in the previous section are based on aggregate national data. This approach assumes that each observation is representative of the behavior of people in the country. This may be defensible when the results are used to gauge the feasibility of development targets. The macro approach also has the advantage that it can be expanded to examine the effect of country-level characteristics such as sector-specific public expenditures. Yet in aggregating across households and regions within a given country, a lot of information gets lost. Furthermore, cross-country regressions typically do not account for the country-specific nature of the relationship between development outcomes and their determinants. Such considerations can be accommodated within a micro-level approach. It is recommended that the macro approach to gauging targets be complemented with micro-level analysis.

Using micro data is becoming increasingly feasible. Over the past decade, many countries have collected nationally representative household survey data. These comprehensive data sets are often well suited to estimating the relative importance of the different determinants of development outcomes, for example the relative determining roles of income, education, community sanitation, health infrastructure, and other factors in child malnutrition rates. This is done through the application of multivariate regression techniques. The resulting coefficients on the different determinants can be used to predict the effect of changes in policy variables. These simulations can inform policymakers about the interventions needed to reach a development target. The feasibility of the target can then be gauged by the technical and fiscal feasibility of these interventions. Box 4.3 describes applications of this technique to maternal mortality in Pakistan and child malnutrition in Ethiopia. For a software application that examines poverty reduction targets based on micro-level analysis (included in SimSIP), please see technical note A.6 for chapter 1, “Poverty Measurement and Analysis.”

Though microsimulation is data-intensive, data availability is no longer the major obstacle to the microsimulation approach. However, the micro-level approach is relatively technical. Moreover, a major shortcoming lies in its inevitable reliance on observed variables. Unobservable or unmeasured variables—such as maternal nutritional knowledge and quality of health care in the case of child malnutrition, or technological knowledge and participation in agricultural extension in the case of agricultural production—may also be key driving factors. Their omission may result in a bias of the estimated coefficients and the related policy simulations. This critique is not limited to microsimulations. It applies equally well to the macrosimulations discussed above. Since it is not always feasible to remedy these problems, it is important to keep the shortcomings in mind. One possible strategy is to use a wide set of targets and cost assessment techniques when developing the development targets. Together, these techniques should provide a reasonable picture of what can be considered achievable.

## 4.4 The Cost and Fiscal Sustainability of Target-Reaching Efforts

Target setting is intrinsically linked to the government’s budgetary process and its fiscal constraints, which opens another avenue for gauging the viability of development targets. It must not only be

#### Box 4.3. Microsimulations for Child Malnutrition and Maternal Mortality

**Child malnutrition in Ethiopia.** In its interim PRSP, Ethiopia committed itself to reducing child malnutrition to half its 1990 level by 2015. Christiaensen and Alderman (2001) use household surveys from 1996–98 to analyze the determinants of child malnutrition and simulate the effect of various interventions. They look in particular at stunting. Household resources, parental education, food prices, and maternal nutritional knowledge are all found to have a large effect on stunting. Community sanitation and health infrastructure also reduce stunting, but this result is less robust to the regression specification. Using the regression estimates, the authors simulate the effect of (1) increasing per adult equivalent incomes by 2.5 percent per year over 15 years; (2) bringing at least one female adult per household up to the primary school education level; and (3) enhancing awareness of malnutrition by increasing by 25 percentage points the proportion of mothers who rightly diagnose their stunted and nonstunted children, respectively, as stunted and nonstunted (which has an effect similar to bringing one female adult per household to the primary education level). When combined, the three interventions reduce stunting by up to 42 percent. Given their optimistic income growth assumptions, this might represent an upper bound of what could realistically be achieved. The microsimulations thus indicate that the government's goal is ambitious, especially since maternal nutrition education programs have not been a high policy priority for the Ethiopian authorities so far.

**Maternal mortality in Pakistan.** Midhet and others (1998) analyze the relationship between maternal mortality and access to health services in two remote rural provinces. Controlling for a wide range of individual- and household-level variables (e.g., socioeconomic status, women's education, and maternal risk factors), they find that district-level health system variables, such as access to and use of peripheral health services, reduce maternal mortality while access to (expensive) emergency obstetric services does not. The authors suggest that peripheral health services may have positive effects because exposure to these services produces such benefits as improved knowledge about family planning and education, improved care during pregnancy, and timely referrals of high-risk deliveries. Next, the authors analyze the relationship between changes in access to peripheral health services and changes in the health system and other non-health-related variables, controlling for individual and community characteristics. In line with expectations, the results suggest that public spending on peripheral health facilities improves access to care. Then, the authors use microsimulations to show that increasing access to peripheral health services by 30 percent among target groups would reduce maternal mortality by up to 20 percent over three years. Finally, they use this finding to compute the associated cost, and compare this cost to the cost of other interventions not directly related to the health care system that also have positive effects on mortality.

technically feasible to attain targets, as discussed in the previous section, efforts to attain them must also be fiscally sustainable. The effect of public (and private) expenditures on development outcomes is a function of both the amount spent on specific interventions and their effectiveness, i.e., their effect per dollar spent. The fiscal feasibility of development targets can thus be gauged by the government's capacity for increasing public spending, discussed below in section 4.4.1, and by its scope for enhancing the efficiency of that spending, discussed in section 4.4.2. It is important to consider both dimensions—funding capacity and capacity to improve overall efficiency—in evaluating the fiscal viability of targets. A third set of issues concerns the government's capacity to implement the programs necessary to attain specific targets. These are addressed in section 4.4.3.

#### 4.4.1 Assessing costs

Estimating the cost of target-reaching efforts involves several methodological issues. It also requires detailed sectoral and program information and analysis.

##### **General considerations**

Assessing the cost of target-reaching efforts is even more difficult than setting targets. Detailed country information and knowledge are needed, and a good dose of common sense and experience is required to suggest realistic cost estimates. In theory, the costs of attaining PRSP output and outcome targets depend on three sets of parameters: (1) the shape of sectoral and program production functions (holding technical efficiency constant); (2) the level of technical efficiency in the various sectors and programs (holding inputs constant); and (3) the factor prices for the various inputs. Part of the difficulty in estimating costs for reaching a set of targets is that all three sets of parameters are likely to be changing simultaneously, at least over the medium term. Indeed, some determinants of costs, such as the level of technical efficiency, are themselves objectives of policy, so they should not be treated as fixed parameters over the whole planning horizon.

In several priority areas of a PRSP, such as education and health, wage costs make up a very large proportion of recurrent costs. Consequently, when costing targets, it is important to be explicit about the assumptions made regarding public sector wages. This may be a delicate issue, especially if public

sector workers are unionized. In some PRSP countries, the cost, over 15 years, of recent wage increases in the public sector, has been estimated to be fairly close to the HIPC relief expected by the countries. This reduces the scope for new interventions designed to improve basic social indicators. More generally, it is desirable to undertake a sensitivity analysis of the cost of reaching various targets to variations in the level of public sector pay. As was the case for target setting, simulation tools have been created to facilitate this task. Specifically, the SimSIP\_Costs software can be used to assess the cost of various targets related to education, health, basic infrastructure, and program interventions, with an eye on public sector wages, especially in the case of teachers. Ideally, the results of the sensitivity analysis should be fed back into the consultative process of the PRSP in order to promote awareness and discussion.

Cost estimates may also be affected by the process of administrative and political decentralization, which is under way in many low-income countries. If responsibility for public service delivery, and the hiring of teachers, medical staff, and agricultural extension personnel, passes from central to local government, it is likely that all three determinants of a target's costs—sectoral and program production functions, technical efficiency, and wage levels—will be affected. Indeed, a major aim of decentralization is precisely to influence these factors so as to improve efficiency.

Finally, it could be argued that cost estimations should use the “social” or shadow prices of inputs when these diverge from observed market prices. Yet in practice, information and other resource constraints on the PRSP process severely limit opportunities for using shadow prices. Furthermore, from the viewpoint of fiscal sustainability, what matters in the end is what the government has to pay in order to attain a set of targets, not what it “ought” to pay.

### **Sectoral analysis**

While the parameters and results of detailed sectoral analyses depend on specific country circumstances, simulation tools have been created to facilitate the work of government staff in charge of PRSPs. Here we review some features of SimSIP\_Costs, a simulator for estimating the cost of reaching education, health, and infrastructure targets (see technical note D.2). For each sector, the user must provide information on demographics, delivery systems, and cost parameters, as indicated in table 4.5. This information is then used to compute outcomes and to assess the overall (public) cost of reaching these outcomes. The cost calculations in SimSIP allow the user, in many cases, to change unit costs over time. As mentioned above, this is important, as unit costs often change over time. For example, unit costs often increase once higher levels of education, health, or infrastructure are attained, because coverage of the more remote areas is often left until the end. Using the same fixed costs over the whole planning horizon could lead to an underestimation of the total cost.

In the education sector, SimSIP\_Costs computes the cost of reaching targets for preschool, primary, and secondary education. Cohort analysis is used to quantify various variables of interest in predicting educational outcomes over time. In traditional cohort analyses, a given class is followed through the grades from the time of entry until graduation, taking into consideration the repetition and dropouts that occur along the way. In SimSIP\_Costs, this model is extended to follow cohorts over time, from one grade to the next, and from one cycle to the next. The simulator allows for many variables to be estimated for each cycle, including:

- **Net enrollment rate.** This is the number of students of the “correct” age registered in the schooling cycle as a fraction of the population in the age bracket. The correct age group for each cycle may differ across countries depending on the theoretical age at entry and the length of the cycle. For example, the primary education cycle may last from five to nine years.
- **Gross enrollment rate.** This is the number of students, regardless of age, who are registered in the cycle, as a proportion of the population in the correct age bracket.
- **Completion rate.** This is the share of students who complete a schooling cycle as a fraction of the population that should have completed that cycle, had all children gone to school and succeeded in completing their studies.

**Table 4.5. Structure of SimSIP\_Costs for the Education, Health, and Infrastructure Sectors**

<b>Assumptions for</b>	<b>Education (pre-, primary, and secondary school)</b>	<b>Mobile basic health care units in rural areas</b>	<b>Infrastructure (water, sanitation, electricity)</b>
<b>Demographics</b>	Entering cohorts (number of children of various age groups potentially joining the education system) by five-year intervals until 2015.	Initial and final population levels by 2015; average number of households by village; average household size in areas served.	Urban, rural, and national population and average household size by five-year intervals until 2015.
<b>Delivery system</b>	Length of schooling cycles; distribution of age at entry for the primary cycle; repetition, promotion, and drop-out rates by cycle or by grade.	Items in basic health care package, composition of mobile teams, number of villages covered by each team, number of visits per year to the same village.	Initial and final coverage; technology chosen for the delivery of each service.
<b>Cost parameters</b>	Supply-side costs (teacher wage, teacher-student ratio, administrative costs, etc.), demand-side costs (stipend value, coverage, etc.) and investment costs (cost per classroom, teacher training, etc.)	Structure for fixed and variable costs at various levels (from mobile health team to ministry of health).	Unit cost for each technology; structure for sharing costs between service provider and user (allows for access and consumption subsidies).
<b>Setting targets</b>	Changes in distribution of age at entry, repetition, promotion, and drop-out rates determine outcomes.	Outcomes are target coverage rates, with cost-effectiveness measured in terms of DALEs (disability adjusted life expectancy).	Outcomes are target coverage rates.

- **Timely completion rate.** This is the share of students who complete a schooling cycle in time as a fraction of the population in the age bracket. To complete a cycle in time, a child must enter the cycle at the right age and avoid repetition through the cycle.
- **Average number of years to graduate.** This is the average number of years taken to complete the cycle of schooling by those students who have successfully finished.

Whether the targets are specified in terms of net or gross enrollment, or any other measure of school performance, the simulator estimates the cost of reaching the targets. More specifically, based on country-level information, the simulator assesses supply-side costs (teacher wage, teacher-student ratio, administrative costs, etc.), demand-side costs (stipend value, coverage, etc.) and investment costs (cost per classroom, teacher training, etc.), the sum of which represents the sectoral cost.

For simulations in the health sector, SimSIP\_Costs allows the user to estimate the cost of providing a basic health care package to households lacking access to health facilities. Following Dicowsky and Cardenas (2000), three basic health packages are considered. They differ from each other by the number of services included. The services included in each basic health care package address some of the main issues facing health policymakers in Latin American countries. They comprise general mortality reduction programs, with special emphasis on acute diarrhea and respiratory diseases within the population less than five year old; children's health programs, such as immunization and nutrient deficiency programs; pregnancy care, including prenatal and postnatal assistance; community and environment programs; adult and senior health issues; education on use of medical drugs; and occupational health programs. Additional services to deal with epidemics, such as that of HIV-AIDS, could be added to the simulator. Implementation of the basic packages is carried out by public servants from the ministry of health, several mobile health teams going from one village to another, and community teams composed of volunteers based in the villages themselves. The mobile teams are composed of a medical doctor, a nurse, a nurse assistant, a technician, and a driver. Community teams are formed of local residents who are not directly compensated but incur variable costs. Officials of the ministry of health include regional and local directors, contributing to fixed costs.

For simulations in the basic infrastructure sector, SimSIP\_Costs allows the user to estimate costs of providing access to water and sanitation. The costs of reaching target coverage levels depend on the

choice of technology. In the case of water, for example, the technology chosen and its cost depend on three criteria: the type of water supply systems (piped or nonpiped), the water distribution mechanism (gravity fed, pump fed, or spring protection systems), and the population density of the area to be served by the respective systems (high-density, semidispersed population, or dispersed population). For sanitation, the alternative technologies under consideration include conventional sewage systems, pour-flush latrines, and dry latrines. The total costs are then functions of parameters that guide who is paying what, i.e., the split into public and private costs. While private costs are paid by households and therefore do not appear in the budget of the state or municipality, it is important to make sure that the services provided are affordable, and SimSIP\_Costs enables the user to specify subsidies to be paid by the state either for access or consumption.

### **Program analysis**

SimSIP\_Costs also enables the user to assess the cost of various programs that could help reach targets. This is done through a review of best-practice social programs that have been implemented in various areas or countries and for which detailed evaluations are available. Since these programs can be replicated in other countries, it is useful for PRSP government staff to have an idea of their expected effect and cost. To give just one example here, we consider Progresa, a successful social program recently implemented in Mexico that provides means-tested conditional transfers to stimulate investment in their human capital by the poor themselves (see box 4.4 for a detailed description).

How effective is the program in contributing to development targets? Apart from its immediate impact on poverty through the cash transfers given to households, Progresa has been found to reduce child mortality by 12 percent. It has also been found to increase the number of years of children's schooling. Because enrollment in primary school is already high in Mexico, the increase for years of primary school was relatively low, at 76 years of schooling for a cohort of 1,000 girls, and 57 years for a cohort of 1,000 boys. The increase in years of secondary school was much larger, at 479 hours for girls and 249 hours for boys. The cost of generating an extra year of schooling was found to be around US\$5,550 for primary education and US\$1,000 for secondary education. Such cost estimates are valuable in assessing the budgetary implications of replicating a program such as Progresa in another country.

#### **4.4.2 Efficiency of public spending**

Given their limited tax base and challenges involved in improving tax collection, it is often difficult for many developing countries to increase spending on social development outcomes. But social development targets may still be attainable through a more efficient use of current resources. Murray and others (1994) find, for example, that a typical country in Sub-Saharan Africa could improve health outcomes by 40 percent simply by reallocating resources to the most cost-effective intervention mix. It is thus crucial to consider both funding capacity and efficiency of public spending when evaluating the feasibility of targets.

There is a long economic tradition of measuring efficiency, especially in the fields of agricultural and industrial economics. Techniques from these disciplines are increasingly being applied to other areas, such as health (Grosskopf and Valdmanis 1987; Evans and others 2000); education (Kirjavainen and Loikkanen 1998); and public administration (Grossman and others 1999). The key underpinning principle, which traces its origins to Farrell (1957), is best illustrated with a one-input one-output example as depicted in figure 4.2.

The objective or outcome is depicted along the vertical axis, while inputs are depicted on the horizontal axis. The curved line represents the maximum possible level of outcome that can be obtained for a given level of inputs. More particularly, it represents the best performance frontier determined by a representative peer group. Efficiency (E) is defined as the ratio of attained or observed outcome to best-practice outcome for that level of inputs. Assume, for example, that a country produces "a" units of outcome for 40 units of inputs. Based on the experience of its peers, it could have produced "a+b" units of outcome for that same level of inputs. The country's efficiency E is thus  $a/(a+b)$ . A country is considered

**Box 4.4. Progresa: A Successful Means-tested Social Transfer Program in Mexico**

Progresa provides means-tested conditional transfers to encourage investment by the poor in their own human capital. The program was introduced in early 1997, in response to rising poverty following the 1995 Mexican macro-economic crisis. It has become the largest poverty alleviation program of the Mexican government, today reaching 2.6 million rural households (40 percent of all rural households and 11 percent of all Mexican households). The program is geared toward improving high-school enrollment and attendance, especially among girls. It also aims to decrease malnutrition among preschool children and pregnant and/or lactating mothers, and to provide incentives for family preventive health care. The program seeks to integrate these objectives so that children’s learning is not affected by poor health, malnutrition, or necessity to work; and so that parental inability to pay for increased nutrition and education is not a constraint on children’s development. The main components of the program are:

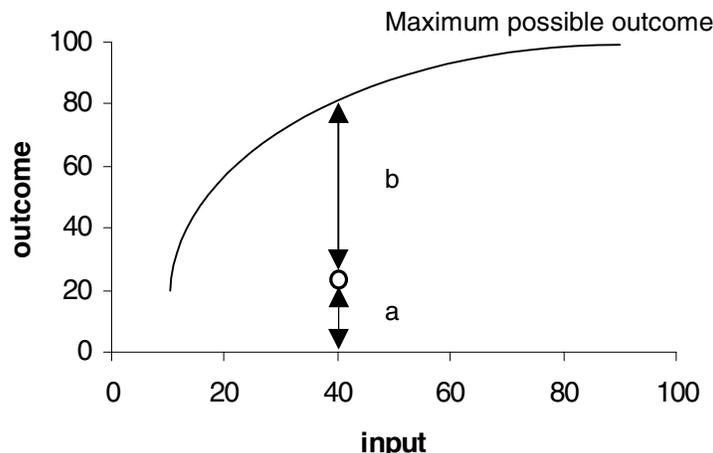
- Educational grants to foster enrollment and regular school attendance; continued receipt of these grants is conditional on individual child attendance reports by school teachers;
- Basic healthcare for all household members, with a strengthening of preventive medicine through health sessions. Session attendance is required to receive full payment of monetary transfers; and
- Monetary transfers and food supplements to improve the family’s food intake, particularly for children and women, but also for older individuals (who benefit from a substantial share of financial transfers, a fact often overlooked when discussing the program). Food supplements are given for malnourished children and pregnant and lactating mothers.

The program follows a two-step targeting procedure. The first step is a geographical identification of marginal communities. In a second step, households are selected within eligible communities. To this end, a survey questionnaire is administered to all households in order to determine socioeconomic status. A principal component analysis is used to classify households as “poor” (eligible) or “nonpoor.” A list of eligible households is then presented to the community, which has an opportunity to adjust it for exclusion or inclusion of households. Eligible households can then decide to enter the program. Eligibility cards are supplied to mothers (when the household is eligible to receive all three benefits) or to the household head (when the household includes no woman or is only eligible for food transfers). Registration takes place during a community assembly. In 1999, at the time of the program evaluation, Progresa’s budget was US\$777 million (0.2 percent of Mexico’s GDP). Administrative costs were 8.9 percent of total costs (including 2.67 percent for targeting costs at the household level and 2.31 percent for conditioning costs).

technically efficient if it produces on the best-practice frontier ( $E=1$ ). Note that efficiency defined in this way is a relative and not an absolute concept.

Calculating efficiency empirically involves determination of the outcome and input variables, empirical determination of the production frontier, and calculation of the individual deviations from that frontier. Care must be taken in the choice of input and outcome indicators. Omission of important inputs may bias the estimation of the frontier, causing biased efficiency measures (Ravallion 2000). Furthermore, in choosing inputs, only directly related and controllable inputs in the production process should be included (Evans and others 2000). Noncontrollable exogenous determinants, such as the initial level of development or measures of performance of the judiciary system, could then be used in a second step to examine the differences in efficiency across the different observations. There are several methods to estimate the production frontier, which are briefly described in technical note D.3. Empirical applications

**Figure 4.2. Measuring Efficiency of Input Use**



of these techniques, to examine the effectiveness of health and education expenditures (box 4.5), indicate that there is a lot of scope for efficiency improvements in public service delivery in developing countries. This suggests that many development targets might well be attainable even when additional resources are limited, i.e., through a more effective use of existing resources.

#### 4.4.3 Fiscal sustainability

Estimating the cost of reaching targets is only one step, albeit the most important, in an overall assessment of a PRSP's fiscal sustainability. Another important consideration is the government's capacity to implement the program. Bevan (2001) distinguishes two aspects of sustainability: "financial" sustainability and "absorptive" sustainability.

##### *Financial sustainability*

Financial sustainability signifies whether a planned expenditure path can be funded without unacceptable financing consequences for either the public or the private sector. Public expenditure can be funded from taxation, domestic and foreign borrowing, external grants (including debt cancellation), and seigniorage from printing money. The macroeconomic literature on financial sustainability is huge, but two issues are worth mentioning here. First, a common problem in the recent fiscal history of low-income countries has been the use of foreign aid to finance the capital costs of projects that exhibit low productivity *ex post*, owing to the recipient government's failure to pay the required level of recurrent costs (particularly maintenance expenditures) over the project period. As the donor community moves from project to program lending, and channels external assistance through the national budget, this problem will hopefully become less acute.

#### Box 4.5. Efficiency of Expenditures on Health and Education

**Efficiency of national health systems.** In its latest annual World Health Report, the World Health Organization (WHO) ranks the health systems of 191 countries based on their relative efficiency in producing health. The efficiency measures are derived from stochastic frontier analysis. Evans and others (2000), who developed the efficiency measures, take disability-adjusted life expectancy (dale) as the measure of a population's health. Real total (public and private) per capita health expenditures and average years of schooling are chosen as inputs. The former is a summary measure for all physical inputs in the health system, while the latter acts as proxy for nonhealth system inputs into health. (The researchers opted against taking income per capita as proxy for nonhealth system inputs, because it is not a direct determinant of health and is also highly correlated with health expenditures.) The stochastic frontier model is estimated through fixed-effects regression analysis, which is in essence a variable intercept model (see technical note D.3). The country with the maximum intercept is taken as the reference country (the frontier), and the relative distance from this maximum, corrected for the minimum expected health levels in the absence of a health system, yields the measure of efficiency.

The scores for each country's health system efficiency or performance index are on the statistical pages of the World Health Organization's website<sup>2</sup>. By way of illustration, note that countries with an efficiency score of 0.5 ( $E=0.5$ ) produce only half the number of disability-adjusted life expectancy years with the same total health expenditures per capita, and the same years of schooling, as their most efficient counterparts. Classifying countries with  $E$  larger than 0.7 as good performers, those with an efficiency index between 0.5 and 0.7 as mediocre performers, and those with an efficiency index below 0.5 as poor performers, Costa Rica ( $E=0.882$ ), Sri Lanka ( $E=0.783$ ), and Bangladesh ( $E=0.709$ ) emerge as good performers; The Gambia ( $E=0.687$ ), Vietnam ( $E=0.611$ ), and Mongolia ( $E=0.581$ ) as mediocre; and most African countries as poor performers. Guinea and Kenya, for example, display an efficiency index, respectively, of only 0.469 and 0.320. Health outcomes in these and many other African countries might be substantially improved, even without expanding current real expenditures on health.

**Efficiency of government expenditures in producing education and health.** Using Free Disposal Hull analysis, Gupta and others (1997) assess the efficiency of government expenditures on education and health in 38 countries in Africa over the periods 1984–87, 1988–91, and 1992–95. Their efficiency is assessed in relation to each other and in comparison with countries in Asia and the Western Hemisphere. The authors take primary and secondary school enrollment, as well as literacy, as outcome indicators for education. Outcome indicators for health are life expectancy, infant survival rate, and immunization rate. Inputs in education and health are measured in terms of per capita government expenditures on education and health, respectively, each expressed in purchasing power parity terms. From a combination of the different education efficiency scores, and relative to the other African countries in the sample, Gupta and others (1997) find that public expenditures on education are efficiently used in The Gambia and Botswana, though not in Burkina Faso and Côte d'Ivoire. Regarding health, Botswana and The Gambia emerge once again as efficient administrations. Inefficient use of public expenditures is noted in Mali, Malawi, and Niger, among other countries. Education and health spending in Africa became more efficient over time. Yet, when compared to Asian and Western countries, it is clear that there is substantial room for efficiency improvement.

Second, a public expenditure path planned to achieve a set of targets makes assumptions (often implicit) regarding the corresponding path of private expenditures (e.g., private consumption and investment) needed to achieve the same targets. For example, public spending on food supplements to malnourished children may be based on the assumption, which may be erroneous, that children's private food consumption within the household is not reduced as a result, or at least not reduced at a rate of one private food dollar for one public food dollar. Even in the absence of user fees, public spending on primary education requires complementary private expenditures on uniforms, transport, and other items if the children are to attend school. The assumptions about the complementarity of public and private resources should be made explicit in any discussion of the financial sustainability of PRSP targets.

Similarly, it is important to document the mix of public resources, both external and domestic, on which the country may rely over time. In the case of Tanzania, for example, a detailed set of public-sector activities required to attain PRSP goals has yet to be fully specified or their costs determined. However, current calculations suggest that public spending as a proportion of GDP may have to rise by over 3 percentage points (from 13.4 percent to 16.7 percent) over time. This is likely to generate a financing gap of around 3 percent of GDP. Since the net present value of the external debt is falling in Tanzania, there is scope for additional concessionary borrowing from abroad. If the current rules regarding cash budgeting are relaxed, the government could also cover part of the financing gap from seigniorage revenue and selling debt, since the domestic debt income ratio is low (Bevan 2001, pp. 20–21). This is the type of scenario that must be considered when assessing fiscal sustainability.

Apart from its sectoral and program-costing modules, SimSIP\_Costs includes an overall fiscal sustainability interface. Assumptions are made regarding GDP growth, the revenues generated through taxation, and the extent of the sustainable public deficit in order to provide an overall envelope of public funding, including financing from donors. Spending for the social sectors is computed as a percentage of total public spending, and compared over time to the estimated cost of reaching the various targets. This helps the user determine if the costs in the various social sectors are affordable from a macroeconomic point of view with or without reallocation of funds toward the social sectors (beyond the reallocation of funds made feasible through HIPC debt relief). The user can also estimate the fiscal tradeoffs between various targets. Since the costs of reaching various targets are computed independently, one may, for example, ask how much access to water could be increased, from a fiscal perspective, if the target for net primary enrollment were reduced by one percentage point.

### ***Absorptive sustainability***

Absorptive sustainability signifies whether a planned expenditure path can be implemented, presuming it can be financed. For the public sector as a whole, absorptive capacity includes the ability to design, disburse, coordinate, control, and monitor public spending. This coordination is both vertical (between central and local government) and horizontal (between line ministries at any given level). Within the public sector, absorptive sustainability is about fiscal flexibility and has two main aspects. First, for the highest priority sectors where spending is due to rise under the PRSP, can the additional expenditure on, for example, rural roads, health, and education be undertaken by the relevant line ministries and other agencies without loss of control, increased leakage, and/or poorer service delivery? Absorptive capacity is difficult to measure. However, it should be feasible to calculate the planned real absolute changes in public expenditure of a given sector or ministry over a three-year period, to meet the PRSP targets, and to compare these changes with a recent time trend for the sector or ministry. If the required increase in real spending to meet PRSP targets exceeds this trend by a significant margin, doubts may be raised about the absorptive sustainability of the planned expenditure path.

Second, for the lowest priority sectors, a comparable exercise can be carried out to establish whether the planned rate of real public spending growth (which may be negative) is consistent with recent historical experience. Fiscal inertia caused by medium- and long-term contracts signed by line ministries, together with other frictional constraints, may limit the speed with which resources can be reallocated among different branches of the public sector. Such contracts are typical and include the following:

1. ***Labor contracts.*** Where a high proportion of public expenditure in a sector is taken up by the wage bill, the rate at which expenditure can be cut depends on the nature of labor contracts in the

sector. This, in turn, depends on the extent of labor unionization, the extent/nature of wage indexation (in high-inflation contracts) and other institutional features that affect the ease with which workers can be dismissed and/or real wages reduced.

2. *Defense contracts.* The purchase of military hardware, e.g., combat aircraft, sometimes ties in the buyer to purchase after-sales services for some minimum period, e.g., maintenance work, etc.

## 4.5 Conclusion

Targets are introduced in the PRSP with two key objectives: to initiate a process of prioritization and to foster a culture of accountability among the different actors involved in the policymaking process. Targets also help mobilize resources for the overall goal of reducing poverty. In order to achieve these objectives, it is essential that the chosen targets be realistic. They might lose their power as incentives if they were unattainable from the start. Unfortunately, experience suggests that in many current PRSPs and I-PRSPs, this may be the case; their targets tend to be too optimistic, and the cost of reaching them tends to be underestimated.

This chapter has provided a set of readily applicable tools for assessing the technical and fiscal feasibility of development targets. Each tool has intrinsic limitations, so it is important to apply as many tools as possible in order to set development goals that are, from a technical and fiscal perspective, realistically achievable. Fortunately, application of these different tools has been made easier through the development of user-friendly, free-of-charge software. While the SimSIP software applications simplify the task at hand, caution is warranted, especially in interpreting the results from the target-setting software. These results are only as reliable as their underlying estimated models. The good news is, these applications are sufficiently flexible to be adapted to country-specific circumstances, which is especially required when estimating costs. Nevertheless, practitioners are encouraged to continuously search the literature for updated and modified applications and new econometric techniques for estimating the relationship between development outcomes and economic performance.

While some applications for microsimulations have been developed within SimSIP, these are by nature country-specific, and they may not be readily applicable to other countries. Here, practitioners can draw on a vast literature on the microanalysis of determinants of development outcomes (Strauss and Thomas 1995). However, user-friendly analytical tools for assessing efficiency of expenditures on social development outcomes are still missing. Since there appears to be a lot of scope for improvement in the efficiency of public service delivery in many countries, this is an important area where additional empirical research would be valuable.

## Notes

1. This can be calculated by applying the following formula:  $dU = -8.02 \ln((1+r)^t)$  where  $dU$  is the percentage point change in malnutrition,  $r$  the GDP per capita growth rate and  $t$  the time period. Rearrangement of this formula yields:  $r = \{\exp(-dU/8.02)\}^{(1/t)} - 1$  and substitution of the actual values for  $dU$  and  $t$  yields  $\{\exp(15/8.02)\}^{(1/25)} - 1 = 0.078$
2. [http://www.nt.who.int/whosis/statistics/whr\\_statistics/select.cfm?path=statistics,whr\\_statistics,whr\\_select&language=english](http://www.nt.who.int/whosis/statistics/whr_statistics/select.cfm?path=statistics,whr_statistics,whr_select&language=english)

## References

- Aigner, D., K. Lovell, and P. Schmidt. 1977. "Formulation and Estimation of Stochastic Frontier Production Function Models." *Journal of Econometrics* 6:21–37.
- Alderman, H., S. Appleton, L. Haddad, L. Song, and Y. Yohannes. 2000. "Reducing Child Malnutrition: How Far Does Income Growth Take Us?" World Bank, Washington, D.C. Processed.

- Bevan, D. L. 2001, May. "Tanzania Public Expenditure Review: 2000/01—the Fiscal Deficit and Sustainability of Fiscal Policy." Paper presented to the consultative meeting of the Public Expenditure Review. Dar es Salaam. Draft.
- Charnes, A., W. W. Cooper, and E. Rhodes. 1978. "Measuring the Efficiency of Decision Making Units." *European Journal of Operational Research* 2(6):429–44.
- Chirikos, T. N., and A. M. Sear. 2000. "Measuring Hospital Efficiency: A Comparison of Two Approaches." *Health Services Research* 34(6):1389–408.
- Christiaensen, L., and H. Alderman. 2001. "Child Malnutrition in Ethiopia: Can Maternal Knowledge Augment the Role of Income." Africa Region Working Paper Series 22. World Bank, Washington, D.C.
- Coelli, T. 1996. "A guide to DEAP version 2.1: a data envelopment analysis (computer) program." *CEPA Working Paper 96/08*, Armidale, New South Wales.
- Demery, L., and M. Walton. 1999. "Are Poverty and Social goals for the 21st Century Attainable?" *IDS Bulletin* 30(2):75–91.
- Dicowsky, R. B., and C. M. Cardenas. 2000. "Paquete basico de servicios de salud para aldeas rurales: Diseno, estimación de costos, costo efectividad y evaluación de impacto economico-fiscal - informe 2: resultados finales" programa de reorganización institucional y extensión de los servicios basicos del sector salud. Tegucigalpa, Honduras.
- Deprins, D., L. Simar, and H. Tulkens. 1984. "Measuring Labor-Efficiency in Post Offices." In *The Performance of Public Enterprises: Concepts and Measurement*. M. Marchand, P. Pestieau, and H. Tulkens, eds. North-Holland Publishing Company, Amsterdam.
- Drèze, J., and A. Sen. 1996. *Indian Development: Selected Regional Perspectives*. Clarendon Press, Oxford
- Evans, D. B., A. Tandon, C. J. L. Murray, and J. A. Lauer. 2000. "The Comparative Efficiency of National Health Systems in Producing Health: An Analysis of 191 Countries." *GPE Discussion Paper Series 29*. World Health Organization, Geneva.
- Fakin, B., and A. de Crombrughe. 1997. "Fiscal Adjustments in Transition Economies - Transfers and the Efficiency of Public Spending: A Comparison with OECD Countries." World Bank Policy Research Paper 1803. World Bank, Washington, D.C.
- Farrell, M. J. 1957. "The Measurement of Productive Efficiency." *Journal of the Royal Statistical Society Series A* 120(3):253–78.
- Filmer, D., and L. Pritchett. 1997. "Child mortality and public spending on health: how much does money matter." Development Research Group, DEC, World Bank. Processed.
- . 1999. "The Impact of public spending on health: does money matter?" *Social Science Med* 49(10):1309–23.
- Grosskopt, S., and V. Valdmanis. 1987. "Measuring Hospital Performance: A Non-Parametric Approach." *Journal of Health Economics* 6(2):89–107.
- Grossman, P. J., P. Mavros, and R. W. Wassmer. 1999. "Public Sector Technical Inefficiency in Large U.S. Cities" *Journal of Urban Economics* 46(2):278–99.
- Gupta, S., K. Honjo, and M. Verhoeven. 1997. "The Efficiency of Government Expenditure: Experiences from Africa." *IMF Working Paper 97/15*. International Monetary Fund, Washington, D.C.
- Kirjavainen, T., and H. A. Loikkanen. 1998. "Efficiency Differences of Finnish Senior Secondary Schools: An Application of DEA and Tobit Analysis." *Economics of Education Review* 17(4):377–94.
- Kumbhakar, S. C., and C. A. K. Lovell. 2000. *Stochastic Frontier Analysis*. Cambridge University Press, Cambridge.

- Maxwell, S. 1999. "International Targets for Poverty Reduction and Food Security: A Mildly Skeptical but Resolutely Pragmatic View with a Call for Greater Subsidiarity." *IDS Bulletin* 30(2):92–105
- Midhet, F., S. Becker, and H. Berendes. 1998. "Contextual determinants of maternal mortality in rural Pakistan." *Social Science and Medicine* 46(12):1587–98.
- Ministry of Finance, Planning and Economic Development, Government of Uganda. 2001. *The 2001 Progress Report on Uganda's PRSP*. Kampala, Uganda.
- Mirmirani, S., and H. C. Li. 1995. "Health Care Efficiency Measurement: An Application of Data Envelopment Analysis." *Rivista Internazionale di Scienze Economiche Commerciali* 42(3):217–29.
- Murray, C., J. Kreuser, and W. Whang. 1994. "Cost-effectiveness analysis and policy choices: investing in health systems." *Bulletin of the World Health Organization* 74(4):663–74.
- Pritchett, L. 1997. "Divergence, Big Time." *Journal of Economic Perspectives* 11:3–17.
- Pritchett, L., and L. Summers. 1996. "Wealthier Is Healthier." *Journal of Human Resources* 31(4):841–68.
- Ravallion, M. 2000. "What Can We Learn about Country Performance from Conditional Comparisons across Countries?" World Bank. Processed.
- Ravallion, M., and S. Chen. 1999. "Growth Rates Needed to Halve the Poverty Rate in 25 Years." Development Research Group, DEC, World Bank. Processed.
- Sachs, J., and Warner. 1995. "Economic Convergence and Economic Policies." NBER Working Paper 5039. Cambridge, MA.
- Strauss, T., and D. Thomas. 1995. Human Resources: Empirical Modeling of Household and Family Decisions, in Behiman, T., and T.N. Srinivasan, eds. *Handbook of Development Economics*, Vol. 3A. North Holland Publishing Company, Amsterdam.
- Tulkens, H. 1993. "On FDH Analysis: Some Methodological Issues and Applications to Retail Banking, Courts and Urban Transit." *Journal of Productivity Analysis* 4:183–210.
- Tulkens, H., and P. Vanden Eeckhaut. 1995. "Non-Parametric Efficiency, Progress and Regress Measures for Panel Data: Methodological Aspects." *European Journal of Operational Research* 80:474–99.
- Wodon, Q., with contributions from R. Ayres, M. Barenstein, N. Hicks, K. Lee, W. Maloney, P. Peeters, C. Siaens, and S. Yitzhaki. 2000. "Poverty and Policy in Latin America and The Caribbean." World Bank Technical Paper 467, World Bank, Washington, D.C.
- Wodon, Q., M. I. Ajwad, B. Ryan, and J. P. Tre. 2001. "SimSIP: Simulations for Social Indicators and Poverty." World Bank. Processed.
- World Bank. 2001. *World Development Indicators*. Washington, D.C.
- Zere, E. 2000. "Hospital Efficiency in Sub-Saharan Africa: Evidence From South Africa." UNU World Institute for Development Economics Research Working Paper 187. Helsinki.



# Annex D

## Development Targets and Costs: Technical Notes

Technical Note D.1 SimSIP_Goals: A Simulator for Setting Targets .....	463
Technical Note D.2 SimSIP_Costs: Estimating the Cost of Reaching Targets .....	465
Technical Note D.3 Estimating Production Frontiers .....	468

### Figures

D.1. A Free Disposal Hull Production Frontier .....	468
D.2. A Data Envelopment Analysis Production Frontier.....	469

### Technical Note D.1 SimSIP\_Goals: A Simulator for Setting Targets

The Poverty Group in the World Bank’s Latin America and Caribbean Region has developed user-friendly, Excel-based simulation tools to help countries prepare PRSPs. Named “SimSIP” (Simulations for Social Indicators and Poverty), the simulators have five components:

- SimSIP\_Goals helps analysts assess whether PRSP targets are realistic.
- SimSIP\_Poverty facilitates simulations for poverty, inequality, and social welfare indicators.
- SimSIP\_Costs estimates what it will cost to reach development targets.
- SimSIP\_Incidence analyzes who is likely to benefit from additional social expenditures.
- SimSIP\_Determinants analyzes the microdeterminants of poverty and other outcomes.

These first two technical notes for chapter 4 briefly explain what SimSIP\_Goals and SimSIP\_Costs can do, and how they work. More details on the various simulators, including user manuals, can be found in Wodon and others (2001). The simulators will be made available, free of charge, on the Internet. They are a work in progress, and additional features will be included over time.

SimSIP\_Goals is a simulator that can be used to set targets for education, health, basic infrastructure, and poverty indicators. For poverty simulations, the analysis can be complemented with the SimSIP\_Poverty application, but this is not discussed here. At present, simulations can be made only for Latin American countries, but these should be extended to other regions in the future. The indicators correspond roughly to the International Development Goals and are listed here by category.

- **Education.** Gross primary, secondary, and tertiary enrollment rates; net primary and secondary enrollment rates; rate of illiteracy among the adult population.
- **Health.** Infant mortality rate, under-five mortality rate, life expectancy, and under-five malnutrition rate.
- **Infrastructure.** Access to water, access to sanitation, and telephone main lines.
- **Poverty and extreme poverty.** Headcount, poverty gap, and squared poverty gap (see chapter 1, “Poverty Measurement and Analysis,” for definitions of these measures).

For education, health, and infrastructure services, the indicators are provided at the national level only. Targets can be based on either historical trends or model-based elasticities.

- **Historical trends.** Projections into the future are based on country-level historical trends observed for each specific indicator. Four different ways of fitting a historical trend at the country level are considered for each indicator. The best-fit historical trend among the four functional forms is selected for the simulations. Time is the only exogenous variable.
- **Model-based elasticities.** The second (and arguably better) alternative is to rely on an econometric model giving elasticities of the indicators to variables such as economic growth, population growth, urbanization, and time. These elasticities have been estimated with two different econometric models using worldwide panel data sets, and they are allowed to vary with a country’s level of economic development (that is, GDP per capita) and urbanization.

For poverty, the indicators are provided at the rural and urban levels. This yields national poverty measures when urbanization is taken into account. The simulations for poverty are based on estimated elasticities of poverty to growth, taking into account the effect of growth on inequality. Future levels of poverty are simulated as a function of economic growth, population growth, and urbanization growth, while the user is provided with the contribution of each variable to poverty reduction. Given assumptions for these variables, the user can also assess how the Gini index of inequality would have to change in order to reduce the headcount of poverty by the stated objective (say, a reduction in the headcount to half its 1990 rate by 2015).

The simulator can be used to assess the effect of economic growth, population growth, urbanization, and time (as a proxy for other variables, such as technological progress) on the indicators. It can thus be used to set realistic targets for the indicators, on the basis of international experience and country-specific initial conditions. While the simulator gives a feeling for the magnitude of the gains that can be achieved over time for the various indicators, it should be used with caution before inferring policy recommendations. In some countries, the simulator may yield more realistic projections than in other countries. The simulator may also work better for some indicators than for others. Thus users are advised to use their own information in order to adapt the simulator results to their country. Below, we provide more details on the methodology used for making forecasts.

### D.1.1 Country-specific time trends for social indicators

Country-specific historical trends are provided for social indicators (education, health, and basic infrastructure), but not for poverty, because in many countries there is no clear time trend in poverty measures. Denoting by  $y$  the social indicator, the country-specific historical trends are based on one of four simple specifications wherein only time appears as an explanatory variable:

Linear	$y = \alpha + \beta t$
Logarithmic	$y = \alpha + \beta \ln t$
Exponential	$y = \alpha e^{\beta t}$
Power	$y = \alpha t^{\beta}$

For each indicator taken separately, and for each country, the specification with the best fit is used for the projection. However, to take into account the most recently observed data, the parameter  $\beta$  is applied from the latest actual data point onward, so that there may be a small break in the historical trend between the past and the future trends if the latest data point is not exactly positioned on the past historical trend. The estimation of such time trends is one variant of the historical benchmarking discussed in section 4.3.1 of chapter 4.

### D.1.2 Model-based forecasts for poverty

At a broad macroeconomic level, poverty is affected by economic growth and by changes in income inequality. By building panel models within a region or a country, estimates of the elasticities of poverty and inequality to growth can be estimated. Provided one has state- or province-level data within a country, or country-level data within a region, panel data sets of poverty, mean income, and inequality measures can be constructed in order to estimate the elasticity of poverty to growth and inequality. Denoting by  $\gamma$  and  $\lambda$  the gross and net elasticities of poverty to growth, by  $\beta$  the elasticity of inequality to growth, and by  $\delta$  the elasticity of poverty to inequality controlling for growth, we have  $\lambda \approx \gamma + \beta\delta$ . This method was applied to poverty measures computed for 12 countries in Latin America by Wodon and others (2000).

The results were provided in table 4.4 of chapter 4. The net elasticities of poverty to growth in that table have been used in the SimSIP\_Goals simulator, in order to yield forecasts for poverty and extreme poverty measures separately for urban and rural areas. It is, however, feasible for the user to specify other chosen elasticities for the simulations. In the simulator, the predicted values are calculated by applying the estimated elasticities to the latest actual data point, and GDP is used as a proxy for private disposable income growth (in Latin America, poverty measures are income-based in part because consumption data are not available in most household surveys; using GDP growth as a proxy for consumption growth would be more problematic). If  $P_0$  is the observed poverty measure for the latest data point available,

$GDP_T$  and  $GDP_0$  represent per capita GDP at the initial period 0 and at the final period T, the forecast for the poverty measure in year T (denoted by  $P_T$ ) is:

$$P_T = P_0 * \left( \frac{GDP_T}{GDP_0} \right)^\lambda$$

For example, if a country with an initial headcount index of poverty of 50 percent has a rate of per capita GDP growth of 4 percent over 10 years, the poverty headcount is expected to decline from its current level to 34 percent if the elasticity of the headcount index is equal to minus one. Alternatively, we can calculate the average per capita GDP growth rate ( $r$ ) needed over a period T to reduce the poverty headcount to a target  $P_T$ . This is obtained as:

$$r = [(P_T/P_0)^{(1/\lambda)} - 1]$$

To reduce the poverty headcount in 10 years from 50 percent to 25 percent, the necessary rate of per capita GDP growth would have to be 7.2 percent per year. Historical evidence and/or projections for GDP and population growth can then be used to check if this is realistic, and poverty reduction targets can be adapted accordingly. Note that in the simulator, the same GDP growth rate is applied separately to urban and rural areas, and the forecasts for urbanization and population growth are then used to weight the urban and rural poverty measures in order to compute the national poverty measure. Another simulator, SimSIP\_Poverty, provides alternative (and more detailed) ways to make poverty simulations.

### D.1.3 Model-based forecasts for social indicators

Apart from reducing poverty, growth also improves nonmonetary indicators of well-being. But other factors may have large impacts as well. Urbanization matters, because it is often easier and cheaper to provide access to public and private services for education, health, and basic infrastructure in urban areas than in rural areas. Time may also have an effect; it can be used, for example, as a proxy for technological progress, such as the development of vaccines which reduce infant mortality. The level and targeting of public social spending also matter, but these are more difficult variables to obtain for quantitative analysis, and there are difficult econometric issues involved in assessing the effect of public spending on outcomes. To simulate future levels for social indicators, SimSIP\_Goals relies on estimates of the elasticities of each indicator to real GDP growth per capita, urbanization, and time using worldwide panel data. The elasticities are allowed to depend on the level of economic development of the country, as well as its level of urbanization.

Using estimates of the elasticities of each social indicator to real per capita GDP growth, urbanization, and time, it is feasible to set targets for the indicators. That is, if we denote the urbanization rate by  $u$ , the elasticity of the social indicator  $y$  to urbanization by  $\phi$ , and the effect of time on the indicator by  $\varphi$ , the future level of the social indicator is computed as:

$$y_T = y_0 * \left( \frac{GDP_T}{GDP_0} \right)^\lambda * \left( \frac{U_T}{U_0} \right)^\phi * e^{\varphi T}$$

In the simulator, as for poverty, the future level of real per capita GDP growth is a function of assumptions made by the user for real GDP growth and population growth. The forecasts are bound by the following restrictions: mortality, illiteracy, and malnutrition rates must be greater than or equal to zero; gross school enrollment rates must be less than 130 percent; and net enrollment rates and access to safe water and sanitation must be less than or equal to 100 percent.

## Technical Note D.2 SimSIP\_Costs: Estimating the Cost of Reaching Targets

This note outlines some of the features of SimSIP\_Costs, a user-friendly, Excel-based simulator that can be used to estimate what it will cost to reach development targets for education, health, basic infrastructure, and poverty indicators. The simulator can easily be adapted from one country to another. It includes a fiscal sustainability interface to assess the macroeconomic implications of additional public spending designed to reach PRSP targets. It also includes interfaces for various types of targeted interventions for the poor, and it

can be used to assess financial tradeoffs between targets in different sectors. Below, we describe some of the hypotheses used to estimate what it will cost to reach education, health, and basic infrastructure targets. Information on the other features of SimSIP\_Costs is available in the SimSIP manual.

### D.2.1 Education

The education simulator is based on a detailed cohort analysis. Using this cohort analysis, it is relatively easy to estimate the cost of reaching education targets, since we know the number of students in school over time. The number and age of students in each grade is a function of parameters chosen by the user, such as the distribution of age at entry in primary school, and the repetition, promotion, and dropout rates per cycle or per grade. Using these parameters, which can change over time, the simulator provides detailed statistics and graphs on the efficiency of the education sector.

Although there are many more options in the simulator than those described below, the basic idea for calculating costs is as follows. In each grade (or cycle), the teacher wage bill is computed by multiplying an average cost per teacher (which is allowed to vary over time) by the number of teachers needed to cater to the student population. The number of teachers is determined by dividing the total gross enrollment by the student-teacher ratio, which is also allowed to vary over time. The “recurrent” supply-side cost is then obtained by adding to the teacher wage bill a provision for administrative costs, which can again vary over time.

$$\text{Recurrent supply-side cost} = \text{Teacher's wage bill} * (1 + \% \text{ administrative costs})$$

$$\text{with Teacher's wage bill} = \text{Number of teachers} * \text{Teacher wage rate}$$

$$\text{Number of teachers} = \text{Gross enrollment} / \text{Student-teacher ratio}$$

The simulator also computes demand-side costs resulting from the possibility of the government granting yearly stipends to qualifying students. The cost depends on the value of the stipends and their coverage rate (that is, the share of all students receiving the stipends).

$$\text{Demand-side costs} = \text{Yearly stipend} * \text{Gross enrollment} * \text{Coverage rate}$$

Investment costs are estimated for training new (or existing) teachers and constructing new classrooms. In the case of new teachers, if  $T_{t+1}$  represents the number of teachers in year  $t+1$ , and  $ATC$  is the average new teacher training cost, the total training cost  $TC$  in year  $t$  is:

$$TC = (T_{t+1} - T_t)ATC$$

Similarly, if  $C$  is the average cost of constructing a new classroom in a given cycle, if the number of students in a cycle is denoted by  $Y$ , and if we assume for simplicity here that the pupil-teacher ratio (PTR) does not change over time, investments for school construction costs are estimated as:

$$\frac{Y_{t+1} - Y_t}{PTR} C$$

As for all the parameters in the system, the unit investment costs for training new teachers and constructing new classrooms are allowed to change over time. In all cases, the share of the students in the public sector (as opposed to the private sector) is taken into account in order to estimate costs.

### D.2.2 Basic package of health care

The health simulator essentially computes the total cost of the implementation of a basic health care package program through mobile health units, taking into account the indirect and direct costs associated with the program. We followed closely the approach proposed by Dicowsky and Cardenas (2000). Each year, the costs vary with the level of coverage of the program. Let  $IFC_t$  and  $IVC_t$  represent Indirect Fixed and Variable Costs, and  $OCT_t$  represent the cost of operation of a single mobile health team in year  $t$ . If we denote the number of mobile health teams by  $N_t$ , the total cost in year  $t$  is:

$$C_t = IFC_t + IVC_t + (N_t \times OCT_t)$$

Indirect fixed costs include salary expenses for supervising staff and civil servants of the Ministry of Health, at the national level and in various regions. The costs are proportional to the amount of time they allocate to the supervision of the basic health package program in their respective region and areas. We may denote by  $S_i^m$  the monthly salary of the  $j$  agents of the Ministry of Health coordinating the health package implementation  $M$ . Monthly salaries are multiplied by a number (say, 14) to reflect 12 months of base pay plus other benefits. The agents are assumed to allocate a share of their time (say, 5 percent) to the program. The resulting indirect fixed costs can be computed as:

$$IFC_t = \left( \sum_{i=1}^j S_i^m \times 14 \right) \times 5\%$$

Indirect variable costs comprise all expenditures allocated to training and travel of health team members, program coordinators, community team members, and officials of the Ministry of Health involved in the programs. These are computed as follows:

$$IVC_t = \left( \sum_{i=1}^m \text{Viaticos}_i \times X_i \right) + \left( \sum_{i=1}^m \text{Cap}_i \times Y_i \right)$$

where  $\text{Viaticos}_i$  and  $\text{Cap}_i$  represent the cost of travels and training for each individual  $i$  involved in the program.  $X_i$  and  $Y_i$  are the number of days during which trips and training occur for the same individuals.

The costs of each mobile health team also consist of indirect and direct costs:

$$OCT_t = DFC_t + DVC_t$$

Direct fixed costs include salary costs of team staff (medical doctor, nurse, nurse assistant, technician, and driver; the user can specify a higher number of each type of worker in a team). Total direct fixed costs are a function of the total number of existing mobile teams. If  $S_i$  represents the monthly salary of each of the  $k$  ( $k = 6$  in this illustration) members in the mobile teams staff, and if we allow the monthly salary to be multiplied by a number such as, say, 16 to include the 12 months of base pay, one month of paid vacation, bonuses, and the salary of a substitute team during the vacation period of each principal team, we get:

$$DFC_t = \sum_{i=1}^k S_i \times 16$$

Direct variable costs include program activities costs. All mobile teams are expected to carry out specific health and nutrition programs as defined in the relevant basic health package. The interface provides the list of programs or activities included in each package. For each activity listed, the costs of material and equipment needed must be specified. Equipment is assumed to depreciate over a given period of time (say, five years), yielding a depreciation rate. The total direct variable costs incurred by each team are estimated based on the number of individuals reached by the programs.

### D.2.3 Basic infrastructure (water and sanitation)

The simulator for basic infrastructure uses assumptions for demographics, as well as cost characteristics of alternative technical options, to estimate the total cost of expanding access to water and sanitation services to a greater portion of the population. Total annual costs include investment expenditures as well as annual operation and maintenance costs incurred within a year. Hence, this assumes all investment is performed over a one-year period. For each service  $j$  and each technology option  $k$ , an annual cost  $C_i$  is calculated. This cost is the product of total cost per beneficiary  $c^{j,k}$  multiplied by the number of individuals who have new access to water or sanitation services that same year. Costs thus depend on the proportion of population benefiting from new access each year. Population growth is taken into account.

The population benefiting from new access is the difference between the number of individuals with access the year before and the number of individuals benefiting from water (or sanitation) services at the end of the following year. For instance, if the level of water supply coverage is expected to increase from 57 percent in 2000 (number of households = 1.2 million) to 59.5 percent in 2010 (number

of households = 1.5 million), the additional number of households reached in 2010 would be equal to  $[(0.595 \times 1.5) - (0.57 \times 1.2)]$ . The total cost per beneficiary ( $C^{j,k}$ ) is the sum of the unit cost of investment ( $i^{j,k}$ ), the operation cost ( $o^{j,k}$ ), and the maintenance cost ( $m^{j,k}$ ) associated with the technology  $k$  selected. The costs can be shared between the households and the municipalities, which provides the possibility of giving access or consumption subsidies. Therefore for each technology  $k$  and service  $j$ , the total cost per beneficiary is:

$$C^{j,k} = i^{j,k} + o^{j,k} + m^{j,k}$$

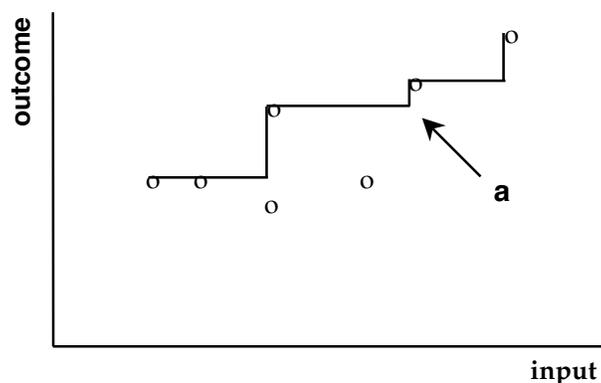
### Technical Note D.3 Estimating Production Frontiers

Production frontiers can be estimated by deterministic or by stochastic methods. In the deterministic approach, an outer envelope that encompasses all observations is constructed. Production frontiers determined in this manner are sensitive to extreme observations, as the approach does not correct for outliers or measurement error. This may bias the resulting efficiency measures. In the stochastic approach, it is explicitly acknowledged that some deviations from the maximum observed output may be caused by exogenous shocks outside the control of the production system. Such deviations are clearly unrelated to inefficiency. Stochastic specifications of the production frontier account for this either by assuming that the error term has two components, one representing random errors and one representing technical inefficiency (the error component model, Aigner, Lovell, and Schmidt 1977), or by allowing for variable intercepts (the fixed effect model, Evans and others 2000). While this approach takes care of potential bias introduced by extreme observations, it potentially introduces other bias by imposing a particular functional form on the frontier. In the literature, both methods are commonly used. To provide some understanding of the principles underlying both approaches, as well as their differences, we briefly present two common deterministic and two stochastic methods.

One common deterministic method to establish the production frontier is the Free Disposal Hull (FDH) approach. In this approach, a piece-wise linear “envelope” is constructed connecting the outer points on the surface such that all observed data points are either on the frontier or below it. Empirical applications include: Deprins, Simar, and Tulkens (1984), to study the efficiency of Belgian retail banking; Fakin and de Crombrughe (1997), to assess the efficiency of government spending in OECD member countries; and Gupta and others (1997), to evaluate the efficiency of government expenditure on education and health. The basic principle is illustrated in figure D.1 using a simple one-input one-output case. All points on the frontier are considered efficient. Efficiency of the other points can be calculated by estimating the relative vertical distance to the frontier. Derivation of the efficiency measures is more complicated in case of multiple inputs and outputs, and we refer to Tulkens (1993) for a more detailed discussion.

Unlike the other techniques discussed below, the FDH technique does not impose many restrictions on the production technology. This is its main advantage. Yet it also has several disadvantages. First, to the extent that multiple observations find themselves on the frontier, the FDH technique only permits a partial ranking, as observations on the frontier are equally efficient. Second, no distinction is made between random factors that might affect production (for example, rainfall in agricultural production) and actual inefficiency. The analysis is not robust to outliers or extreme data points.

Figure D.1. A Free Disposal Hull Production Frontier



Data Envelopment Analysis (DEA) is another common nonparametric deterministic approach to estimating production frontiers. In this approach, linear programming methods are used to construct a linear envelope to bind the data relative to which efficiency measures can be calculated. Multiple inputs and outputs can be considered. A comprehensive discussion of this technique and its differences from FDH can be found in Charnes, Cooper, and Rhodes (1978); Coelli (1990); and Tulkens and Vanden Eeckhaut (1995). The frontier implied by this approach is illustrated in figure D.2 for the simple one-input one-output case.

In contrast to FDH analysis, DEA assumes that the production possibility set is convex, implying that linear combinations of best-observed production results lie on or below the production possibility frontier. Consequently, point a, which was efficient under the FDH approach, is no longer efficient according to DEA. Fewer observations lie on the frontier, which enhances the number of observations that can be completely ranked. Yet the approach remains deterministic and true inefficiency can still not be separated from random variation.

The most common stochastic approach for estimating production frontiers, often referred to as the “error components model,” goes back to Aigner, Lovell, and Schmidt (1977). In this approach, a parametric production function is estimated and the specification of this function explicitly accounts for the fact that deviations from the maximum observed output may also be due to factors unrelated to inefficiency. To address this problem, it is assumed that the error term has two components: one representing random errors and another representing technical inefficiency.

Denote by  $Y_{jt}$  output of unit  $j$  at time  $t$ , by  $X_{jt}$  a vector of inputs, by  $v_{jt}$  an error term with mean zero, and  $u_j$  a random variable representing unit-specific (technical) inefficiency. The latter error term is constrained to be non-negative ( $u_j \geq 0$ ). The error component model can be represented mathematically as:

$$Y_{jt} = \alpha + X'_{jt} \beta + v_{jt} - u_j \quad (1)$$

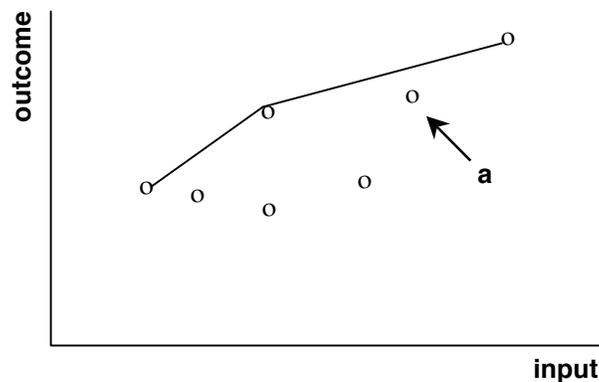
Technical efficiency can be derived as the ratio of the expected value of observed output for country  $j$  to the expected value of the output when  $u_j = 0$ . Or,

$$TE_j = E(Y_{jt} | u_j, X_{jt}) / E(Y_{jt} | u_j=0, X_{jt}) \quad (2)$$

The denominator represents the production frontier, because the inefficiency term  $u_j$  is zero. Coefficients in equation (1) can be estimated using maximum likelihood methods. It is further assumed that  $v$  and  $u$  can be separated (note that it is  $v-u$  which is observed), and one must also make certain assumptions regarding the distribution of  $u$ . As the  $u$ 's are constrained to be non-negative, they are typically assumed to be distributed half-normal or truncated-normal. Efficiency rankings appear to be fairly robust to the choice of the distribution (Kumbhakar and Lovell 2000). Finally, note that the production frontier, estimated this way, does not necessarily encompass all observations. While the expected output value must lie on or below the envelope, the actual output value may well lie above it if the random error for that observation is large enough.

Another stochastic method for estimating production frontiers is the fixed effect approach, which is in essence a variable intercept model. This is the approach used by Evans and others (2000) to estimate

**Figure D.2. A Data Envelopment Analysis Production Frontier**



the comparative efficiency of national health systems in producing health (see box 4.5 in chapter 4). The production process presented in equation (1) can be rewritten as:

$$Y_{jt} = \alpha_j + X'_{jt} \beta + v_{jt} \quad (3)$$

where  $\alpha_j = \alpha - u_j$  is an observation-specific intercept that can be estimated using the fixed effects approach. The frontier intercept is  $\alpha$  and the observation-specific inefficiencies are represented by  $u_j$ . To ensure that  $u_j$  is non-negative, the observation with the largest  $\alpha_j$  (denoted  $\alpha_m$ ) is taken as reference and is deemed fully efficient. Thus  $\alpha_j$  equals  $\alpha_m - u_j$ . Technical efficiency can be calculated as in equation (2).