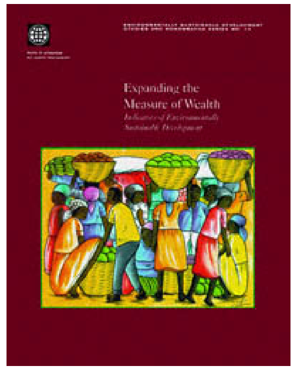

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Expanding the Measure of Wealth

Indicators of Environmentally Sustainable Development

Environmentally Sustainable Development Studies and Monographs Series No. 17

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FOREWORD

The publication by the World Bank in late 1995 of *Monitoring Environmental Progress: A Report on Work in Progress* generated great interest in the use of indicators to measure the pace and direction of change in environmentally sustainable development. In particular, the attempts to redefine what it means to be "wealthy" or "poor" by recognizing that a country's wealth is the combination of various forms of capitalproduced, natural, and human resourcesled to new thinking on what constitutes wealth and how it could be measured. The emphasis on stocks of wealth supports a new paradigm for sustainable development, as a process of managing a portfolio of assets to preserve and enhance the opportunities people face.

In response to growing worldwide interest, the World Bank established an Indicators and Environmental Valuation Unit in the Environment Department to serve as a focal point for work on indicators and related issues. At present work in this area is proceeding on several fronts: developing environmental indicators that can be monitored for Bank investment projects, expanding the set of environmental indicators in the newly revised *World Development Indicators* produced by the International Economics Department of the Bank, and continuing work on resource accounting and indicators of sustainability.

This report was produced by the Indicators and Environmental Valuation Unit. It is appropriately subtitled *Indicators of Environmentally Sustainable Development* because it highlights "portfolio" indicators for tracking a country's progress toward sustainable development. These include new estimates of national wealth and genuine savings, a detailed analysis of changes in subsidies with environmental consequences, and progress on the conceptual foundations of social capital. While many of these new estimates are more refined than those presented in 1995, the underlying story remains the same. If anything, the new estimates reinforce the importance of the natural resource base of all economies as well as the fundamental role of human resources (including both human capital and the more difficult to define but important concept of social capital) in determining a nation's wealth and, in turn, the opportunities for welfare gains for a nation's population.

The Bank's work on indicators has attracted a high level of interest from many others around the worldboth researchers and policymakers. We would like to recognize the numerous inputs and comments received and specifically acknowledge the generous financial support from the Governments of Norway and Sweden for this expanded work on indicators.

We present our results to provoke discussion and further research. We are convinced that these new approaches to indicators serve the paradigm of sustainable development founded on healthy ecosystems, vigorous economies, and equitable social systems.

ISMAIL SERAGELDIN
VICE PRESIDENT
ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT

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This volume is the product of a team effort led by the Indicators and Environmental Valuation Unit of the Environment Department of the World Bank. The members of the unit are John Dixon, chief; Jan Bakkes, Kirk Hamilton, Arundhati Kunte, Ernst Lutz, Stefano Pagiola, and Jian Xie. Research assistance was provided by Michael Clemens and Andrew Sunil Rajkumar. The primary authors are:

Chapter 1, "Introduction," Dixon and Hamilton

Chapter 2, "Are We Saving Enough for the Future?," Hamilton and Clemens

Chapter 3, "Measuring the Wealth of Nations," Dixon, Hamilton, and Kunte

Chapter 4, "Subsidy Policies and the Environment," Pagiola, Rajkumar, and Xie

Chapter 5, "Land Quality Indicators," Sara Scherr (International Food Policy Research Institute), Christian Pieri (Agriculture Department), and Lutz

Chapter 6, "Social Capital: The Missing Link?" Christiaan Grootaert (Social Policy Division, Environment Department)

Chapter 7, "Poverty and the Environment," Pagiola and Kunte

Chapter 8, "international Progress in Indicator Development," Bakkes.

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Chapter 1
Introduction

Natural resources count, but people count even more. This is the main lesson from the new estimates of the wealth of nations contained in this report. By expanding the measure of wealth to include natural capital and human resources in addition to produced assets (the traditional measure of wealth) one can examine both the total of national wealth using this broader definition, and the differences found between countries. This analysis yields important insights in the search for development that is economically and environmentally sustainable.

It should not be surprising that the role of people and society is the most important in determining overall national wealth. Investments in education and health care, the more traditional items associated with the term *human capital*, are complemented by the more difficult to define concept of *social capital*, which relates to how individuals and societies organize and interact, for good or bad. The importance of the human factor, manifest as raw labor, as an educated and healthy population, or as functioning, collective institutions helps explain unexpected differences between countries. For example, two countries with similar endowments of natural capital (and sometimes similar levels of investment in produced assets) might have very different growth paths and levels of well-being and might have quite different levels of overall environmental quality.

This report explores a number of indicators of environmentally sustainable development that include the links between environmental quality and economic growth and between the use of resources and the quality of the resource stock. This is done because we realize that economic growth that is paid for by rapid resource depletion or degradation and that results in major health and productivity impacts on society is probably neither sustainable nor desirable.

The seven chapters that follow are presented in two parts, divided by an explicit focus on links between the macroeconomy and the environment (Part One), and evolving indicator themes (Part Two).

Part One
Indicators Linking the Macroeconomy and the Environment

The links between various economic forces and the environment are the theme of the next three chapters. Whether the focus is on estimates of national wealth or rates of subsidies and net savings, these chapters highlight new analytical approaches to a better understanding of the magnitude and direction of these forces and their links to environmental quality and national wellbeing.

Portfolio Indicators

Chapters 2 and 3 are representative of "portfolio" indicators; chapter 2 is concerned with the dynamics of creating and maintaining wealth. The indicator chosen to explore this is *genuine* savingthe true rate of saving of a nation after accounting

for the depreciation of produced assets, the depletion of natural resources, investments in human capital, and the value of global damages from carbon emissions. Negative rates of genuine saving must lead, eventually, to declining well-being. The analysis shows that many of the most resource-dependent countries do have low or negative rates of genuine saving and that the value of pollution damages may be large in rapidly urbanizing and industrializing countries. Because the rate of genuine saving is determined by a wide range of macroeconomic, resource, and environmental policies, this indicator has the potential to link the concerns of traditional National Environmental Action Plans to the interests of the key economic ministries.

Whereas genuine savings is a flow measure having direct policy links, stock estimates also yield valuable insights. Chapter 3 presents estimates of the wealth of nations in which produced assets, natural capital, and human resources are all factored into the analysis. The analysis explores the composition of wealth at a point in time (largely for the year 1994). The overall wealth number therefore gives an indication of the amount of these three forms of capital that each nation commands. The numbers and groupings of countries are not terribly surprisingthe Organisation for Economic Co-operation and Development (OECD) countries rank high and many of the poorer countries of Africa and Central Asia (when measured by traditional GNP per capita) rank low. What is of note is the composition of wealth within each country and how it changes as countries develop. These changes are clearly seen in the analysis of countries by income groupsboth the size of the national wealth "pie" grows and the distribution among components changes as countries increase in aggregate wealth.

Environment-Linked Subsidies

Subsidy reform and the potential for this reform to benefit the environment is the subject of chapter 4. Subsidies on fossil fuels and agricultural inputs are a drain on the Treasury, distort investment decisions, and lead to excessive releases of pollutants to the environment. Subsidy reduction is therefore the classic "win-win" policy reform, with the potential to both increase economic efficiency and reduce deleterious effects on the environment. In the countries studied, fossil fuel subsidies have dropped from more than $100 billion in 1990/91 to nearly $60 billion in 1995/96, with the countries of Eastern Europe being the primary contributors to the decline. (It should be noted that accurate data from this region are notoriously difficult to obtain and that these numbers should be considered as very preliminary results.) While it is still too early to judge the scale of the positive effects of these reforms on the environment, there is every reason to be confident that they will be substantial.

Part Two
Evolving Indicator Themes

The past few years have witnessed rapidly increasing interest in, and applied work on, the use of indicators to monitor change. The chapters included here highlight substantive progress in thinking on such diverse topics as land quality, social capital, and poverty and the environment. The last chapter presents selected information on international progress in indicator development, which illustrates both what has been accomplished and the remaining challenges.

Land Quality Indicators

Land resources form the most basic natural asset of most countries. As seen in chapter 3, agricultural lands and pasture account for up to 80 percent of many countries' natural capital. Obviously, it is important to maintain and even enhance the productivity of this resource. Chapter 5 considers the issue of land quality indicators (LQIs)what they are, how they can be estimated, and what has been learned from preliminary applications of the LQI approach to selected countries. The initial country and subregional results presented here indicate that there is considerable potential for use of LQIs to inform decisionmaking and that local-level indicators tend to be the most useful for policy formulation. Data constraints, however, are a very real problem for LQIs.

Social Indicators

We started this introduction by stating that natural resources matter, but that people are even more important. Chapters 6 and 7 consider two distinct

aspects of the role of people in determining the nature and rate of economic growth. Chapter 6 explores the difficult to quantify concept of social capital, the extra element that defines how individuals and societies interact, organize themselves, and share responsibilities and rewards. It is now recognized that social capital is a critical explanatory variable in explaining the success of certain countries and the lack of progress of others. Although there are a number of definitions of social capital available, and a variety of indicators are proposed that can be used to identify and track changes in social capital over time, we unfortunately know less about how it is created and how to invest in its development.

Chapter 7 explores the links between poverty and the environment. Although it is still not completely clear whether poverty causes environmental degradation or whether environmental degradation causes poverty, there is enough experience worldwide to conclude that the two characteristics are commonly associated. As such, the use of indicators of resource quality or degradation and indicators of the incidence of poverty offer important tools for improved problem identification and informed decisionmaking.

Other Work on Indicators

The work at the World Bank is just one example of an extensive range of indicator development efforts around the world. The final chapter in the report explores a number of the different national and supranational indicator efforts. The systems vary depending on the extent of data aggregation involved (the chapter identifies three levels of aggregations: large individual sets, thematic indicators, and systemic indicators) and the intended end-use of each approach.

A number of country programs are explored, and a range of cross-national indicator efforts are also discussed. The portfolio indicators reported in chapter 2 (genuine saving) and chapter 3 (national wealth) and the land quality indicators in chapter 5 are all examples of representative efforts.

As will be clear to the reader of this report, the indicator arena is full of interesting and challenging issues. It is also obvious that much of the work is in its infancy. Many of the results presented here are initial efforts at estimating indicators and are offered in the spirit of transparent exchange of research results and thinking. We hope to provoke dialogue and to advance both the methodologies used and the policy applications of indicators for sustainable development.

PART ONE
INDICATORS LINKING THE MACROECONOMY AND THE ENVIRONMENT

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Chapter 2
Are We Saving Enough for the Future?

Despite the pressing short-term priorities most countries have for controlling inflation, reducing unemployment and fostering economic growth, the last decade has seen a remarkable upsurge of concern about the *sustainability* of economic development over the longer term. Much of this thinking is rooted in the report of the Brundtland Commission in 1987, which argued that current development choices, by exploiting and degrading the environment, may diminish the well-being of future generations. While it has long been appreciated that economic processes have environmental consequences, a crucial message in the Brundtland Commission report is its emphasis on the extent of overlap between the economic and environmental spheres, with linkages in both directions.

The United Nations Conference on Environment and Development (the Rio Conference) in 1992 helped to cement this understanding and prompted most countries to commit to achieving sustainable development. This led to the notunexpected problems of coming up with an operational definition of sustainable development and designing policies for sustainable development. Simply defining broad goals is not sufficient, howeverwe need indicators to measure progress toward sustainable development.

However it is defined in detail, achieving sustainable development is at heart a process of creating and maintaining wealth. *Wealth* in this context is conceived broadly, to include produced assets, natural resources, healthy ecosystems, and human resources. This places the indicator problem squarely in the realm of integrated economic and environmental accountingloosely dubbed *green national accounting* (Hamilton and Lutz 1996)and suggests that expanding our traditional national accounting measures of savings and wealth could be an important step in guiding policies for sustainable development. Adjusting savings measures to reflect environmental depletion also fits well with many of the traditional concerns of development economics, which emphasizes the savings-investment gap and the critical role that financing investment plays in the development process.

Developing "greener" national accounts holds the additional promise of treating environmental problems within a framework that the key economic ministries in any government will understand. For too long now ministries of finance and planning have paid scant attention to the exploitation of the natural resource base or the damaging effects of environmental pollution, while countries have been developing National Environmental Action Plans that read as if they were written *by* the environment ministry *for* the environment ministry, with no links to the economics ministries.

Genuine Saving

work by Pearce and Atkinson (1993). The new estimates of genuine saving feature broader coverage of natural resources, improved data and methods of calculation, and significant enhancements in the treatment of human resources.

The policy implications of measuring genuine saving are quite direct: persistently negative rates of genuine saving must lead, eventually, to declining well-being. For policymakers the linkage of sustainable development to genuine rates of saving means that there are many possible interventions to increase sustainability, from the macroeconomic to the purely environmentalthese will be discussed in the concluding section.

The traditional measure of a nation's rate of accumulation of wealth, as reported in the World Bank's *World Development Indicators* for instance, is *gross* saving. This is calculated as a residual: GNP minus public and private consumption. Gross saving represents the total amount of produced output that is set aside for the future in the form either of foreign lending or of investments in productive assets. Gross savings rates can say little about the sustainability of development, however, because productive assets depreciate through normal wear and tear: if this depreciation is greater than gross saving, then aggregate wealth, as measured by produced assets, is in decline. Net saving, total gross saving less the value of depreciation of produced assets, is one step closer to a sustainability indicator, but focuses narrowly on produced assets.

Measures of *genuine* saving address a much broader conception of sustainability, by valuing changes in the natural resource base and environmental quality in addition to produced assets. The simplest way to explain the accounting that underpins genuine saving is with a picture. Figure 2.1 presents the components of genuine saving as shares of GNP for Tunisia.

The starting point in the calculation of genuine saving is just standard national accounting. The top curve in figure 2.1 is gross domestic investment, the total of investments in structures, machinery and equipment, and inventory accumulation. Net foreign borrowing, including net official transfers, is then subtracted from this top curve to give gross saving, the difference between production and consumption over the years. Next the depreciation of produced assets is deducted, yielding the curve for net saving. Finally, the bottom line (literally and figuratively) is genuine saving, which is obtained by subtracting the value Of resource depletion and pollution damages from net saving.

Figure 2.1.
Genuine saving for Tunisia, 197094
Note: Gross domestic investment minus net foreign borrowing equals gross saving; gross saving minus depreciation equals net saving; net saving minus depletion equals genuine saving.
Source: World Bank calculations.

Resource depletion is measured as the total rents on resource extraction and harvest. For each resourcebauxite, copper, gold, iron ore, lead, nickel, silver, tin, coal, crude oil, natural gas, and phosphate rockrents are estimated as the difference between the value of production at world prices and total costs of production, including depreciation of fixed assets and return on capital. Strictly speaking, this measures economic profits on extraction rather than scarcity rents, and for technical reasons this gives an upward bias to the value of depletion (and a downward bias to genuine saving) in what follows. No explicit adjustment is made for resource discoveries, since exploration expenditures are treated as investment in standard national accounting (see Hamilton 1994).

Forest resources enter the depletion calculation as the difference between the rental value of roundwood harvest and the corresponding value of natural growth both in forests and plantations. Only where harvest exceeds growth is a depletion charge made for any given country. This valuation captures the commercial value of forests, therefore, but ignores the other services provided by trees, including carbon storage, watershed protection, and the supply of nontimber (and nonfuelwood) products.

Pollution damages can enter green national accounts in several ways. While damage to produced assets (acid rain damaging building materials, for example) is in principle included in depreciation figures, in practice most statistical systems are not detailed enough to pick this up. The effects of pollution on output (damage to crops, lost production owing to morbidity) are already reflected in the standard national accounts, but not explicitly. The key pollution adjustment is for welfare effects, valuing the willingness to pay to avoid excess mortality and the pain and suffering from pollution-linked morbidity.

Underlying the treatment of pollution in green national accounting is an extended Hicksian notion of income. First, it is reasonable to assume that people derive welfare from, and have preferences for, both consumption and environmental quality. If societies seek to maximize this extended conception of welfare over long time horizons, then wealth can be conceived as the present value of this stream of welfare now and in the future. "Green" net national product (NNP) is the maximum amount of produced output that can be consumed at a point in time while leaving this measure of wealth constant, and genuine saving is the difference between green NNP and consumption. For most significant pollutants (particulate matter, acid emissions, and lead emitted to air; fecal matter, heavy metals, and biological oxygen demand in water) the adjustment required to derive green NNP is the deduction of pollution emissions valued at their marginal social costs, as measured by willingness to pay.

In what follows, the value of damages from pollution emissions is calculated only for carbon dioxide, using a figure for marginal global damages of US$20 per metric ton of carbon emitted (Fankhauser 1995). This value serves simply as a placeholder for other pollutants, whose effects would require detailed country-level analysis in order to be properly reflected in the genuine savings calculations. Box 2.1 presents the effects of valuing air and water pollution in the genuine savings calculation for Indiathe results suggest that pollution damages may be significant in a wide range of rapidly urbanizing and industrializing countries.

Critical natural resources (for example, rainforests and the biodiversity they harbor) and critical pollutant levels (destruction of the ozone layer by chloroflorocarbon emissions, for instance) can be accommodated in the measure of genuine saving. In the case of critical pollutants, correct measures of marginal damages will provide the necessary deduction from the savings rate. To the extent that rainforests are overexploited, the excess clearance should be valued based on global willingness to pay for preservation, a willingness that should rise sharply as critical levels of forest are approached. While the theory of genuine saving can deal quite adequately with critical stocks of resources or pollutants, the practice is more difficult. Values associated with critical stocks are not measured in the empirical analysis below, partly for pragmatic reasons (many pollutants are local, for instance) and partly because there is inadequate information to establish good measures of global willingess to pay.

There are some obvious assets left out of the foregoing description of genuine saving. Fish are excluded for a number of practical reasons, including the difficulty of measuring stocks, the mobility of these stocks, and the fact that rents appear to have been largely dissipated in many fisheries owing to the lack of effective management regimes. Soil erosion has figured prominently in many of the empirical green national accounting studies carried out for individual countries. Attaching a value to soil erosion, however, requires detailed local data that are not widely available. Moreover, as box 2.2 argues, significant research is still required to determine the *economic costs*, as opposed to physical losses, of soil erosion and degradation in developing countries.

As the next chapter on measuring the wealth of nations will discuss, underlying the sustainable development paradigm is an expansion of economic assets to include both natural and human resources. While the ramifications for savings calculations of natural resource depletion have just been described, the treatment of human resources presents some interesting conceptual issues. First, it is clear that educational expenditures on capital goods (equipment and buildings for schools and universities, for instance) are al-

Box 2.1 Pollution and genuine saving in India

The inclusion of pollution damages in genuine saving calculations requires detailed country-specific data and careful consideration of which effects of pollution are properly reflected in a savings measure. As a general rule the economic cost of pollution damages falls into three categories: effects on economic assets, effects on current output, and welfare effects associated with excess mortality and morbidity.

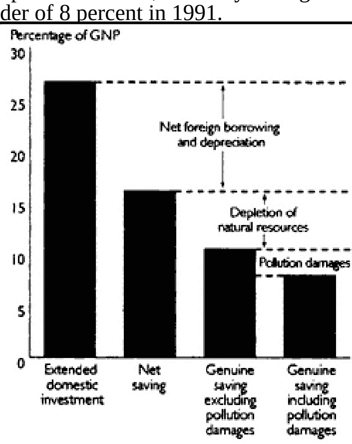
The theory of green national accounting (Hamilton 1996) suggests that welfare effects should be deducted from genuine saving if the appropriate marginal willingness-to-pay measures can be obtained. International experience in measuring pollution damages indicates that welfare effects are larger in value than the damage to economic assets (from acid rain, for example) and reductions in current output (crops damaged by acid rain, for instance). Brandon and Hommann (1995) value pollution damages for India in a recent study, which can serve as a rough guide to the magnitude of damages in a developing country with significant pollution emissions. The study first estimates the loss in disability-adjusted life years (DALYs) associated with water pollution (largely from sewage) to be on the order 14.3 million DALYs in 1991. Using India's annual per capita GNP of US$330 as the lower bound of willingness to pay to avoid the loss of a DALY yields a figure of roughly US$4.7 billion as the value of the welfare loss. Brandon and Hommann point out that this value could be nearly twice as large if other possible valuations were applied.

The air pollutants with the largest effects in India are particulate matter (especially PM10, particles less than 10 microns in size that lodge in the lungs) and lead from gasoline. By transferring U.S. estimates of the willingness to pay to reduce the risk of death to the Indian context, Brandon and Hommann suggest that the welfare loss associated with air pollution could have been as large as US$2.1 billion in 1991. An analysis by Cropper and Simon (1996) of data for New Delhi suggests, however, that owing to different distributions of underlying health status between the populations of the U.S. and India, the figure for excess deaths could be one-third of that calculated by Brandon and Hommann.

As an illustrative valuation of pollution effects, therefore, the figure for combined air and water pollution damages of US$6.8 billion is used. This amount represents roughly 2.5 percent of GNP and is consis tent with the conclusion in Brandon and Hommann that damages for water pollution are considerably larger than those for air. Box figure 2.1 shows the decomposition of genuine saving in India in 1991.

In this figure, extended domestic investment is the value of domestic investment in produced assets plus current expenditures on educationthe latter were roughly 3.5 percent of GNP in 1991. The gap from extended domestic investment to net saving consists of net foreign borrowing (1.0 percent of GNP) and depreciation of produced assets.

Depletion of natural resources (oil, gas, coal, and minerals) and the value of carbon dioxide emissions amount to roughly 5.6 percent of GNP. With respect to pollution only further country-level studies, based on sound epidemiology, will increase our confidence in the transferability of industrial-country willingness-to-pay measures to the developing country context. These crude estimates do suggest, however, that reducing pollution is not simply a luxury for rich countries. Starting from traditional gross domestic investment levels of 23 percent of GNP, the analysis of genuine saving suggests that India's true rate of saving was on the order of 8 percent in 1991.



Box figure 2.1
Genuine saving in India, 1991

ready treated as investment in the standard national accounts, and so are included in both gross and genuine savings rates. However *current* education expenditures, on teachers' salaries and textbooks for example, are treated as consumption in the national accounts, which is clearly inconsistent with the expanded conception of wealth.

Properly valuing human capital is an exercise fraught with difficulty. A first approximation presented in the genuine savings calculations below, is simply to treat current education expenditures as investment rather than consumption. This leads to a notion of *extended domestic investment* that will serve as the starting point in the calculation of genuine saving.

Box 2.2 Unanswered questions: saving and soil degradation
Good soil is an important factor of production, and maintaining the asset is important for preserving the productive potential for the future. The quality or quantity of this asset can be diminished by rain, wind, cultivation practices, or simply the removal of nutrients through harvests. Farmers throughout the world are counteracting the trend toward degradation generally by low-cost means such as mulching, contour farming, grass strips, and vegetative barriers. More costly structures like terracing are seldom adopted.
Soil degradation for the current period is reflected in the national accounts through diminished yields or through higher costs of production where farmers counteract the degradation, for example with higher fertilizer applications. What is not recorded is the reduction in the stock of this natural capital. Inasmuch as such a reduction has a direct impact on future agricultural production, it represents a depreciation that should, in principle, be reflected by genuine saving. But a smaller stock of soil simply in terms of quantity has much different implications than a smaller stock of metals, minerals, forests, or fish stocks. What is crucial from an economic and accounting perspective is not the stock of remaining soil as such but the longerterm productivity effects resulting from the diminished stock. In that regard it is not the amount of soil eroded that is the key but rather the amount (depth) and quality of the soil that remains, including the soil that is deposited in other fields used for agriculture. In addition, one must consider other factors that impact productivity (like compaction, pH balance, organic matter content) that generally receive less attention. Actual field research that shows the connection between soil loss, degradation and deposition, and the agricultural productivity in developing countries has been rare, and even where such information exists it cannot easily be extrapolated since soil degradation can differ from field to field based on types of soil, slope, vegetation cover, and cultivation practices. Not surprisingly, therefore, estimates of the costs of soil erosion and degradation that have been made at national levels have varied widely.
In work on Indonesia Repetto and others (1989) estimated that capitalized losses in future productivity are approximately 40 percent of the annual value of upland farm production. For Mali, Bishop and Allen (1989), using conservative assumptions of a ten-year time horizon and a 10 percent discount rate, estimated that the present value of current and future net farm income forgone nationwide due to one year of average soil loss amounts to between 4 and 16 percent of agricultural GDP. The World Resources Institute and the Tropical Science Center (Solórzano and others, 1991) estimated that soil depreciation amounts to almost 10 percent of Costa Rica's annual agricultural production. These and other efforts to date have been based on weak and incomplete datacertainly more work on data and methods is required to yield firmer estimates.
In addition to on-site effects of soil erosion and degradation one must consider off-site effects. Some of these show up as costs in the national accounts in the current period. Examples would be dredging of channels or decreased fish catch from water with high turbidity. In other cases costs are more hidden (like sedimentation of reservoirs used for hydropower or irrigation) or not accounted for (like damage of sediments to coral reefs).
In assessments of the depreciation of a capital stockin this case the stock of soilthat are based on discounting the future income losses, the discount rate chosen strongly influences the results. For nations as a whole and for national income and accounting purposes one may assume rates of 5 to 10 percent. For individual farmers these rates tend to be higher, particularly for smaller farms.
Research on soil erosion and degradation is difficult as it is influenced by stochastic variables (such as rainfall intensity). Much more work is needed to extend the focus from plot-level experiments to the watershed and from purely technical aspects to one that simultaneously considers economic and social aspects. Research is being carried out at present on land quality indicators (see chapter 5).

Valuing human capital formation in this way implies that the accounting framework in this chapter differs from that presented in chapter 3, which will emphasise the more inclusive notion of human *resources*. Here the emphasis is narrowly on human capital, and the measure is a gross measure of capital formation. To the extent that education creates *disembodied* capital in the form of knowledge that is disseminated and stored, this treatment is appropriate (the alternative would be to assume that human capital depreciates when individuals die).

The two broad categories of adjustments to standard savings figures will move these measures in opposite directions, with resource depletion and environmental degradation decreasing saving while current educational expenditures increase it. For expositional purposes, therefore, the analysis of regional trends in genuine saving in the next subsection will consider only depletion and degradation effects, while the discussion of human capital in the following subsection makes the full adjustment for natural resources, carbon dioxide, and investments in human resources.

Regional Trends in Genuine Saving

A calculation of average genuine saving ratesthat is, genuine saving as a percentage of GNPreveals striking differences among various regions of the world. In many developing areas decisive moments in economic performance are reflected in large movements in the genuine savings rate, shown in the figures that follow.

Sub-Saharan Africa Consumes While East Asia Saves

The comparison of genuine savings rates reveals a remarkable trend for the countries of Sub- Saharan Africa (figure 2.2). In that region average genuine savings rates rarely exceeded 5 percent of GNP during the 1970s, followed by a sharp negative turn at the end of that decade from which they have never recovered. Despite slight recovery in the early 1990s, regional genuine *dissaving* has recently been near 7 percent. Côte d'Ivoire and Nigeria, which together represent 16 percent of regional economic activity, exert great influence on these statistics with their rates of genuine dissaving approaching 2030 percent of GNP. The precipitous drop around 1980 correlates well with the onset and aftereffects of the second oil price shock, with a negative flip in Nigeria's current account balance, and with regional GDP growth rates averaging less than half their values before the plunge in genuine saving. Equally important, negative genuine savings rates have been accompanied by persistently low regional indicators of human welfare, including education, nutrition, and medical care (World Bank 1996b).

The oil crisis also coincided with a period of decline in genuine saving throughout Latin America and the Caribbean, where figures had previously remained near 8 to 9 percent of GNP. In 1982, the year of Mexico's debt crisis, regional genuine saving plummeted to 5 percent. As the area has emerged from debt, returned to democratic rule, and spurred the vigorous growth of the *jaguars*, genuine savings rates have shown a consistently positive trend. They remain, however, well below 5 percent of GNP, as strong savers like Brazil and Chile are offset by the genuine dissaving of Venezuela and Ecuador and the near-zero genuine saving of Mexico.

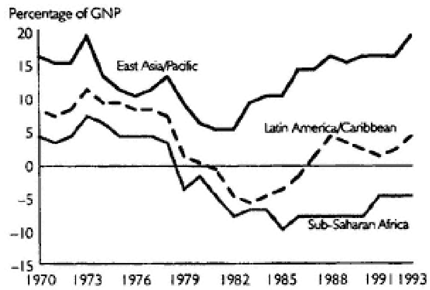


Figure 2.2
Genuine savings rates by region
Source: World Bank calculations.

In stark contrast to the above stands the East Asia and Pacific region, with recent genuine savings rates topping 15 percent of GNP and no signs of reversing a long-term upward trend. High genuine savings rates since the early 1980s in China, Hong Kong, the Republic of Korea, Singapore, Thailand, and Taiwan (China) have mirrored the recent outstanding economic performance of these economies. In the middle range of genuine savings rates for the region lie Indonesia's and Malaysia'slower than those of the East Asian tigers but still on a par with some of the higher rates in Latin America. Regional dissavers like Lao People's Democratic Republic, Papua New Guinea, and Vietnam show some signs of approaching positive genuine saving rates.

Are Fossil Fuel Exporters on a Sustainable Path?

Consistently negative genuine saving in the Middle East and North Africa region stands in sharp relief against the policies in other areas of the world (figure 2.3). Recent genuine savings rates of 25 to 40 percent in Bahrain, Oman, Saudi Arabia, and Yemen have not been offset by the modestly positive savers of the early 1990s such as Algeria, Egypt, Israel, Morocco, and Tunisia. What happened to the enormous rents made from fuel exports as crude oil prices rose by 150 percent between 1978 and 1979? While significant investments did take place, the net effect on saving was still negative, a problem that was exacerbated by the Iran-Iraq war.

Regional total consumption as a share of GNP rose from around 50 percent in the 1970s to more than 70 percent by the end of the 1980s, and imports of food and manufactured goods flowed into the region as Saudi Arabia and Iran turned their current account surpluses of the 1970s into deficits in the 1980s (World Bank 1996a). Despite overall regional gains in the early 1980s, recent rates of genuine dissaving hover between 10 and 15 percent.

South Asia and High-Income Countries

In South Asia near-zero recent genuine saving in Bangladesh and Nepal is offset by consistently positive rates of genuine savings in India, which float at just under 10 percent and buoy up the entire region. India's GNP per capita growth rate of around 3 percent in recent years is above the average for its income group.

Finally, rates of genuine saving in the highincome OECD countries, pushed upward by high investment, lack of dependence on natural resource depletion, and strong exports of high value-added goods and services, are near 10 percent for much of the period depicted. Countries with greater intensities of natural resource extraction, such as Australia, Canada, and the United States, had the lowest genuine savings rates, recently between 1 and 3 percent per year, while continental Western Europe and Japan were the biggest savers, often exceeding 10 to 15 percent. Recent recessions in 198283 and 1990 coincided with downward turns in genuine savings rates, but the figures consistently exhibit an absence of the volatility and large rates of genuine dissaving seen in other regions.

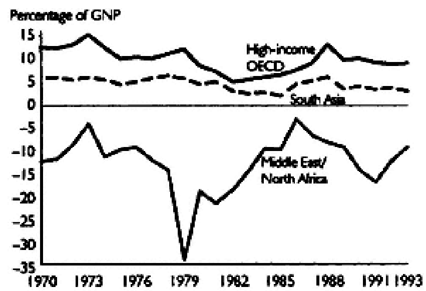


Figure 2.3
Genuine savings rates by region
Source: World Bank calculations.

The above picture of genuine savings rates is not complete, however. For just as standard measures of saving ignore consumption of natural resource assets such as forests, it can be argued that they also ignore investment in one of a nation's most valuable assets: its people.

Investing in Human Capital

The process of calculating genuine saving is, in essence, one of broadening the traditional definition of what constitutes an asset. Up to this point in the regional examples given above, standard measures of net saving (gross saving minus depreciation of produced capital) were adjusted downward by an estimate of depreciation in the value of natural capital due to natural resource depletion and an allowance for pollution damages. There exist additional stocks, however, whose contribution to production is essential yet which are not considered assets even within the extended definition of saving presented so far. Perhaps the most important of these is the knowledge, experience, and skills embodied in a nation's populace, its *human capital*

The world's nations augment the stock of human capital in large part through their education systems, into which they collectively pour trillions of dollars each year. Standard national accounts label as an *investment* less than 10 percent of this amount, or only that portion which is spent on fixed capital such as school buildings. Current (as opposed to capital) expenditures on education include teachers' salaries and the purchase of books and are treated strictly as consumption. Within the genuine savings framework, however, this is clearly incorrect. If a country's human capital is to be regarded as a valuable asset, expenditures on its formation must be seen as an investment (Hamilton 1994).

Controversy surrounds the correct method of valuing such an investment in the human capital stock, since one dollar's current expenditure on education does not necessarily yield exactly one dollar's worth of human capital (see, for example, Jorgensen and Fraumeni 1992). Traditional savings rates should theoretically be adjusted by the change in value of human capital to reflect this investment, but there is as yet no consensus on

how to carry out this valuation. What can be said with certainty, however, is that current education expenditures are not consumption, within a framework where the notion of wealth is expanded to include human resources. As a first approximation, therefore, rates of genuine saving are adjusted upward by the levels of current spending on education.

Chile Invests in Its Young People

The effects of including human capital investment in the genuine savings calculation can be significant. In Chile, for example, current education expenditures represented about 3.1 percent of GNP in the early 1990s (figure 2.4). Such investment helped keep genuine savings rates from slipping into the negative realm in the late 1980s, and represent more than one-third of the high rates seen in recent years. In 1993 and 1994 nearly half of the rents from natural resource depletion were, notionally at least, being reinvested in human capital.

The Rich Get Richer?

Including this measure of human capital investment in genuine saving accentuates the differences between countries with strong and those within weak savings efforts. Without the effects of education spending, there is only a modest difference between recent average genuine savings rates among low- and middle-income countries, while the high-income countries exceed this level by around 5 percent (figure 2.5). Weighing the effects of storing up human capital, however, changes the savings picture. Large investments in education by the most economically successful countries lead them to exceed the genuine savings rates of their counterparts in other income groups by around 8 percent in the same period. Investments in young people by middle-income countries were also noticeably larger than in low-income nations. This mirrors the preponderance of human resources as a share of wealth in high-income countries shown later in chapter 3.

Education and Regional Genuine Saving Rates

Adjusting rates of genuine saving to embrace changes in human capital assets shifts regional genuine savings rates markedly upward (table 2.1). In Sub-Saharan Africa accounting for education investment means that recent genuine savings rates are negative but closer to zero. In the Middle East and North Africa region genuine savings rates are consistently negative even after the adjustment. Finally, high rates of education investment in high-income OECD countries and the East Asia and Pacific region sharpen the contrast between the genuine savings effort in these areas and across the rest of the globe.

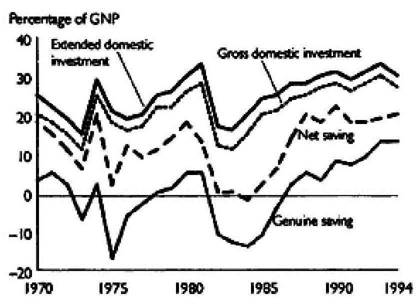


Figure 2.4
Human capital and genuine saving in Chile
Note: Extended domestic investment is gross domestic investment plus current spending on education; gross domestic investment minus depreciation equals net saving; net saving minus depletion equals genuine saving.
Source: World Bank calculations.

Conclusions

The World Bank study *Oil Windfalls: Blessing or Curse*? (Gelb 1988) poses the critical question that comes to mind when regional trends in genuine saving are examined. It is evident from figures 2.2 and 2.3 that measuring genuine saving tends to depress the savings rates of resource-rich countries compared with resource-poor countries. However, it is obviously incorrect to conclude from this that natural resource endowments are necessarily detrimental to economic performance (for evidence that growth rates have been weaker for resource- intensive economies, see Sachs and Warner 1995).

The depressed rates of genuine saving for resource-rich countries represent an opportunity not seized. These countries have the potential to transform a resource endowment into other eco-

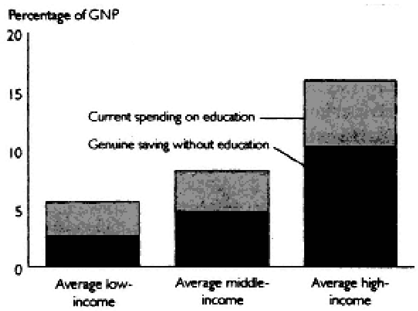


Figure 2.5
Contribution of current education expenditures
to genuine saving (average 198790)
Source: World Bank calculations.

nomic assets that will boost incomes and growth. This potential has not been realized for a variety of reasons. Closer examination of the data shows that it is often the *gross* savings effort that is insufficient in these countries, which points the finger squarely at broader macroeconomic policies. But resource and environmental policies clearly have a role to play as well.

Note that it is perfectly reasonable for countries to choose to develop and deplete nonrenewable resources as a source of development finance. But this is only reasonable if the resource rents are in fact invested rather than being consumed. Measuring negative rates of genuine saving is an indication that due prudence is not being followedthat some amount of the national wealth is simply being consumed, to the detriment of future well-being.

A particularly useful way for policymakers to think of a genuine savings chart such as figure 2.1 is in terms of which policies have an impact on the levels of the individual curves. The level of gross saving anchors the curves, in the sense that they will all shift up or down with the fundamental saving effort. The determinants of gross saving, basically fiscal and monetary policies but including more micro-level issues such as the viability of the financial sector, therefore play a central role in determining policy responses to deficient genuine saving.

The level of gross domestic investment is influenced both by the willingness of the private sector to investwhich is again closely tied to macroeconomic policiesand by public investment programs. The investment of natural resource rents, collected through government royalties, is a central issue in this regard. In addition to the quantity of public investment, quality is also a critical factor; this is one of the central lessons of the *Oil Windfalls* study. Investments in human capital represent in many countries some of the highest quality outlets for public investments. Extending the measure of domestic investment to include current education expenditures, as shown in figure 2.4, highlights this issue for policymakers.

The ministries of finance, development planning, and human resources therefore all have key roles to play in determining the rate of genuine

Table 2.1 Genuine saving *(percentage of GNP)*

Region and income category	*Average, 197079*	*Average, 198089*	*1990*	*1991*	*1992*	*1993*
Region						
Sub-Saharan Africa	7.3	-3.2	-3.8	- 1.2	-0.6	- 1.1
Latin America and Caribbean	10.4	1.9	5.5	4. 1	4.7	6. 1
East Asia and Pacific	15.1	12.6	18.6	18.7	18.7	21.3
Middle East and North Africa	-8.9	-7.7	-8.8	-10.8	-6.6	- 1.8
South Asia	7.2	6.5	7.6	6.3	7.1	6.4
High-income OECD	15.7	12.4	15.7	14.5	14.0	13.9
Income category						
Low	9.8	3.3	5.7	7.5	9.0	10.5
Middle	7.2	2.9	10.0	9.7	7.8	8.1
High	15.2	12.3	15.9	14.6	14.1	14.1

Note: Data include an adjustment for current spending on education.
Source: World Bank calculations.

saving. The gap between net saving and genuine saving is determined by resource and environmental ministries. It is to the policies of these ministries that we now turn.

For resource ministries the challenge is to ensure efficient resource extraction and harvest. Security of tenure for producers is therefore one of the principal concerns, especially for living resources such as forests and fish. Rent capture is the other main issue. Without sufficient capture of available rents through resource royalties there is a strong incentive for producers to overexploit natural resources, depressing genuine saving from its efficient level.

For environment ministries the issue is not to reduce pollution damages to zero, but rather to reduce them to socially optimal levels. This implies that there will always be some gap between net saving and genuine saving resulting from pollution emissions, but there will be an optimal level for this gap. The efficiency of environmental policies has clear consequences for the other macro variables discussed previously, in particular the willingness of the private sector to invest.

The bottom line in the analysis of genuine saving is that policies leading to persistently negative savings rates must entail, eventually, declines in welfare. The intuition, or hope, that greening the national accounts could influence policies for sustainable development has taken some time to be realized, but the analysis of saving and wealth holds out this possibility. This analysis also emphasizes that the key economic ministries, the human resources ministry, and the resource and environmental ministries all have important policy levers at their command if the goal is to achieve sustainable development. Whether natural resource endowments and the benefits of a healthy environment can be translated into sustained well-being is a question of good or bad policy choices.

Technical Appendix

$$GFC_{t+1} - GFC_t = GDI_t - D_t$$

where *GFC* is gross fixed capital stock in year *t*, *GDI* is gross domestic investment in year *t*, and *D* is depreciation of human-made capital in year *t*, all in constant prices in local currency.

Genuine saving was calculated as the difference between net saving and the sum of rents from all extraction and harvest of natural resources as well as damages from carbon dioxide emissions. For each nonrenewable resource, and in all countries in each of the years 19701994, rent was estimated as

$$R = (P - C)\,Q$$

where *R* is rent, *P* is world market price, *C* is the average unit production cost (cost of raw material extraction and transportation to city or port), and *Q* is production volume. Strictly speaking, *R* measures economic profit rather than scarcity rent. The effect of calculating economic profits rather than scarcity rents (price minus *marginal* cost) is to overstate depletion and understate genuine savings, which has a clear impact on the figures for the Middle East and North Africa region in this chapter. This method of valuation also assigns a higher value of depletion than that implied by the valuation of resource stocks described later in chapter 3this is largely a consequence of not having time series of resource stock data. The nonrenewable resources thus treated were crude oil, natural gas, hard coal, lignite, bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin, and zinc. Most figures for production volumes came from the Bank's internal Economic and So-

cial Database. Owing to the physical characteristics of natural gas and lignite, there is no single, uniform world price for these commodities; a shadow world price was estimated. For natural gas this was the average of several free-on-board export prices from Algeria, Canada, the Netherlands and Norway. For lignite the shadow price was estimated from the average international export price for steam coal by observing the relationship between internal prices for lignite and steam coal in countries where the market for both is relatively competitive, such as Australia and Canada, and assuming a similar relationship for international prices. Production cost estimates were collected from a wide variety of sources, both private and government, as well as from sectoral experts within the Bank.

Because forests are living resources, a different method for calculating depletion was employed in the case of roundwood harvest. For each country and year a depletion charge was made only when roundwood harvest exceeded natural growth in the country for that year. Many countries produce roundwood volumes well below their annual increments, and for them genuine saving was unaffected. Estimates of annual increment and production costs were obtained through consultation with a variety of Bank experts on forestry. Roundwood production volumes and wood prices were obtained from United Nations Food and Agriculture Organization (FAO) data. Since roundwood production is not homogeneous but rather represents a combination of coniferous wood, fuelwood, and other types of values, roundwood could not be given a single price. One way to estimate a price would be to disaggregate roundwood production according to coniferous production volume, fuelwood production volume, and so on. Another method would be to create a composite price for roundwood as an average of the prices of the different types of wood, weighted by their contributions to total production volume. The two methods are mathematically equivalent and for the sake of convenience the second was chosen. The roundwood price used for each country-year was a weighted average of coniferous softwood price, an estimated fuelwood price, and a third price that, depending on the region to which the country in question belonged, varied from a nonconiferous softwood price to a regional average tropical hardwood price. The weights in the average were the relative contributions of the three types of wood to national roundwood production volume. The relative contribution of coniferous wood came from the FAO, and the contribution of fuelwood from World Resources Institute data. Fuelwood price was estimated based on internal Bank sector studies.

Damages from carbon dioxide emissions were calculated by taking historical carbon emissions estimates from the United States' Oak Ridge National Laboratories Carbon Dioxide Information Analysis Center and multiplying by a conservative estimate of $20 marginal global damages per ton of carbon emitted (Fankhauser 1995). Note that these are *global* damages, so that the net damages caused worldwide by emissions in a given country are assigned to the emitting country.

Finally, calculations in the second half of the chapter include the effects on genuine saving of current (nonfixed capital) spending on education. For the estimates of genuine saving including human capital formation, the calculation proceeded precisely as abovewith the exception that the starting point was not gross domestic investment (GDI) but rather *extended domestic investment*, equal to the sum of GDI and current education expenditures. Data on current education spending came from the United Nations.

For each year regional and income-class average figures for genuine savings rates are the quotient of aggregate genuine saving and aggregate GNP for the set of all those countries in the region or income class for which data on both genuine savings and GNP are available for that year.

Note

1. Sachs and Warner (1995) show that the resourceintensiveness of countries is negatively correlated with rates of growth since 1970. They offer a number of possible explanations, including a model of "Dutch disease."

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Chapter 3
Measuring the Wealth of Nations

Writing some 220 years ago in *The Wealth of Nations*, Adam Smith recognized the fundamental importance of labor and its skill level in explaining observed differences between the wealth of different countries, even those with similar endowments of natural resources. In the opening paragraph to what is fully titled *An Inquiry into the Nature and Causes of the Wealth of Nations*, Smith wrote:

> The annual labor of every nation is the fund which originally supplies it with all the necessities and conveniences of life which it annually consumes, and which consist always either in the immediate produce of labor, or in what is purchased with that produce from other nations.

Smith recognized that a country's endowment of natural resources was important; he also focused on and emphasized the importance of the human factor. In fact, Adam Smith wrote that "whatever the soil, climate, or extent of territory of any particular nation, the abundance or scantiness of its annual supply [output]" fundamentally depends on its human resources"the skill, dexterity, and judgment of its labour."

Adam Smith's insight of 220 years ago continues to hold. Our analysis of the wealth of nations indicates that stocks of both produced assets (human-made capital) and natural resources are important components of national wealth. However, we also find that human resources and the way that individuals and societies are organized are the most important determinant of the wealth of nations. Building on work presented in the 1995 edition of *Monitoring Environmental Progress* (World Bank 1995) and *Sustainability and the Wealth of Nations* (Serageldin 1996) new estimates have been made of the three major capital components that determine a nation's wealth: *produced assets, natural capital*, and *human resources*, the last including raw labor, human capital, and the elusive, but important, element known as social capital. This chapter presents the results of new estimates of these different components and discusses the insights gained from this broader analysis of the determinants of national wealth. Box 3.1 gives an intuitive introduction to these expanded wealth measures.

There are close links between wealth measures and sustainable development. While the Brundtland Commission defined sustainable development in terms of meeting the needs of future generations, there is growing recognition that these *needs* may not be comparable across countries and across time. An emerging and powerful interpretation of sustainable development concentrates on preserving and enhancing the *opportunities* open to people in countries around the world (Serageldin and Steer 1994). From this viewpoint shifting attention from flow measures of economic activity, such as GNP, to the *stocks* of environmental resources, produced assets, and human resources is crucial. Stocks of wealth underpin the opportunities people face, and the process of sustainable development is fundamentally

Box 3.1 Interpreting the wealth estimates

A useful intuition into these wealth estimates comes from interpreting the wealth of the "average" Central American in 1994. As shown in box table 3.1 below, total wealth per capita in Central America was US$52 thousand. What does this really mean? The first step in interpreting this figure is to abstract completely from the existing distribution of wealthto pretend, in effect, that the average Central American actually owned an average share of the region's assets.

As an "average" Central American, you are 23 years old, and your life expectancy is 68 years. Assuming that you retire at age 65, therefore, a substantial part of your wealth is the present value of the returns to your labor in the economy over the 42 years that you expect to work; it is (pessimistically) assumed that you will continue to add the same value each year, and the (social) discount rate is assumed to be 4 percent. If you were to borrow against your future income this would be the figure that a prospective lender would need to know.

You also own, as the representative Central American, all the produced and natural assets of the region. As one person in 32 million, your share of produced assets and associated land amounts to nearly $8,000. This part of your portfolio can be conceived as shares in a mutual fund, a fund which owns all of the produced assets in the region. Part of the shares you own come from your own savings, while the rest are an inheritance from your parents.

Box table 3.1 Decomposition of wealth per capita in Central America, 1994

Wealth	*U.S. dollars*	*Percent*
Human resources	41,000	79
Natural capital	3,000	6
Produced assets	8,000	15
Total	52,000	100

Source: Authors' estimates.

Your natural inheritance as a Central American totals to nearly $3,000, largely in the form of agricultural land, forests, and protected areas. Again, this can be conceived as shares in a mutual fund, one which owns all of the natural resources in the region, but there is a critical difference compared with your holdings of produced assets. First, where the resources are managed sustainably (good soil management, sustainable harvesting of forests), the income from this part of your portfolio is in effect an unlimited annuity, one which yields a steady income in perpetuity. However, where renewable resources are not managed sustainably, or in the case of nonrenewable resources, this portion of your portfolio is like a sinking fund that is eventually exhausted. Moreover, the amount of the sinking fund that is liquidated each year is not incomeit must be reinvested in other assets in order to maintain your wealth.

The bottom line for Central Americans and virtually all the citizens of the countries analyzed in this chapter is that the majority of your wealth is the return to your effort and the social capital from which you benefit.

That having been granted, produced assets and urban land are still significant shares of wealthup to 31 percent for the average Japaneseand natural wealth is important in many countries, up to 42 percent for the average citizen of Madagascar, for instance.

the process of creating, maintaining, and managing wealth. This is one of the prime motivations for the World Bank in pushing ahead with the estimates in this chapter.

For thoroughly pragmatic reasons the wealth estimates in this chapter (and the savings estimates in the previous one) are based on the *instrumental* or *use* values of natural resources, although place-holder values for protected areas and nontimber forest benefits are included as well. There is a considerable willingness worldwide to pay to preserve nature and the critical functions that ecosystems provide, but we have no robust means by which to estimate this amount for the whole range of countries presented here. So while this work takes several important steps in the direction of recognizing the role of natural and human resources in development, much work remains to be done. This is an area in which analysts working in individual countries should be able to make significant progress.

In addition, any attempt to estimate wealth across the great diversity of countries found in the world today must make many bold and simplifying assumptions. Recognizing this, we will be as transparent as possible with both our assumptions and the data used in the calculations. The regional results presented in this chapter are designed to focus attention on the various components of national wealth, and the investments in and management of these components. This is essential if development is to be sustainable.

Components of National Wealth

Although the classical economists recognized the importance of land, labor, and capital in explaining economic growth and national wealth, in the post-World War II period national well-being has been measured by gross domestic product (GDP)the total value of production in an economy)or gross national product (GNP)GDP plus net factor income from abroad. Countries were ranked by their level of GNP per capita, and few questions were asked about the underlying resource base for GNP growth and whether it was sustainable.

The World Bank classified countries according to GNP per capita, and used this criterion to divide the countries of the world into four main categories: low income (roughly under $750 per capita), lower middle income (about $750 to $2,900 per capita), upper middle income (about $2,900 to $9,000 per capita), and high income countries (more than $9,000 per capita). In *World Development Report 1996* the Bank, for the first time, also ranked countries by Purchasing Power Parity (PPP) estimates of GNP in the core basic indicator table. PPP is a rate of exchange for currencies that equates the purchasing power of given units of a particular currency to what one dollar would purchase in the United States. The use of PPP estimates had the effect of reducing the spread between the poorest and richest countries, although few countries actually shifted from one income group to another.

More recently, several new approaches have been developed to help address the inherent shortcomings of GDP and GNP measures. These include the development of *"green" national accounts* that take into account the role of the stocks as well as the flows of renewable and nonrenewable resources, and the related concept of *genuine savings*. Green GNP is the informal name given to national income measures that are adjusted for the depletion of natural resources and degradation of the environment. The types of adjustments that must be made to standard GNP include measuring the user costs of exploiting natural resourcesthe change in value of a copper mine as a result of extracting ore for a year, for exampleand valuing the social costs of pollution emissions.

From the viewpoint of measuring the sustainability of economic development, the green national accounting aggregate with the most policy relevance is "genuine" saving. This represents the value of the net change in the whole range of assets that are important for development: produced assets, natural resources, environmental quality, human resources, and foreign assets. For a fuller presentation of the underlying concepts and empirical evidence on genuine saving, see chapter 2 in this report. This chapter also makes the link from the indicatorgenuine savingto the policy issues that are directly relevant in achieving sustainable development.

Both green national accounts and genuine savings measures provide important policy guidance on the pace and direction of change of a nation's economy. They address how a country is managed and the sources of national growth. Building on many of these same ideas, the wealth estimates in this chapter take a broader view of a country and ask the following questions:

What are the components and contributing factors to national wealth?

How can these be managed to promote sustainable economic development?

Human resources turn out, not unexpectedly, to be the dominant form of wealth in the majority of countries. We use the term *resources* advisedly, to distinguish the estimates presented below from *human capital*, which is generally considered to be the product of education. *Human resources* includes the returns both to education and to raw labor. This distinction is important in most developing countries.

The wealth of nations approach requires the explicit inclusion of environmental, social, and human factors in addition to the more commonly measured economic variables. The approach focuses on the instrumental or use values of natural resources, partly because the methods of valuation are well established for these uses. For the moment at least, this means that many of the critically important ecological and life-support functions provided by natural systems, as well as existence values and the aesthetic pleasure we derive from nature, are not measured as part of the wealth of nations. Protected areas are, however, included in the wealth estimates, valued at the opportunity cost of preservation. The value

of protected areas is closely linked to accessibility, as is revealed by cases where we have good data on willingness to pay for these benefits (see the discussion in box 3.2). In addition, nontimber forest benefits are also estimated, as described below.

This chapter summarizes the results of wealth estimates for almost 100 countries. Although there is a natural temptation to compare the rankings of individual countrieswho is first, which last? or how is a neighboring country ranked relative to one's own ranking?The real value of these estimates is in the explicit recognition of the different components of national wealth, and what lessons can be learned from both those countries that have been judged successful and those that have been less successful in promoting sustainable development.

The next section presents initial findings of this exercise followed by the broad conclusions and policy implications of measuring the wealth of nations. In order to interpret these results, however, it is important that the reader understand the assumptions that underlie the analysis. Details of the methodology and assumptions can be found in the technical appendix at the end of this chapter, a summary of which is presented in box 3.3.

Initial Findings and Emerging Pattern for the Wealth of Nations

The most aggregate results of the new wealth calculations are shown in table 3.1 (note the uneven wealth ranges reported in this table). The only criteria used for selecting countries to be included in the analysis are data availability and reliabilityas a result, countries of the former Soviet Union and Eastern Europe are not included. Among the most notable of the other countries affected by problems of data quality are Nigeria and Algeria. One effect of the wealth calculation, evident in table 3.1, is to compress the ranges between countries when compared with standard exchange-rate-based GNP per capita. Whereas the ratio of the mean GNP per capita in the upper quintile of countries to the mean in the lowest quintile is a little more than 100, this shrinks to a ratio of roughly 17 when the figures being compared are wealth per capita. While valuing natural resources plays a role in compressing the range, the key factor influencing this result is the use of PPP-based GNP to value human resources.

The three countries ranking highest in wealth per capita in table 3.1 are hardly surprising. Switzerland is wealthy in terms of both human resources and produced assets, while the United States and Canada are relatively better endowed with natural resources. Norway leads the Scandinavians, owing to North Sea oil and gas, while productive agricultural land raises the rank of New Zealand. The richer middle-income countries begin to appear in the per capita wealth

Box 3.2 Valuing protected areas
Protected areas bring a wide range of benefits. However, the specific benefits generated by a particular area tend to vary substantially, both in nature and magnitude. Data and resource constraints prevented a full examination of the value of protected areas in this version of the wealth of nations estimates. The approach adopted, which values protected areas at their opportunity cost, is an estimate of their minimum value.
In most high-income countries the greatest benefits generated by protected areas are often based on their existence value and on the recreational opportunities they offer. Surveys and observations of actual behavior show that many people have a relatively high willingness to pay for these benefits. Although natural tourism is growing in many middle-income countries, both the willingness and the ability to pay for such benefits are often lower in lower-income countries. By attracting tourists, however, protected areas often generate benefits for lower-income countries. Indeed, protected areas form the basis of a thriving tourist industry in several countries, such as Kenya and Costa Rica. About 10,000 tourists visit Costa Rica annually specifically to visit the Monteverde Cloud Forest Reserve, for example; each is estimated to generate about $1,000 in local earnings.
Protected areas often also provide a range of other services to the national economy. In Haiti, for example, a recent economic analysis showed that expenditures on the Pic Macaya National Park were amply justified by the reduction in downstream damage from flooding and sedimentation alone. Far from being a luxury that a poor country could ill afford, this protected area played an important role by mitigating damage to one of the main irrigated areas in the country and to its supporting infrastructure. This case also illustrates the difficulty of estimating the value of protected areas except on a case-by-case basis; other protected areas in the same region had a lower value simply because there was less vulnerable infrastructure to protect downstream.

Box 3.3 The wealth accountant's toolkit
Measuring the total wealth of a country necessarily involves some heroic assumptions. The first choice a wealth accountant confronts is the discount rate: a social rate of 4 percent per annum is used throughout the measurements. Total wealth is the sum of each of the following components.
Minerals and fossil fuels are valued by taking the present value of a constant stream of resource-specific rents (or, to be more precise, economic profits, the gross profit on extraction less depreciation of produced assets and return on capital) over the life of proved reserves.
Timber is valued as the present value of an infinite stream of constant resource rents where the rate of harvest is less than annual natural growth (the mean annual increment). Where timber harvest is not sustainable, because harvest exceeds growth, a reserve life is calculated and the timber resource is treated in the same manner as a mineral.
Nontimber benefits of forests are valued by assuming that 10 percent of forested area will yield an infinite stream of benefits in the form of nontimber products, hunting, recreation and tourism. Perhectare values of nontimber benefits vary from $112 to $145 in developing and developed countries.
Cropland is valued as an infinite stream of land rents, where land productivity is projected by region up to the year 2025 and held constant thereafter. Individual rental rates for rice, wheat, and maize are multiplied by production values at world prices to arrive at per-hectare unit rents for cereal lands; other arable land is valued at 80 percent of this rate.
Pasture land is treated similarly to croplandrental rates are derived from the value of beef, mutton, milk, and wool production at world prices.
Protected areas are valued at their opportunity cost: the per-hectare rate for pasture land.
Produced assets are calculated using a perpetual inventory model, with investment data and an assumed life table for assets being the major inputs. Urban land is valued as a fixed proportion of produced assets.
Human resources are measured residually. The wealth value of returns to both labor and capital is measured as the present value of the following: nonagricultural GNP, *plus* agricultural wages, *minus* rents on minerals and fossil fuels, and *minus* depreciation of produced assets. Agricultural wages include proprietors' income and exclude resource rent; agriculture includes hunting, fishing, and logging. The present value is taken over the mean productive years of the populationthe lesser of 65 years or life expectancy at age one, *minus* the mean age of the population. Subtracting produced assets derived from the perpetual inventory model, and urban land from this present value yields the value of human resources at current exchange rates. This is then revalued using the purchasing power parity rate to obtain the final value of human resources.
Not included: Fish are excluded from the analysis, partly for data reasons and partly because poor management has driven rents to zero in so many of the world's marine fisheries. Inland fisheries could be valued but data limitations prevent this at present. Water is also not includedmost water use is already included in the value of agricultural and industrial output. Domestic water use could be valued in the future but was not included here.

range of $100,000 to $200,000, again boosted by natural resource endowments: Chile (minerals, forests), Argentina (agricultural land), Trinidad and Tobago (oil), Malaysia (oil, forests), and some of the Middle Eastern oil states.

As a generalization a broad array of Southeast Asian, and South and Central American countries fall in the range of $50,000 to $150,000 per capita. Of the Sub-Saharan African countries Botswana and Namibia are the highest ranking, falling in the range of $50,000 to $100,000. All other Sub- Saharan African countries fall below US$50,000, as do China and most of South Asia.

While human resources are the dominant source of wealth for most nations, natural resources play a considerable role in a number of cases. One measure of this is provided by the differences in country rankings by PPP-based GNP per capita and total wealth per capita, as shown in table 3.2. While rankings are necessarily *relative*, so that a rise by one country must correspond to a fall by another, these differences in rankings give some appreciation for the importance of natural resources in a variety of countries.

The industrial countries most clearly affected are Australia and New Zealand, while developing countries where increases in rank are important include many from Sub-Saharan Africa, Central and South America, and the Caribbean.

Table 3.1 Countries ranked by wealth per capita, 1994 *(thousand US$)*

300400	*250300*	*200250*	*150200*	*100150*	*75100*	*5075*	*2550*	*<25*
United States	Australia	Finland	portugal	Chile	Mauritius	Namibia	SriLanka	Mauritania
Switzerland	France	Ireland	Saudi Arabia	Argentina	Panama	Dom. Rep.	Jamaica	Niger
Canada	Denmark	Spain	Korea, Rep. of	Greece	Costa Rica	Ecuador	Philippines	Bangladesh
Japan	Belgium			Malaysia	Brazil	Jordan	El Salvador	Centr. Aft. Rep.
Norway	Austria			Trinidad and Tobago	Botswana	Paraguay	P. New Guinea	Côte d'Ivoire
	Germany			Uruguay	Colombia	Indonesia	China	India
	New Zealand			Thailand	South Africa	Peru	Bolivia	Kenya
	Netherlands			Mexico	Tunisia	Morocco	Honduras	Guinea-Bissau
	United Kingdom			Venezuela	Turkey	Egypt	Pakistan	Gambia, The
	Sweden					Guatemala	Cameroon	Vietnam
	Italy						Senegal	Togo
							Congo	Nepal
							Zimbabwe	Madagascar
							Lesotho	Uganda
							Ghana	Chad
							Nicaragua	Zambia
							Benin	Burkina Faso
								Haiti
								Mali
								Sierra Leone
								Burundi
								Mozambique
								Tanzania
								Malawi
								Rwanda

Notes: Countries are ordered in rough wealth per capita intervals based on preliminary results. Note that wealth intervals are uneven. Estimates for Eastern Europe and countries of the former Soviet Union are not included because of uncertainty about data quality.
Source: Authors' estimates.

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Regional and IncomeLevel Comparisons

As seen in the regional breakdown of total wealth (table 3.3), the overall predominance of human resources in explaining national wealth is striking, followed in importance by produced assets and then by natural capital.

Regional Comparisons

Human resources account for 60 percent or more of total wealth in all regions except the Middle East and more than 70 percent in 5 of the 12 regions presented. Produced assets are generally second in importance and vary from a low of 15 percent of the total wealth to a high of 30 percent, with 20 percent or less for the poorest regions. Natural capital is generally third in importance in explaining national wealth, but again it varies widely, from a low of 2 percent to a high of 39 percent of the total. Natural capital exceeds the value of produced assets in the Middle East and West Africa. The country-level natural capital numbers underlying these regional aggregates are presented in appendix table 1.

Care must be taken in interpreting the low share of natural capital in the most developed regions. This is not the same as saying that natural capital is unimportant in these regions, but rather that there is a preponderance of human resources and produced assets. If the agriculture of North America and Western Europe were halved in productivity tomorrow, for instance, the consequences for human welfare both locally and globally would be extremely serious.

Table 3.2 Increases in country rankings
(rank by wealth per capita compared with rank by PPP GNP per capita)

Country	*Increase in rank*	*Natural capital ($/capita)*
Niger	15	12,000
Madagascar	9	7,000
Australia	7	35,000
Guinea-Bissau	7	8,000
Senegal	6	5,000
Mali	5	5,000
New Zealand	5	51,000
Central African Rep.	4	6,000
Honduras	4	3,000
Canada	3	37,000
Paraguay	3	7,000
Chad	3	6,000
Dominican Rep.	2	8,000
Saudi Arabia	2	72,000
El Salvador	2	1,000

Source: Authors' estimates.

Regional variations are illustrated in figure 3.1, which gives the shares of total regional wealth. The Sub-Saharan Africa and South America charts present a more balanced breakdown of sources of wealth: natural capital accounts for about 13 percent in Sub-Saharan Africa and 9

Table 3.3 Wealth per capita by region, 1994

	Dollars per capita				*Percent share of total wealth*		
Region	*Total wealth*	*Human resources*	*Produced assets*	*Natural capital*	*Human resources*	*Produced assets*	*Natural capital*
North America	326,000	249,000	62,000	16,000	76	19	5
Pacific OECD	302,000	205,000	90,000	8,000	68	30	2
Western Europe	237,000	177,000	55,000	6,000	74	23	2
Middle East	150,000	65,000	27,000	58,000	43	18	39
South America	95,000	70,000	16,000	9,000	74	17	9
North Africa	55,000	38,000	14,000	3,000	69	26	5
Central America	52,000	41,000	8,000	3,000	79	15	6
Caribbean	48,000	33,000	10,000	5,000	69	21	11
East Asia	47,000	36,000	7,000	4,000	77	15	8
East and Southern Africa	30,000	20,000	7,000	3,000	66	25	10
West Africa	22,000	13,000	4,000	5,000	60	18	21
South Asia	22,000	14,000	4,000	4,000	65	19	16

Note: West Africa does not include Nigeria's data because of data quality issues. Similarly, Algeria's data are not included in the estimates for North Africa.
Source: Authors' estimates.

percent in South America, produced assets for another 23 percent and 17 percent, and returns to human resources for the remaining 64 percent and 74 percent respectively. In contrast, wealth shares in the Middle East reflect the primary importance of the oil and gas resources found therefully 39 percent of total wealth comes from natural capital, almost entirely accounted for by oil and gas.

Since some low-income countries are highly resource dependent, it is worth examining more closely the composition of wealth in these countries, as shown in figure 3.2. Not surprisingly, these economies, which are largely dependent on export revenues from primary commodities (other than petroleum), have a large share of their wealth in natural capital (20 percent).

Importance of Natural Capital

Even though natural capital is normally third in importance as a source of wealth behind human resources and produced assets, it does form the ecological basis for life and is a fundamental building block of national wealth. The composition of natural capital varies from country to country, and a disaggregation by income groupings is instructive (table 3.4). Not surprisingly, agricultural lands (including pasturelands) are the most important type of natural capital, often accounting for half or more of all natural wealth. This is especially common in the poorest countries, where agricultural croplands alone account for 80 percent of the total natural capital and pasturelands add another 4 percent. Timber resources are important but not dominant, accounting for 3 to 10 percent of the total value, with non-timber forest benefits and protected areas each adding another few percentage points. A somewhat surprising finding is the importance of metals, minerals, and fossil energy sources. The share of this aggregate category ranges from a low of 8 percent in the poorest countries to 48 percent in the uppermiddle-income countries that include many of the energy exporters.

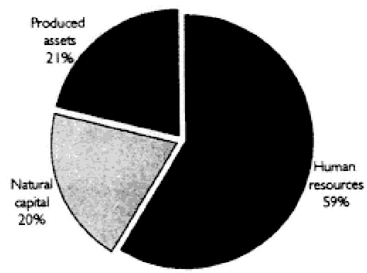

Figure 3.2
Wealth shares in low-income natural resource exporters, 1994
Source: Authors' estimates.

The lessons for sustainable development based on the analysis of the composition of natural capital include the importance of maintaining the potentially renewable resource base in a healthy state. This applies to agricultural lands, pastures, and forests and protected areas. Since the last category in table 3.4, the metals and min-

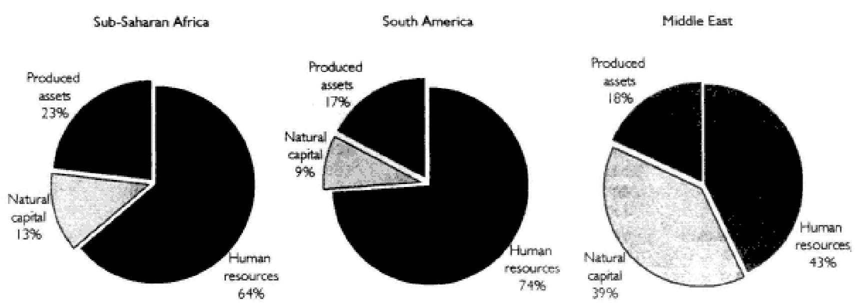

Figure 3.1
Wealth shares across selected regions, 1994
Note: Sub-Saharan Africa does not include data on Nigeria.
Source: Authors' estimates.

Table 3.4 The components of natural capital, 1994
(percentage shares)

Country income class	*Agricultural cropland*	*Pasture land*	*Timber*	*Nontimber forest benefits*	*Protected areas*	*Metals, minerals, oil, coal, gas*
High	41	15	10	4	11	19
Upper middle	28	10	6	5	2	48
Lower middle	56	5	5	3	4	27
Low	80	4	3	2	2	8

Source: Authors' estimates.

erals and fossil energy sources, are by definition nonrenewable, the important policy questions for these resources are those relating to the rate of depletion and whether the revenues gained from depletion are invested or consumed. Since these nonrenewable resources account for 10 percent to 50 percent of all natural capital, these are not trivial questions.

Conclusions and Policy Implications

Valuing human resources on the basis of the purchasing power of currencies (the PPP approach) rather than nominal exchange rates significantly decreases the range between low-income and high-income countries, giving a truer picture of the consumption possibilities that citizens of these countries enjoy. This has a major impact on the estimates of wealth presented here.

This does not mean that poverty has been "assumed away" in these estimates: forty two of the ninety countries examined have wealth per capita figures of less than $50,000 and twenty five of these have per capita wealth of less than $25,000. This compares with an OECD. average wealth in excess of $250,000 per capita.

Agricultural land is the dominant natural resource across country income classes, making up more than 50 percent of natural capital, with the exception of upper-middle- income countries (where petroleum-exporting countries tend to be classified). This is especially the case for low-income countries, where agricultural land is more than 80 percent of natural wealth. It must be emphasized again, however, that use value is the predominant method of valuing natural re sources employed in these estimates.

Natural capital is important regionally, making up more than 10 percent of total wealth in the Caribbean, East and SouthernAfrica, the Middle East, South Asia, and West Africa.

Petroleum and mineral resources are important components of wealth outside of the low-income countries, ranging from 8 percent to nearly 50 percent of natural capital.

Human resources, including the returns to raw labor, are the dominant component of wealth, between 40 to nearly 80 percent of the total in all regions.

There is no simple story about natural resource wealth and growth. While there is some evidence that the most resource- intensive economies have grown more slowly than their peers since the 1970s (Sachs and Warner 1995), in the end the transformation of resource wealth into income growth depends on sound policy, in particular the effectiveness of public investment of resource rents.

It must be emphasized that the analysis of aggregate wealth presented here ignores the distribution of wealth within countries. An issue for many countries will therefore be not only the management of existing wealth but also policies affecting its distribution. Analyzing aggregate wealth also masks the contribution of social capital to economic development (see chapter 6). This preliminary exercise suggests new avenues for broadening and strengthening wealth estimates (see box 3.4) as well.

Perhaps the key policy question from the analysis is raised by figure 3.2: how does a low income resource-exporting country transform itself into a high income country? There is no simple policy prescription, but elements of the answer must include: by exploiting exhaustible resources and investing the rents effectively; by managing renewable resources (forest, fisheries,

agricultural land) sustainably; by increasing investment in produced assets; and by increasing investment in human capital in lockstep with other investments.

The measurement of the wealth of nations in total and in its components is largely motivated by concerns about sustainable development, in particular the notion of sustainable development as preserving and enhancing opportunity. While this is important in itself, given the commitments that the World Bank and its client countries have made to achieving environmentally sustainable development, it also suggests a new paradigm for economic development. The traditional approach to development places a heavy emphasis on building infrastructure. The analysis of wealth suggests a new model for economic development: *development as portfolio management*, the process of transforming an endowment of assets in order to achieve development objectives.

Nations on the path to development have three broad forms of endowment with which to work: natural resources, raw labor, and the social capital that is the result of the cultural traditions and historical experience of the nation in question. These endowments, plus the historical accumulation of produced assets and human capital, represent the starting point for the development process. Part of this endowment, the natural resource base, can be a source of development finance when properly managed; when combined with savings by households and institutions, and net foreign saving, a pool of finance for development is created. A key role for governments is in establishing the incentive framework within which private saving and investment are made. But government investment is critically important as well, whether in infrastructure, education, or the sorts of institutional structures within which social capital can grow. In terms of development outcomes, the quality of public investment is paramount. There is a wealth of empirical experience to suggest that investments in human capital are a very high quality outlet for public investments.

The analysis of wealth in this chapter supports this new development paradigm and suggests the following broad facts:

Natural resources are an important share of wealth in many countries, particularly low-income countries.

Management of natural resources and the environment is therefore an important part of the development process.

Human resources nevertheless form the dominant share of wealth, even in low-income countries.

Portfolio balance may be importantthat is, while investments in produced assets are a necessary part of the development process, concomitant investments in human capital are required, and these represent a highly levered target for public (and private) investment.

Where does this analysis lead? One impact is largely didactic: the measurement of wealth provides the information needed to change the thinking of policymakers about the nature and composition of wealth. However, reassessing the

Box 3.4 Directions for future work
In undertaking this exercise, several simplifying but well-founded assumptions have been made. The exercise has come up against constraints of data availability and quality, some of which can be more easily resolved than others. But there are certain areas in which further work could clearly enhance the estimates considerably and thus increase their policy relevance.
First, as measured here, total wealth comprises three types of capitalnatural capital, produced assets, and human resources (including human and social capital). It does not include the value of a nation's stock of financial assets and liabilities. Since the net value of financial assets and liabilities is equal to net foreign indebtedness, there would be considerable value in including the level of indebtedness in the wealth measure. The level of indebtedness of an economy has a clear link to its capacity for investing in the different types of capital for future generations.
Second, the estimates of subsoil assets are based on proven recoverable reserves. But unproved reserves also have a market value and an economic value based on option pricing. An estimate of the value of unproved reserves could also be included in total wealth.
Finally, the value of a nation's water resources enters the current calculations implicitly, via the value of agricultural land. Water is an important input into agricultural production and its value is included in the returns to land. Even though in many countries the lion's share of water resources go to agricultural uses, water use by industry and households could also be valued by estimating consumptive uses and estimating economic values for different uses.

measure of wealth every five years or so would have practical implications as well, by providing a set of milestones on portfolio composition to help guide the development planning process. For the year-to-year process of economic and natural resource management, flow measures will likely have the most policy relevance. This is the motivation for the previous chapter on the measurement and policy implications of *genuine* savingnote however, that saving is the measure of *changes* in wealth, so the conceptual framework is very much the same.

Natural wealth can be a source of development finance. But there is no guarantee that bountiful natural resources will lead to development that is sustainable and equitable. Only sound policy can transform one into the other.

Technical Appendix

The methods employed to measure the wealth of nations are firmly rooted in economic theory. Resource rents provide the basis for valuing natural resources, and stock values are estimated by taking the present value of flows. There are two overriding goals in choosing the calculation methods used in this chapter:

1. The methods must permit cross-country comparisons.

2. The methods must focus on the economic potential in countries.

As a practical matter the second point dictates using world prices to value natural resources and tradable assets, abstracting from whatever distortions may exist in local markets. It also motivates the use of purchasing power parity (PPP) exchange rates for the valuation of human resources, to better represent the consumption possibilities entailed by the returns to these resources. The first point argues for the use of both world prices and a common discount rate across countries in making the wealth estimations (the choice of discount rate is described below).

If the focus in measuring wealth had been narrowly on human capital, working with educational attainment data and estimates of the returns to education in different countries would have been the preferred calculation method. This would have restricted the scope of the wealth estimates considerably, completely ignoring the role that Social capital plays in the development process. So while the estimation of the returns to human resources as a residual, described below, is in one sense *second-best* in terms of rigor, it is the only way to arrive at a more encompassing measure of the role that human capital, raw labor, and social capital play in the development process. However, the residual approach does not permit separate estimates of the individual constituents of human resources.

The calculation methods used here are constrained both by the goals set out above and by the limitations of the data sets available internationally. Analysts working in individual countries could improve upon the estimates presented here in a number of ways. First, a discount rate that is more appropriate for the country in question could be used. Next, better estimates of total resource rents would result from site-specific data on costs of extraction and harvest. Third, more robust values of the stock of produced assets could be employed. And if land and agricultural produce markets are relatively undistorted, more direct values for agricultural and urban land could be derived from sales data. Finally, detailed data on educational attainment and the returns to education could permit a direct estimate of the value of human capital, leaving raw labor and social capital as the only residual categories in the total wealth calculation.

Produced Assets

Produced assets, also known as human-made capital, have always been an important policy variable for national economic planning. In the wealth calculations the value of produced assets is based on the perpetual inventory model (Nehru and Dhareshwar 1993). These 1990 estimates have been extended to 1994 by calculating the net accumulation (initial capital stock plus gross domestic investment less depreciation).

Note that machinery and equipment are valued at the nominal, unadjusted prices reported

in traditional national accounts. For other produced assetsbuildings and other structuresvaluation is at PPP exchange rates, since there is a large non-tradable component to these assets.

Urban land has been valued as a fixed proportion of the value of buildings and other structures. Balance sheet accounts for Canada (Statistics Canada 1985) reveal that the value of urban land is roughly 33 percent of the stock value of structures, and this percentage is used as a placeholder in the current estimates.

Choice of Discount Rate

Most of the stock estimates derived for wealth measurement are based on taking the present value of flows, making the choice of discount rate clearly critical. Since the concern here is with sustainable development, the appropriate value would be the discount rate that a government would choose in allocating resources across generations in its quest for sustainable development. This is essentially an argument for using social rather than private rates of discount, eliminating the effects of taxes and risk that elevate private discount rates.

The growth theory literature establishes the social rate of return on investment (SRRI) to be given by

$$SRRI = r + uc$$

where r is the pure rate of time preference (the rate of impatience), u is the elasticity of the marginal utility of income, and c is the growth rate of per capita consumption. Estimates of the SRRI for industrial countries (see, for instance, Pearce and Ulph 1995) arrive at values in the range of 2 to 4 percent. For the fastest growing developing countries it is clear that rates considerably higher than this would be appropriate, reflecting per capita consumption growth rates that may be as high as 7 to 9 percent. For the poorest-performing developing countries per capita consumption growth rates have been near zero for nearly two decades, and so a choice of SRRI less than that for developed countries would be appropriate.

Because making cross-country comparisons is one of the goals of this chapter, a single discount rate for all countries of 4 percent was chosen. The effects of choosing a higher or lower rate would be complex, depending on the mix of assets that countries possess, with the effects being most extreme for countries that have relatively longlived assets (large mineral deposits, sustainably managed forests, and young populations with long life expectancies, for instance). While this will be the subject of future empirical investigation, it seems clear that the effect of altering the choice of discount rate would be to ratchet all of the total wealth values across countries up or down, with relatively minor changes in country rankings and asset mixes within countries.

Natural Capital

Natural capital includes the entire environmental patrimony of a country. The estimates presented here are based on a subset of resources selected for their general importance and the availability of data. For any given country certain important resources may not be included, pointing out the importance of making more detailed national wealth estimates to inform policymaking at the national level.

The elements included in the natural capital estimates presented here include agricultural land, pasture lands, forests (timber and nontimber benefits), protected areas, metals and minerals, and coal, oil, and natural gas. There are two major measurement issues: what is included in each variable, and how are values determined? For all of the elements of natural capital included in the wealth estimates, international market prices were used, adjusted by an appropriate factor to represent the *rent* portion of the traded price. The economic rent of any natural resource (also referred to as "Ricardian" rent when comparisons are made between resources of varying productivity) is the difference between the market price and the cost of the various inputs needed to extract, process, and market it. As such, it represents the inherent surplus value in the extraction or harvest of a resource. When there is overexploitation of a resource like a fishery, rents may be driven to zero (the entire market value of the fish is absorbed by labor and capital costs, for example), thereby dissipating the natural *profit* inherent in the resource.

The approach used here means that all countries are treated equally with respect to the val-

ues assigned to their natural resources. For components that are widely traded, such as metals, minerals, and hydrocarbons, this is a reasonable assumption. For agricultural products and their use in calculations of the values assigned to farmland and pasture, this assumption may introduce an upward bias to land values in many of the poorest countries. This is especially true for remoter areas where transport costs and lack of markets mean that there may be only limited opportunities for trade in agricultural products.

Agricultural cropland is valued based on the average per hectare return (production times world commodity price) for three principal grainsrice, wheat and maizewith the average price weighted by the area sown to each crop in any individual country. A crop-specific adjustment factor, varying from 30 to 50 percent, is applied to the gross value to represent the net economic value (the economic rent) of each hectare (World Bank 1992, 1993, 1995a). This annual value, adjusted for changes in yield and area under cultivation over time (estimates from the International Food Policy Research Institute, Evenson and Rosegrant 1995, and Rosegrant and others 1995), is then taken into perpetuity at a 4 percent discount rate to indicate the present and future values associated with sustainably managed agricultural lands. Other arable land is valued at 80 percent of the country-specific average per hectare for these crops. This adjustment is made to recognize the fact that other crops are likely to produce lower returns per hectare. While this is a reasonable assumption for many of the coarse grains and tuber crops, this assumption is probably not accurate for certain high-valued crops such as coffee, tea, vegetables, or cocoa. Therefore, for countries that grow a lot of high-value noncereal crops our assumption would underestimate the value of land.

Pasturelands were valued in a similar manner, whereby the national output of meat, wool, and milk is valued at international prices and an appropriate rental rate (in this case 45 percent) is applied to estimate returns to pastureland. This value is taken into perpetuity at a 4 percent discount rate. In countries where there are significant feedlot operations, yielding a very high apparent return to pasture, the per-hectare value is capped at the level of the return to cropland.

Forests are a potentially renewable resource that can be managed in either a sustainable or an unsustainable manner. The value of forestland is based on annual roundwood production valued at timber rents (price minus production costs). In countries where timber production is below net annual increments, this annual value is then capitalized using a 4 percent discount rate in perpetuity. However, in countries where roundwood production is greater than net annual increments, forests are treated as a mine and the annual value is capitalized over the time to exhaustion.

Protected areas are lands that are set aside to protect biodiversity or unique cultural, scenic, or historic sites. There are many different types of benefits associated with protected areas, some of which are easier to value (for example, tourism or recreation) and others of which are very hard to value (for example, unknown genetic materials). Because of the difficulties in placing values on many of the benefits from protected areas we have used an opportunity cost approach to recognize that there is a positive value associated with these areas. In this case the values previously identified for pastureland are used as a proxy for a minimal value for protected areas. This is done for two reasons: first, many protected areas are lands where agriculture, forestry, or pasture are the most likely alternative uses; and second, the implicit value of protected areas must be at least this large or else the area would not be protected and would have been allocated to other, more directly productive uses. Of course, in some cases protected areas are areas without any productive alternative uses (for example glaciers or deserts) and in these cases the assumption used here may be an overestimate of their minimum value.

Nontimber forest benefits. In each country one-tenth of forest area is multiplied by a per-hectare estimate of nontimber forest benefits ($145 per hectare in industrial and $112 per hectare in developing countries; Lampietti and Dixon 1995). This annual value is then capitalized at a 4 percent discount rate over an infinite time horizon. This value is used as a "place holder" to recognize that there are important values associated with forests over and above the direct timber values.

Metals and minerals are classic nonrenewable resources that can only be managed in a nonre-

newable manner. The estimate of a nation's wealth of metals and minerals is therefore a function of production and reserves, average extraction rate, and the economic rent from their extraction. Detailed calculations for the genuine savings estimates (see chapter 2) are used to estimate a nation's mineral wealth. Yearly production (extraction) is valued using estimates of resource rents for the following metals and minerals: bauxite, copper, iron ore, lead, nickel, phosphate rock, tin, and zinc. The return is smoothed over the period 199094 and then capitalized at a 4 percent discount rate over the remaining time to exhaustion. Present value is calculated by assuming an optimal path for unit scarcity rents and a constant revenue stream (see appendix box 1). The reserve measure used is for *proven* reserves, the quantity of resource that can be exploited profitably at current prices and coststhis is a conservative measure, therefore, and will tend to change over time with new discoveries, new technologies, and changes in world prices. Where data on reserves were not available, time to exhaustion is assumed to be 20 years.

Oil, coal, and gas are the main energy resources included in the wealth analysis. These fuels are also nonrenewable. Yearly production is valued using estimates of resource rents. The value of returns is smoothed over the period 199094 and then capitalized at a 4 percent discount rate over the remaining time to exhaustion. As with metals and minerals, present value is calculated by assuming an optimal path for unit scarcity rents and a constant revenue stream (see appendix box 1). Where data on reserves were not available, time to exhaustion is assumed to be 20 years.

Human Resources

The most difficult component of national wealth to measure is the return to individuals and societies from the use of natural capital and produced capital. In this calculation the value assigned to human resources is a residual value based on the return to a country's population estimated by multiplying agricultural GDP (which includes the value added of the forestry and fisheries sectors in the aggregate national accounts data used here) by 45 percent to reflect the return to labor component, and then *adding* all non-agricultural GNP and *subtracting* the economic rents from subsoil assets and the depreciation of produced assets. Since the value of resource stocks has been explicitly accounted for under natural capital, it is important to subtract the rents on current production of these stocks from current income (nonagricultural GNP) so as not to double count. This amount is then discounted over the average number of productive years of the population, calculated by taking the life expectancy of the national population at year 1 (or 65, whichever is lower) and subtracting the mean (average) age of the population. This calculation estimates the returns to human resources, produced assets, and urban land with the given population or age distribution and the current labor force that implicitly reflects current levels of under- and unemployment.

The lower of age 65 or life expectancy at age 1 is used as the cutoff since we assume that individuals are no longer working and producing beyond that age. For example, in India life expectancy at age 1 is 61 years, and the average age of the population is 27 years, yielding remaining years of productive activity of 34 years. For Sweden, the life expectancy at age 1 is 78 and the mean age of the population is 40. Using an upper bound value of 65 to reflect working life rather than life expectancy, in Sweden this yields a time horizon of 25 years.

These annual values are converted to a stock using a 4 percent discount rate. From this stock value we subtract the value of produced assets and urban land to arrive at the present value of human resources.

Because GNP includes net flows of wages and property incomes abroad, the methodology just described for arriving at the residual return to human resources implies that these net flows of income abroad are all ascribed to human resources. Some portion at least of these flows is probably better ascribed to produced assets, which will increase or decrease the estimated value of human resources according to whether the net flow into a given country is (respectively) negative or positive. This forms part of the agenda for refining the wealth estimates in the future.

Unlike the assumptions made for natural capital, for which international prices are used, and for produced assets for which national prices are

Appendix box 1 Valuing subsoil assets
In the absence of competitive markets for stocks of subsoil assets, estimating their value necessarily entails taking present values of the total rents (defined as the economic profits on extraction: net operating surplus less a "normal" return on produced assets) generated over the life of the resource deposit. Calculating this present value requires strong assumptions about the discount rate and the time path of total rents.
Two pragmatic alternative approaches to valuing subsoil assets have been suggested in the literature: net prices and simple present values. The latter is favored by many national statisticians because it uses quite neutral assumptions: total rents are assumed to be constant over a mine life that is determined by the current reserves to production ratio, and the present value is taken using the social discount rate as the discount factor. The net price approach (used, for instance, in Repetto and others 1989) is even simpler: the resource deposit is valued as the current unit economic profit times the quantity of resource in the ground.
The problem with the simple present value approach to valuation is that it assumes no optimization; mine owners would implicitly be holding assets whose yield is zero. However, the net price approach faces equally serious difficulties: to be consistent with optimization, it implicitly assumes that unit extraction costs are constant and that resource prices rise at near exponential rates. The empirical evidence is against the latter assumption at leasttrends in prices for subsoil resources have been flat or slightly declining for the past several decades.
If resource prices are assumed to continue their flat trend and unit scarcity rents (price minus marginal extraction costs) are assumed to increase as optimization requires, then at least two other approaches to valuation are possible. One is to assume constant production quantities over the life of the deposit; the second is to assume constant resource revenues, which, when combined with rising unit scarcity rents, implies declining quantities extracted. The second of these is clearly the more attractive: it seems a reasonable proposition that in an uncertain world resource owners would seek stability in their revenues while aiming for a path for scarcity rents that is optimal. It is the "constant revenue" assumption that is used in this chapter. Empirically, this gives values that are substantially greater than the simple present value estimate, but less than the net price approach.
Because real mines do not behave like textbook mines, the problem of valuing subsoil assets is inherently one in which there are no good solutions, only "less bad" ones. The constant revenue approach used here fits this criterion by being consistent both with optimization and the empirical fact of a flat long-term trend in prices of subsoil resources.

used, for human resources we have used PPP values rather than unadjusted national prices. This adjustment has the effect of flattening the distribution of per capita incomes, increasing the values for the poorest countries, and reducing per capita incomes for some of the high-income countries. For example, in *World Development Report 1996*, the GNP per capita figure at nominal exchange rates for India is $320 while the PPP estimate is $1,280; for Japan the GNP estimate is $34,630 per capita, while the PPP is $21,140.

The values for human resources combine many diverse elements, including the impacts of investment in education and health, and, most difficult to measure, social capital, the "ether" within which societies use and combine physical, natural and human capital. Social capital is discussed at length in chapter 6.

Appendix table 1 Country-level natural capital estimates

Country	*Natural capital*	*Pastureland*	*Cropland*	*Timber resources*	*Nontimber forest resources*	*Protected areas*	*Subsoil assets*
	$ per capita (percentage of total)						
Argentina	9,850	3.270 (33)	5,200 (53)	280 (3)	480 (5)	100 (1)	520 (5)
Australia	35,340	7,270 (21)	14,150 (40)	1,030 (3)	2,150 (6)	1,650 (5)	9,080 (26)
Austria	7,570	1,480 (20)	2,410 (32)	1,720 (23)	150 (2)	1,580 (21)	230 (3)
Bangladesh	3,110	60 (2)	3,000 (97)	0 (0)	0 (0)	10 (0)	20 (1)
Belgium	1,750	470 (27)	1,110 (63)	100 (6)	20 (1)	50 (3)	10 (1)
Benin	1,930	70 (4)	1,030 (54)	440 (23)	250 (13)	120 (6)	10 (1)
Bolivia	6,060	690 (11)	2,520 (42)	160 (3)	1,820 (30)	240 (4)	640 (11)
Botswana	5,620	1,180 (21)	260 (5)	420 (8)	2,700 (48)	490 (9)	570 (10)
Brazil	7,060	1,070 (15)	2,740 (39)	1,200 (17)	960 (14)	190 (3)	910 (13)
Burkina Faso	2,400	210 (9)	1,870 (78)	100 (4)	120 (5)	90 (4)	.. ..
Burundi	1,940	90 (5)	1,820 (94)	10 (0)	10 (1)	10 (0)	0 (0)
Cameroon	6,800	270 (4)	4,840 (71)	650 (10)	430 (6)	270 (4)	340 (5)
Canada	36,590	2,310 (6)	9,910 (27)	6,230 (17)	4,560 (12)	6,830 (19)	6,750 (18)
Central Aft. Rep.	6,470	440 (7)	2,010 (31)	520 (8)	2,600 (40)	900 (14)	.. ..
Chad	5,550	470 (9)	4,110 (74)	340 (6)	500 (9)	120 (2)	.. ..
Chile	14,440	1,100 (8)	4,910 (34)	1,560 (11)	180 (1)	1,110 (8)	5,580 (39)
China	2,670	100 (4)	2,010 (75)	90 (3)	30 (1)	10 (1)	420 (16)

0 less than $10 per capita.
(0) less than 1 percent.
.. No data.
Note: Numbers in parentheses are percentages of the total. Estimates for Eastern Europe and the countries of the former Soviet Union are not included because of uncertainty about data quality. Similar problems exist for Algeria and Nigeria.

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Appendix table 1 Country-level natural capital estimates *(continued)*

Country	*Natural capital*	*Pastureland*	*Cropland*	*Timber resources*	*Nontimber forest resources*	*Protected areas*	*Subsoil assets*
	$ per capita (percentage of total)						
Colombia	6,100	1,160 (19)	2,490 (41)	390 (6)	410 (7)	270 (4)	1,380 (23)
Congo	4,420	20 (1)	200 (4)	1,040 (24)	2,200 (50)	0 (0)	960 (22)
Costa Rica	7,860	1,480 (19)	5,690 (72)	180 (2)	100 (1)	410 (5)	.. ..
Côte d'Ivoire	3,790	80 (2)	2,870 (76)	570 (15)	210 (6)	10 (0)	30 (1)
Denmark	11,070	270 (2)	7,210 (65)	380 (3)	30 (0)	1,930 (17)	1,260 (11)
Dominican Rep.	8,380	560 (7)	7,310 (87)	90 (1)	30 (0)	280 (3)	100 (1)
Ecuador	11,330	1,160 (10)	4,880 (43)	440 (4)	270 (2)	2,610 (23)	1,970 (17)
Egypt	2,360	420 (18)	1,540 (65)	0 (0)	70 (0)	70 (3)	330 (14)
El Salvador	1,150	250 (22)	890 (77)	10 (1)	10 (0)	0 (0)	.. ..
Finland	15,930	90 (1)	4,670 (29)	6,970 (44)	1,660 (10)	2,420 (15)	110 (1)
France	8,120	1,350 (17)	5,210 (64)	700 (9)	90 (1)	700 (9)	60 (1)
Gambia, The	2,120	190 (9)	1,850 (87)	10 (1)	20 (1)	50 (2)	.. ..
Germany	4,150	430 (10)	2,100 (51)	490 (12)	30 (1)	750 (18)	350 (8)
Ghana	1,920	60 (3)	1,510 (78)	190 (10)	150 (8)	10 (1)	10 (1)
Greece	5,210	1,490 (29)	3,080 (59)	170 (3)	90 (2)	60 (1)	320 (6)
Guatemala	1,720	300 (18)	930 (54)	170 (10)	110 (6)	150 (9)	60 (4)
Guinea-Bissau	7,970	200 (2)	7,440 (93)	330 (4)	.. ..	.. ..	.. ..
Haiti	840	110 (13)	720 (86)	0 (0)	0 (0)	0 (0)	0 (0)
Honduras	3,380	410 (12)	1,610 (47)	820 (24)	210 (6)	230 (7)	100 (3)

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Appendix table 1 Country-level natural capital estimates *(continued)*

Country	*Natural capital*	*Pastureland*	*Cropland*	*Timber resources*	*Nontimber forest resources*	*Protected areas*	*Subsoil assets*
	$ per capita (percentage of total)						
India	3,910	90	3,440	50	20	110	210
		(2)	(88)	(1)	(0)	(3)	(5)
Indonesia	7,480	60	5,780	720	150	100	670
		(1)	(77)	(10)	(2)	(1)	(9)
Ireland	17,780	11,770	4,810	510	40	120	530
		(66)	(27)	(3)	(0)	(1)	(3)
Italy	3,400	430	2,430	110	40	230	160
		(13)	(71)	(3)	(1)	(7)	(5)
Jamaica	3,080	110	280	50	10	0	2,630
		(4)	(9)	(2)	(0)	(0)	(85)
Japan	2,300	120	1,360	220	70	490	40
		(5)	(59)	(10)	(3)	(21)	(2)
Jordan	1,020	260	360	0	0	100	300
		(26)	(35)	(0)	(0)	(9)	(29)
Kenya	1,730	740	840	10	10	120	0
		(43)	(49)	(1)	(1)	(7)	(0)
Korea, Rep. of	2,940	50	2,290	120	40	390	50
		(2)	(78)	(4)	(1)	(13)	(2)
Lesotho	940	340	600	0	0	0	..
		(36)	(64)	(0)	(0)	(0)	..
Madagascar	6,510	500	5,350	310	330	20	..
		(8)	(82)	(5)	(5)	(0)	..
Malawi	880	60	600	90	80	40	..
		(7)	(68)	(11)	(10)	(4)	..
Malaysia	11,820	20	6,190	1,310	230	840	3,230
		(0)	(52)	(11)	(2)	(7)	(27)
Mali	4,840	530	3,620	270	340	70	..
		(11)	(75)	(6)	(7)	(1)	..
Mauritania	5,100	1,060	2,270	0	70	50	1,640
		(21)	(45)	(0)	(1)	(1)	(32)
Mauritius	1,240	20	1,180	10	10	10	..
		(2)	(95)	(1)	(1)	(1)	..
Mexico	6,630	810	1,520	200	140	110	3,860
		(12)	(23)	(3)	(2)	(2)	(58)
Morocco	2,210	480	1,480	60	100	10	80
		(22)	(67)	(3)	(5)	(0)	(4)
Mozambique	1,130	90	360	400	280	0	0
		(8)	(32)	(35)	(25)	(0)	(0)

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Appendix table 1 Country-level natural capital estimates *(continued)*

Country	*Natural capital*	*Pastureland*	*Cropland*	*Timber resources*	*Nontimber forest resources*	*Protected areas*	*Subsoil assets*
	$ per capita (percentage of total)						
Namibia	7,180	1,400 (20)	1,230 (17)	.. ..	2,310 (32)	380 (5)	1,860 (26)
Nepal	2,900	380 (13)	2,150 (74)	90 (3)	60 (2)	210 (7)	10 (0)
Netherlands, The	4,140	560 (14)	1,020 (25)	80 (2)	10 (0)	230 (6)	2,250 (54)
New Zealand	51,090	22,130 (43)	12,600 (25)	4,340 (9)	770 (1)	9,950 (19)	1,300 (3)
Nicaragua	3,690	540 (15)	2,110 (57)	580 (16)	360 (10)	90 (2)	0 (0)
Niger	12,340	310 (3)	11,600 (94)	50 (0)	80 (1)	300 (2)	0 (0)
Norway	30,220	110 (0)	1,680 (6)	2,520 (8)	700 (2)	5,110 (17)	20,090 (66)
Pakistan	1,880	140 (7)	1,480 (79)	0 (0)	0 (0)	100 (6)	150 (8)
Panama	6,300	930 (15)	3,960 (63)	270 (4)	310 (5)	830 (13)	.. ..
Papua New Guinea	7,490	10 (0)	560 (7)	1,550 (21)	2,370 (32)	20 (0)	2,980 (40)
Paraguay	6,990	1,490 (21)	3,590 (51)	1,150 (16)	650 (9)	100 (1)	.. ..
Peru	4,630	350 (8)	2,770 (60)	220 (5)	800 (17)	50 (1)	430 (9)
Philippines	2,730	50 (2)	2,400 (88)	140 (5)	30 (1)	30 (1)	80 (3)
Portugal	4,040	280 (7)	2,140 (53)	1,140 (28)	110 (3)	190 (5)	190 (5)
Rwanda	1,110	100 (9)	930 (84)	0 (0)	10 (1)	70 (6)	0 (0)
Saudi Arabia	71,880	330 (0)	3,600 (5)	.. ..	20 (0)	20 (0)	67,910 (94)
Senegal	5,300	290 (6)	4,180 (79)	310 (6)	250 (5)	210 (4)	60 (1)
Sierra Leone	3,040	60 (2)	2,570 (84)	180 (6)	110 (4)	0 (0)	120 (4)
South Africa	4,200	880 (21)	1,790 (43)	90 (2)	30 (1)	80 (2)	1,340 (32)

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Appendix table 1 Country-level natural capital estimates *(continued)*

Country	*Natural capital*	*Pastureland*	*Cropland*	*Timber resources*	*Nontimber forest resources*	*Protected areas*	*Subsoil assets*
	$ per capita (percentage of total)						
Spain	5,740	940 (16)	3,690 (64)	430 (8)	140 (3)	390 (7)	140 (3)
Sri Lanka	3,480	140 (4)	2,970 (85)	90 (3)	30 (1)	250 (7)	0 (0)
Sweden	14,590	440 (3)	4,390 (30)	5,890 (40)	1,160 (8)	2,300 (16)	410 (3)
Switzerland	3,050	950 (31)	820 (27)	600 (20)	50 (2)	620 (20)	0 (0)
Tanzania	2,200	310 (14)	920 (42)	530 (24)	310 (14)	120 (6)	0 (0)
Thailand	7,600	110 (1)	6,270 (83)	110 (1)	50 (1)	980 (13)	80 (1)
Togo	2,670	50 (2)	2,250 (84)	0 (0)	90 (3)	170 (6)	120 (4)
Trinidad and Tobago	12,110	70 (1)	2,540 (21)	40 (0)	40 (0)	100 (1)	9,310 (77)
Tunisia	6,370	550 (9)	5,070 (80)	10 (0)	20 (0)	10 (0)	710 (11)
Turkey	3,940	490 (12)	2,950 (75)	170 (4)	90 (2)	40 (1)	200 (5)
Uganda	2,230	120 (5)	1,680 (75)	210 (9)	90 (4)	130 (6)	0 (0)
United Kingdom	4,940	1,540 (31)	1,820 (37)	110 (2)	20 (0)	710 (14)	730 (15)
United States	16,500	2,570 (16)	7,210 (44)	1,730 (10)	410 (2)	1,400 (8)	3,180 (19)
Uruguay	14,810	6,040 (41)	8,530 (58)	160 (1)	60 (0)	10 (0)	.. ..
Venezuela	20,820	860 (4)	3,130 (15)	40 (0)	570 (3)	1,270 (6)	14,960 (72)
Vietnam	3,990	70 (2)	3,490 (87)	70 (2)	30 (1)	260 (7)	70 (2)
Zambia	5,490	160 (3)	3,330 (61)	660 (12)	940 (17)	30 (1)	360 (7)
Zimbabwe	2,520	450 (18)	990 (39)	400 (16)	220 (9)	280 (11)	170 (7)

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Chapter 4
Subsidy Policies and the Environment

It has long been recognized that government interventions often harm efficiency. In recent years it has also been increasingly recognized that many government interventions can result in substantial environmental damage. This situation creates the potential for win-win policy reforms that both increase efficiency and reduce environmental problems. This potential is particularly great when policies subsidize environmentally damaging activities.

This chapter examines recent trends in subsidy policies in the energy and agricultural input sectors. These sectors are thought to have considerable potential for win-win policy reforms because of the high levels of inefficiency caused by subsidy policies and the extent to which they have exacerbated environmental problems.

The chapter begins with a discussion of the different forms of government interventions and the problem of measuring their effect on economic incentives. Because interventions can encourage or discourage activities in many ways, a broad definition of subsidies is needed. The discussion then turns to the effect of subsidy policies on the environment. The nature and extent of subsidy policies in the energy and agricultural input sectors are then discussed in detail. In particular the chapter examines the extent to which subsidy policies have changed over time.

Government Policies and the Environment

Governments intervene in their economies for a variety of reasons. Some interventions provide public goods such as infrastructure, which tend to be under-provided by private sector activity, or attempt to remedy perceived market failures. Governments also intervene to pursue nonefficiency objectives such as income distribution or regional development objectives. And some interventions are based on considerations of political patronage. Whatever their intent, policies often persist long after the original reasons have been fulfilled (or not). They also tend to create vested interests.

Government interventions can take a variety of forms: excise taxes and subsidies affect the prices of goods directly; tariffs increase the price of imported goods directly while import quotas increase them indirectly; exchange rate policy affects the value of all tradable commodities; and rules and regulations limit the choices economic agents can make. In many countries governments have also been directly involved in the production and distribution of important commodities. It is not uncommon for policies to work in opposite directions. While some policies might encourage an activity, others might discourage it.

Efficiency Effects

Except where policies correct market failures, they always result in a loss of efficiency. This is a tradeoff that may well be worth making; societies have many worthy objectives that are not related to economic efficiency. Often, however, policies are enacted without sufficient considerationor with blithe disregardof their efficiency consequences.

These consequences can prove quite disproportionate to the non- efficiency objectives achievedif, indeed, the non-efficiency objectives are achieved at all. It is not uncommon for policies to fail to achieve their objectives or even for them to have perverse effects.

Subsidy Policies

The focus of this chapter is on policies that subsidize environmentally damaging activities. In this context subsidy policies are broadly defined as any policies whose effect is to reduce the costs of an activity relative to what they would have been in the absence of the policies. For example, government agencies might sell pesticides to farmers for less than their cost of production or provide credit for buying pesticides at below-market interest rates. In both these cases government funds are being used to reduce the cost of the pesticide to farmers. We shall call such policies *explicit subsidies*. The cost of pesticides to farmers can also be reduced by other, more indirect means, such as policies that allow pesticide imports at preferential exchange rates. Although such policies do not rely on explicit expenditures of government funds, they artificially reduce the cost of pesticide use to farmers and thus have exactly the same effect on behavior as an equivalent explicit subsidy.

Under this approach the extent of subsidies for input use is given by the difference between what users pay for that input and what they would have paid in the absence of all policies, multiplied by the quantity used. The *subsidy rate* is the difference in price expressed as a proportion of the unsubsidized price. Because subsidy rates do not depend on quantities used, they are often better guides to policy changes than subsidies. The amount of *explicit subsidies* is given by government expenditures on subsidies. This is only a subset of all subsidies, and thus is a poor indicator of the extent to which incentives are affected. However, the magnitude of explicit subsidies is often of interest to decisionmakers who have to allocate scarce budgetary resources.

Whether subsidies are direct or indirect, they reduce the cost of inputs. Use of subsidized inputs is encouraged and will be higher than it would have been in the absence of the subsidies. This creates an inefficiency because goods no longer flow to the use in which they have the highest return.

Subsidies and the Environment

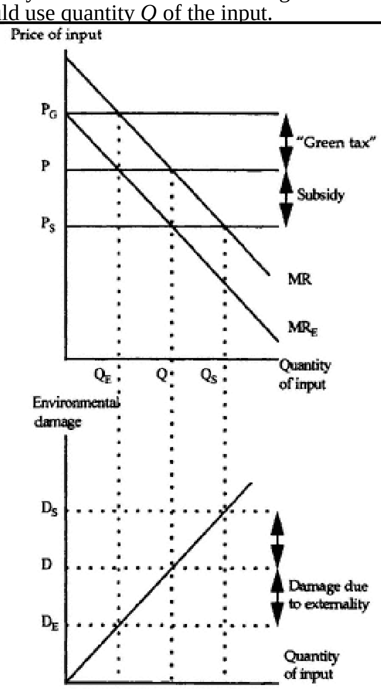
In recent years it has become increasingly clear that misguided government policies and distorted markets that set inappropriate prices for natural resources can result in substantial environmental damage (World Bank 1992; Panayotou 1993; Munasinghe and Cruz 1995). The specific impact of particular policies on the environment is not always clear, however. Some policies have unambiguously harmful effects on the environment, but others have uncertain environmental effects. Even when the direction of environmental impact is clear, the magnitude of the effect is often difficult to establish without elaborate empirical analysisan effort often inhibited by the deficiencies of available data. Likewise, analysis of the likely effects of policy reform is made difficult by the complexity of linkages between policies and the environment and the scarcity of data on their magnitude. In a second-best world in which multiple distortions and market failures exist, it cannot be automatically assumed that all policy reform is beneficial.

There is nothing ambiguous about the harmful impacts of subsidizing environmentally damaging inputs, however. Since any increase in use of such inputs increases environmental damage, and since subsidies result in increased use, the direction of impact is clear (box 4.1). The magnitude of the impact is often uncertain, however. The extent of damage depends on two factors: the responsiveness of input use to changes in subsidies, and the amount of damage caused by each unit of input use.

Win-Win Policy Reform.

Box 4.1 The simple economics of win-win subsidy reform

The double benefits of subsidy reform in the case of environmentally-damaging inputs are easily demonstrated. Consider an input such as a fertilizer or a pesticide. In deciding how much of that input to use, farmers consider both the benefit they expect to receive and the cost of the input. The marginal return to additional units of the input generally diminishes as use of the input increases. Farmers use the input until the marginal return obtained from using an additional unit of the input equals the cost of the input. Box figure 4.1 shows this by the intersection of the marginal revenue (*MR*) line and the price (*P*) line. On this basis farmers would use quantity *Q* of the input.



Box figure 4.1
Links between prices, input use, and environmental damage

Efficiency effects of subsidies. If the government subsidizes use of the input, farmers will perceive a lower price for the input, PS. Accordingly, they will increase their use of the input to quantity *Q*S. This results in a social inefficiency. Because of the subsidy the price of the input no longer reflects its social opportunity cost, and more of it is used than would be socially optimal. Removing the subsidy would increase efficiency.

Environmental effects of subsidies. Now suppose that use of this input also results in environmental damage, as shown in the lower panel of the figure. In the case of fertilizers or pesticides this damage could take the form of polluted runoff, for example. The greater the use of the input, the greater the environmental damage. Since subsidizing an input induces farmers to use more of it, the resulting environmental damage will increase, from *D* to *DS*.

Win-win reforms. Reducing or eliminating subsidies on environmentally damaging inputs would therefore, be a win-win reform since there would be both efficiency and environmental benefits. Efficiency would improve because overuse of the input would decrease. The environment would benefit because the reduced use of the input resulting from removing the subsidy would reduce environmental damage, from *D*S back to *D*.

Limitations of subsidy reforms. This is not to say, however, that simply removing subsidies would result in a socially optimal outcome. The pollution costs of input use are an externality that farmers have no incentive to take into account, so they would still be overusing the input even in the absence of subsidies. If the value of the environmental damages could be calculated, then the socially optimal level of input use could be calculated. This is shown by curve *MRE*, which shows the marginal revenue resulting from use of the input *taking environmental costs into account*. Using this curve, the socially optimal level of input use is *QE*. At this level the marginal benefits derived from use of the input exactly offset its cost and that of the resulting environmental damage, *DE*. To ensure that farmers choose this input level, a green tax would have to be applied, increasing the price they perceive to *PG*. Alternatively, measures could be taken to encourage a shift to an alternative, cleaner technologythat is, one in which less or no environmental damage is caused per unit of output. Removing subsidies, therefore, is often only a first step toward ensuring that environmentally damaging inputs are used in a socially optimal way.

policies create both economic inefficiency and increased environmental damage, removing them is a win-win reform.

Limitations.

While removing subsidies will both improve efficiency and reduce environmental damage, it will not necessarily result in so-

cially optimal outcomes. Indeed, it is often safe to assume that it will notremoving subsidies will reduce incentives to overuse environmentally damaging inputs, but it will not create incentives to take environmental externalities into account (box 4.1). Additional measures may also be necessary to complement the subsidy reforms and ensure that they have the desired effect.

Care is also necessary when, as is often the case, there are multiple distortions. Removing one distortion may not result in improved efficiency if other distortions remain. The same is true of environmental problems. For example, removing subsidies on relatively clean fuels such as natural gas may worsen problems if subsidies persist for other, dirtier fuels, since the change in relative prices will make the latter more attractive.

Measuring Subsidies

Measuring subsidies is complicated by the great variety of policy instruments used by governments and by the poor quality of available data. Given the broad definition of subsidies adopted here, the approach taken to subsidy measurement consists of comparing the prices of the goods under consideration to reference prices that represent the prices these goods would have had in the absence of policies. This approach captures the net effect of all the different policy instruments that affect a good's price.

For tradable goods (goods that are or could be traded internationally) the reference price used is the world (or *border*) price, corrected for transport costs into or out of the country (depending on whether the country is an importer or exporter).

For nontradable goods the reference price used is the long-run marginal cost of production.

The technical notes to this chapter provide details on the actual procedures and data sources used in each case.

Energy Subsidies

Subsidies for energy production or use have been a common form of intervention in both industrial and developing countries. In 1985, total fossil fuel subsidies (for both developing and industrial countries) were estimated to be US$330 billion, $130 billion of which came from the Soviet Union (Burniaux and others 1992). (All values are given in 1995 U.S. dollars, unless otherwise indicated.) In 199092 total fossil fuel subsidies were estimated to be $235245 billion (Larsen and Shah 1992; Larsen 1994) not including OECD countries, in which subsidies were estimated at $12 billion in 199091 (IEA 1995).

This section focuses on fossil fuel subsidies. Fossil fuels are the main forms of energy used in the world today, accounting for about 90 percent of total world primary energy supply (including fossil fuels used to generate electricity). The current state of fossil fuel subsidies is examined and compared with the situation five years ago, based on a recent draft study (Rajkumar 1996).

Energy Use and the Environment

Energy use is, of course, necessary for economic activity. But energy use can also have a variety of harmful effects on the environment.

Air pollution. Fossil fuel combustion releases pollutants such as sulphur dioxide (SO2), nitrogen oxides (NOx), and particulates (TSP) into the atmosphere. Particulates and sulphur dioxide can cause acute and chronic respiratory conditions such as pharyngitis, bronchitis, and asthma, as well as lung cancer and abnormal physiological development. Nitrous oxides can cause respiratory disease in children. Acid rain (from sulphur dioxide), soot, and ash from incomplete combustion can also cause damage to forests and biodiversity.

Water pollution. Water quality can be adversely affected by mine drainage, oil pollution, and acid deposition from excessive fuel use.

Global effects. Fossil fuel combustion and transport result in emission of greenhouse gases such as carbon dioxide and methane.

Safety concerns. Some forms of energy production and distribution pose large safety risks.

Different forms of energy harm the environment in different ways, and to different degrees. Table 4.1 provides indicative levels of emissions associated with different types of fuels. Coal burning in thermal power stations and in domestic stoves is the chief source of particulates and sulphur dioxide. Diesel trucks and buses are also responsible for high emissions, with biomass combustion playing a role in some rural areas. Carbon monoxide, lead, and nitrous oxides are associated primarily with gasoline and diesel con-

sumption. In general, natural gas is the cleanest fossil fuel, while coal results in the highest levels of emissions and pollution. Hydroelectric power does not produce emissions, but it can profoundly modify ecosystems affected by dam and reservoir construction as well as aquatic life and riverine ecosystems downstream; it may also force resettlement of people. The impact of energy use on the environment is also affected by the nature and location of energy use as well as by the type of fuel.

Because the harmful effects of energy use are externalities from the perspective of individual users, they are typically not incorporated into consumption decisions, thus resulting in excessive levels of damage. Given the existence of externalities, it would usually be desirable to tax energy use. Conversely, subsidies on energy use exacerbate environmental problems. Removal of subsidies, therefore, is only a firstalbeit crucialstep toward socially efficient energy use.

Patterns of Energy Subsidies

Energy is subsidized in many ways, both direct and indirect. Among the more explicit are direct grants and tax breaks to producers and distributors. State-owned or state-managed companies are often heavily involved in the energy sector. Price controls are common. Countries with extensive energy resources often impose export restrictions, thus keeping domestic prices artificially low.

A distinction can be made between end-user or consumer subsidies and producer subsidies. Consumers are subsidized if consumer prices are kept lower than free-market levels, while producers are subsidized if producer prices are higher than they would have been in a noninterventionary situation. It is possible and common for both types of subsidies to coexist, creating a wedge between producer prices and consumer prices. In general, energy subsidies in developing countries tend to favor consumers, while subsidies in industrial countries tend to favor producers.

Table 4.1 Indicative emissions from different fossil fuels
(tons of emissions per petajoule of energy content)

Fuel type	*SO2*	*TSP*	*NOx*	*CO2*
Lignite	211,900	112,500	43440	9399,000
Hard coal	141,300	112,500	43440	8591,000
Natural gas	1	23	45290	3840,000
Liquid fuels	101,400	0.593	100400	6266,000
Others	2,000	3,000	1,600	460,000

Note: These values are only indicative and vary according to the particular characteristics of the fossil fuel, the use to which it is put, and the efficiency of energy conversion.
1 petajoule = 1 × 10E15 joules.
Source: IEA 1989; Homer 1993.

Whatever form energy subsidies take, the resuit is prices that fail to reflect the true economic costs of supply. Low consumer prices result in overuse, inefficient use, and wastage of energy. High producer prices encourage excessive production and the operation of high-cost, uneconomic units that would otherwise be uncompetitive. Production patterns become more energy- and capital-intensive and less labor-intensive. Subsidies also tend to drain government budgets, often resulting in higher taxes, displacement of private investment by government borrowing, and higher external debt levels, all of which can have negative effects on economic output and growth.

The pattern of subsidization suggests that, in most cases, energy use would fall substantially if subsidies were reduced. This is not always the case, however.

Removal of distortions may, in the long run, resuit in increased production efficiency, higher economic growth, and increased energy consumption. There is substantial potential for cost-cutting in many subsidized coal sectors in developing countries, for example.

Because energy plays such an important part in economic activity, subsidy removal is likely to have substantial general equilibrium effects, making prediction of the impact of reforms difficult.

Where inter-fuel substitution is possible, price reductions may affect the composition rather than the quantity of fuel use. Since the environmental effects of fuels differ, such changes in the composition of fuel use can affect the level of environmental damage.

Subsidy removal affects use and production patterns only to the extent that individuals and firms respond to prices. In many transition economies this is still far from being the case, especially for state enterprises.

Estimating Fossil Fuel Subsidies in Developing Countries

The last five years have seen significant changes in the magnitude of energy subsidies throughout the world. To evaluate these changes a comparison of fossil fuel subsidies in 199192 and 199596 in a sample of nineteen developing countries and Russia was carried out (Rajkumar, 1996). The countries in the sample account for 77 percent of the world's total energy consumption outside the industrial world, and for 38 percent of global carbon dioxide emissions (table 4.2). The sample also includes the countries known to be large energy subsidizers. To ease comparability and take advantage of recent improvements in available data, 199091 subsidies were re-estimated using the same methodology, assumptions, and data sources.

Estimates of subsidies are based on two approaches. Technical details are provided in the appendix to this chapter. A full description of the methodology and the assumptions made can be found in Rajkumar (1996), which also provides a complete breakdown of subsidies by country, fuel type, and sector.

Petroleum Products and Natural Gas.

Coal.

The relative bulkiness of coal limits trade except for certain grades. The cost of transporting coal can be prohibitive in large countries, thus effectively isolating much of their domestic markets from the world market.

Much of the coal produced and used in Eastern Europe is brown coal, which has relatively low heat content. Because of its high transport costs per unit of useful heat value, there is virtually no trade of this coal on world markets.

In a domestic market that is isolated from trade, prices in the absence of intervention would converge to the long-run marginal cost of production. At prices below marginal cost, highercost mines would shut down, thus reducing production and forcing consumer prices to rise until demand was met by the new level of output. Thus, a *gap between consumer prices and marginal costs* indicates a subsidy to both producers and consumers, and the size of the gap indicates the size of the (combined) subsidy per unit.

Limitations.

Transition Economies.

Table 4.2 Characteristics of countries in the sample

Country or group	*Carbon dioxide emissions (million metric tones) 1992* Solid fuels	Liquid fuels	Gas	*GNP per capita (1995 dollars) 1994*	*Population (millions) 1994*	*Energy intensity 1993*
Russia	607	683	758	2,650	148	2.06
Eastern and Central Europe						
Bulgaria	29	15	8	1,250	8	1.20
Czech Rep.	100	19	12	3,200	10	1.40
Hungary	20	23	16	3,840	10	0.89
Poland	283	37	16	2,410	39	1.11
Romania	39	35	43	1,270	23	1.43
Asia						
China	2,088	398	30	530	1.191	1.37
India	552	161	22	320	914	0.65
Korea, Rep. of	93	167	9	8,260	45	0.37
Thailand	16	73	15	2,410	58	0.36
Oil producers						
Egypt, Arab Rep. of	3	57	16	720	57	0.87
Indonesia	15	97	40	880	190	0.51
Iran, Islamic Rep. of	6	152	48	2,120	63	0.58
Mexico	13	251	53	4,180	89	0.39
Nigeria	0	37	9	280	108	0.43
Saudi Arabia	0	124	66	7,050	18	0.70
Venezuela	1	57	47	2,760	21	0.80
Others						
Argentina	3	59	48	8,110	34	0.29
Brazil	40	154	8	2,970	159	0.21
South Africa	239	48	0	3,040	41	0.88
World	8,588	9,050	3,828			

Note: Energy intensity is defined as total energy use divided by GDP, measured in tons of oil equivalent per thousand US$.

Source: World Bank data; World Resources Institute 1996; IEA 1995.

Finally, three more points should be noted.

Between 1990 and 1995 total energy use declined by more than 25 percent in the former Soviet Union and by about 20 percent in Central and Eastern Europe as a result of economic conditions. Total subsidies would have declined, therefore, even if the subsidy rates remained the same. Changes in subsidy rates provide a better indicator of reform in these countries than total subsidies.

Changes in measured subsidies depend partly on movements in border prices; if domestic prices remain the same and border prices fall, the subsidy rate would appear to fall even in the absence of policy reforms. Recent declines in world prices for natural gas and petroleum products therefore account for part of the measured change in subsidies. (When this effect is corrected for, the qualitative results do not change substantially, as discussed in the technical notes.)

The estimates are for aggregate subsidies for each fuel type, for any particular country. They do not capture the effect of distortions due to differential pricing among sub- categories of fuels or among different types of users. Developing countries often price fuels consumed widely by households at lower levels relative to supply costs than fuels consumed by industries, partly for political reasons and partly out of concern for distributional consequences. Subsidies on kerosene, a fuel widely consumed by Asian households, tend to be higher than subsidies for other petroleum products, for example.

Box 4.2 Price reform problems in transition economies
Comparisons of subsidies in centrally planned and transition economies with those in market economies must be made with care, since prices can have very different meanings.
In centrally planned economies, particularly in the Soviet Union, production and consumption were determined by central planners. While prices existed and payments were made, they had no effect on decisions; they were purely accounting prices. Moreover, since any deficits were covered by the state, costs were also of little concern. Similarly, household energy use was often not metereda problem that still persistsso consumers were equally insensitive to prices.
As the transition to market economies proceeds, prices are becoming more meaningful. Currently, however, many elements of the old system still remain, and are hampering the effectiveness of subsidy reform.
Bill collections for utilities are low, particularly in the former Soviet Union. In the Russian natural gas sector, for example, it is estimated that 50 percent of bills were not paid in 1994, with state enterprises the main culprits. Moreover, many state enterprises still operate on the basis of soft budget constraints, with deficits being covered by the state.
In Ukraine official coal prices have been raised to the point that they are only about 10 percent below official costs (official costs, however, comprise mainly operating costs, grossly underestimating capital costs). The effects of this have been limited, however, by nonpayment problems. Debt is growing, with accumulating arrears in payments both by consumers to mines and by mines to employees.

Trends in Fossil Fuel Subsidies

The results of the study are summarized in table 4.3 and figure 4.1. The results show a substantial reduction in total subsidies since 199091. Total fossil fuel subsidies fell from about $119 billion in 199091 to about $58 billion in 199596. Part of this reduction, however, has resulted from declining energy use. Unit subsidy rates, shown in table 4.3, are thus more indicative of the extent of subsidy reform. Average subsidy rates fell in all regions and for all fuel types. Total subsidies fell by about $60 billion.

Central and Eastern Europe and Russia

Available evidence indicates that energy subsidies in Central and Eastern Europe and in the Soviet Union were high throughout the 1970s and 1980s.

As part of their transition from planned to market economies these countries have made substantial moves toward subsidy reduction. While levels of intervention remain high, prices have generally been allowed to rise in both nominal and real terms. Subsidy reduction has been especially dramatic in Russia, where subsidies on petroleum products, natural gas, and coal have declined by almost $20 billion over the period 199094 (Gurvich and others 1996). While some of the reduction in the transition economies can be attributed to the fall in real GDP they have experienced, subsidy rates have also fallen in practically all countries sampled and for all fuel types. Despite these improvements much remains to be done.

Many transition economies have large coal sectors. Since coal use is especially harmful to the environment (see table 4.1), reform in this sector is particularly important. Employment considerations, however, have impeded prog-ress. The Czech Republic, Hungary, and Poland have already taken significant steps toward reforming their coal sectors, while Bulgaria and Romania are further behind. In Russia and Ukraine, however, restructuring has hardly begun. According to recent World Bank studies the future viable core of the industry in Russia will be only about two-thirds its current size. In Ukraine at least a third of all coal mines need to be closed, and nonpayment of bills, wages, and input prices is a particularly severe problem (box 4.2).

Although Central and Eastern Europe and Russia account for the bulk of the estimated fossil fuel subsidy reduction between 199091 and 1995, the results must be interpreted with care. Because of soft budget constraints in transition economies, the effect of subsidy reduction on incentives for use remains unclear. If reforms continue and payment of bills is legally enforced, the reduction in subsidies will result in increased energy efficiency and substantial reductions in environmental pollution (box 4.3).

China and India

Document

Table 4.3 Subsidy rates and total subsidies for fossil fuels, 199091 and 199596

	Subsidy rates (%)								*Total subsidies*		
	Petroleum products		*Natural gas*		*Coal*		*Totals*		*(1995 US$ millions)*		*(% GDP)*
Country or group	*199091*	*199596*	*199091*	*199596*	*199091*	*199596*	*199091*	*199596*	*199091*	*199596*	*199596*
Russiaa	38	16	67	42	48	25	45	31	28,797	9,427	1.50
Eastern Europe											
Bulgaria	43	24	27	23	65	33	54	29	2,003	733	7.05
Czech Rep.		0	39	29	29	28	24	22	1,173	978	2.96
Hungary	2	2	28	34	na	na	13	16	548	560	1.47
Poland	28	1	40	6	63	26	50	18	4,653	1,692	1.97
Romania	27	2	64	54	80	33	54	37	4,743	1,876	7.24
Total	22	4	48	37	53	26	42	23	13,120	5,838	3.19
Asia											
China	55	2	na	na	37	29	42	20	24,545	10,297	2.42
India	21	15	na	na	32	27	25	19	4,250	2,663	1.06
Korea, Rep. of	0	na	na	na	na	na	0	0	42	12	0.00
Thailand	10	9	na	na	na	na	10	9	524	459	0.37
Total	30	5	na	na	35	29	33	16	29,362	13,430	1.19
Oil producers											
Egypt, Arab Rep. of	50	33	70	56	na	na	55	40	2,299	1,336	3.39
Indonesia	28	21	43	17	na	na	29	21	2,071	1,333	0.921
Iran, Islamic Rep. of	88	77	82	75	na	na	86	77	13,076	9,622	8.68
Mexico	32	12	31	39	na	na	32	16	5,403	2,271	0.66
Nigeria	60	38	na	na	na	na	60	38	928	592	1.87
Saudi Arabia	63	28	76	61	na	na	66	34	3,837	1,720	1.42
Venezuela	70	55	86	85	na	na	76	66	3,455	2,397	4.00
Total	54	38	64	59	na	na	56	42	31,067	19,272	2.26
Others											
Argentina	4	3	24	3	na	na	12	3	659	150	0.06
Brazil	26	0	na	na	na	na	26	0	2,193	11	0.00
South Africa	8	6	na	na	20	na	12	4	981	367	0.31
Total	16	3	24	3	20	na	17	2	3,833	528	0.06
OECD	na	na	na	na	na	na	na	na	12,453	9,890	0.05
Total	36	16	58	44	57	44	45	28	118,632	58,385	0.27

Note: A zero indicates less than 1 percent.

a. Estimates for Russia are for 1990 and 1994 in PPP dollars and are taken from Gurvich and others 1996. See technical appendix for details of derivation.

Source: Rajkumar 1996 for developing countries; IEA 1995 for OECD; Gurvich and others 1996.

Changes in real energy prices in China have occurred as part of the ongoing economic reforms (box 4.4). Reforms began in the 1980s and have continued into the 1990s. While most energy prices are still set by the government, efforts are made to base them on economic costs. Energy intensity in China has fallen by about 30 percent since 1984, which can be at least partly attributed to these reforms.

India has also continued to reduce energy subsidies, albeit more slowly than China. All petroleum products are at or above world prices, with the notable exception of kerosene, a fuel widely consumed by households. Coal pithead prices have also been raised, and since 1991 average prices have covered operating costs, with some allowance for capital depreciation. Furthermore, prices for higher grades of coal are no longer fixed by the central government.

Because the pricing system does not sufficiently differentiate between mines, however, significant cross-subsidization of higher-cost mines by lower-cost ones remains, thus sustaining many uneconomic mines. Similarly, the degree of differentiation among grades of coal is low, resulting in cross-subsidization among lower grades. Removal of subsidies and market reforms may also promote coal-washing, which would reduce emissions per unit of coal used.

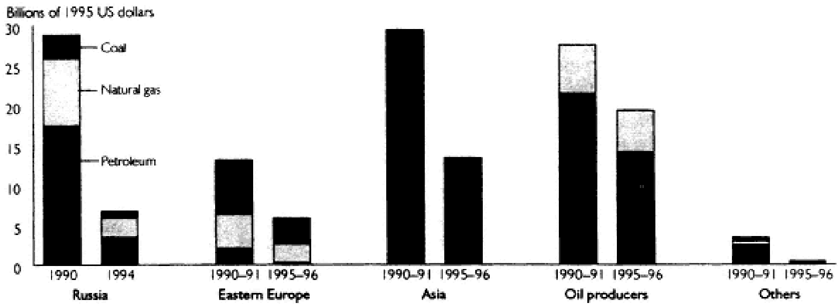


Figure 4.1
Estimated changes in energy subsidies in selected countries, 199091 to 199596
Note: See table 4.3 for countries in each group.
Source: World Bank estimates.

Other Asian Countries

Asian countries generally experienced a reduction in subsidies in the early 1990s, although quantities consumed increased significantly as a result of high economic growth.

Oil Producers

The main oil-producing countries have historically had relatively high energy subsidies. Prices were set administratively and kept below border prices and sometimes even below cost. These countries argued that energy should be priced at low levels for the benefit of all, but particularly the poor (Kosmo 1987). Data from a sample of oil exporters showed average energy subsidies in 1985 as being 5.6 percent of GDP (Kosmo 1987). These subsidies persisted through the 1980s despite falling oil prices and growing budgetary difficulties, with some exceptions, such as Indonesia, which eliminated gasoline and fuel oil subsidies by 1985. In Mexico, Venezuela, and to a lesser extent Egypt, nominal price increases were eroded by inflation. Real domestic prices in the Islamic Republic of Iran remained among the lowest in the Middle East, even after it became a net importer of petroleum in the 1980s during the war with Iraq; in 1991 its total subsidies amounted to 9 percent of GDP. Domestic consumption responded strongly to the highly subsidized prices, growing almost twice as fast as real GDP on average.

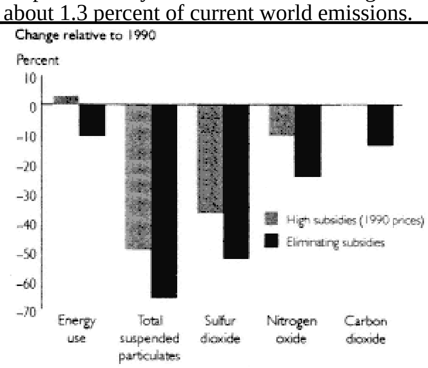
A combination of budget problems, high debt-service ratios, and the desire to remain net exporters caused a change in attitudes toward energy subsidies in the 1990s. All the oil producers in the sample increased real prices for petroleum products substantially. Prices more than doubled in Iran and almost tripled in Saudi Arabia over the past two years, for example. Venezuela raised gasoline prices by more than 500 percent in April 1996, partly due to IMF pressure. Average subsidy rates for this group have now fallen from 56 percent to 42 percent. A greater concern for efficiency has also developed. Before 1995, for example, Saudi Arabia maintained the price of diesel, a refined petroleum product, below that of fuel oil, a residual product. As a resuit diesel oil was often used instead of fuel oil to generate power, a gross waste of resources. This imbalance has now been corrected, with diesel oil prices rising from 3.2 cents to 11.2 cents per liter. (For comparison, the price of diesel to end users in the United States, before tax, was 18 cents in 1995).

Despite recent reductions subsidy rates among oil producers remain high compared with those in other countries. This group still has some of the largest subsidizers in the world. The rate of reform has also been uneven. Natural gas subsidies are still high, with little upward movement in real prices (except in Indonesia). Most of these countries plan to reduce subsidies further, however. Iran, for example, has stated that it intends to eliminate petroleum product subsidies within five years.

Latin America

In Latin American countries as a whole real domestic prices for fossil fuels fell

Box 4.3 Energy in Russia: what lies ahead?
Russia has dramatically reduced its energy subsidies, and there is potential for further reduction. Most effects of these reductions are still to be felt, however.
The World Bank, in collaboration with Russian experts, has developed a model to forecast energy consumption and emissions over the next fifteen years. These forecasts incorporate a number of assumptions, including annual GDP growth of 5 percent after 2000, a long-term recovery of the Russian coal sector, and reduced reliance on nuclear power.
According to these forecasts, complete subsidy elimination would reduce energy consumption by more than 10 percent relative to its 1990 level, whereas maintaining prices at their 1990 levels would result in slightly increased consumption. With complete subsidy removal, in 2010 emission of particulates would be 40 percent lower and emission of carbon dioxide 14 percent lower than they would be in the absence of price reform after 1990. Complete subsidy removal would reduce global carbon dioxide emissions by about 290 million tonnes, or about 1.3 percent of current world emissions.



Box figure 4.3
Projected change in energy consumption and emissions in Russia, 19972010
Source: World Bank projections.

slightly in the 1980s as a result of high inflation rates in many of the region's countries, with especially large falls in ultra-inflationary Brazil. Argentina was a notable exception; despite galloping inflation, nominal prices outpaced inflation, so that by 1990 only kerosene and light fuel oil remained subsidized. In the 1990s a stabilizing of inflation rates was accompanied by a rise in real fuel prices. Brazil experienced a strong rise in real petroleum product prices.

Other Developing Countries

In the rest of the developing world price movements were mixed. In most of Sub-Saharan Africa energy subsidies have not been importantindeed, gasoline, diesel, and, to a lesser extent, kerosene have often been explicitly taxed for revenue purposes. South Africa began a process of deregulation in the late 1980s, privatizing portions of the coal sector and reducing subsidies to the synthetic petroleum product sector. The industry is now completely deregulated and privatized, and foreign ownership is permitted. Subsidies persist for synthetic petroleum product manufacturing, in which coal is an input, but they are due to be phased out by the end of 1998.

Box 4.4 China: subsidy reform in the coal sector
China has made remarkable progress in reforming energy price over the last five years, with fossil fuel subsidies falling from $24 billion a year $10 billion. This reform continues a process begun in the 1980s.
The steady reduction in subsidies to the huge coal sector, which accounts for 73 percent of China's commercial energy needs, has been particularly impressive. Coal subsidy rates fell from 61 percent in 1984 (Kosmo 1987) to 29 percent in 1995. These reforms have been achieved by allowing the gradual entry into the sector of collective and individual mines (operating alongside state mines). Currently about 50 percent of production is carried out by these private mines (Wang 1996). Price controls on coal from state mines have also been partially lifted, so that less than 20 percent of all coal is now sold at controlled prices. Moreover, the problems of nonpayment of bills, which have plagued the coal sectors in the former Soviet Union, have been overcome in China. A strict contract system has been in operation since 1994, whereby state mines only supply coal that has been paid for in advance.
Available data indicate that China's reforms have had very significant effects on energy efficiency. Energy intensity in Chinaonce among the highest in the worldhas fallen by about 30 percent since 1985.
Source: Kosmo 1987; Wang 1986.

Box 4.5 Electricity subsidies
About 34 percent of the world's commercial energy production is used to generate electricity and heat; about two-thirds of this comes from the combustion of fossil fuels. The fossil fuel and power sectors are thus interlinked, and policies affecting one will affect the other.
This has special relevance in the context of subsidies to the power sector. Heat and electricity can be subsidized in a number of ways. Capital inputs to the sector can be provided below cost; electricity prices can be kept low, with the state bearing the resulting losses; and fossil fuels can be provided to the power sector at subsidized prices.
Power subsidies are often high in developing countries. Total electricity subsidies in the early 1990s have been estimated at about $54 billion, or about 3.6 percent of GNP on average for developing countries; adding heat subsidies would increase estimated power subsidies further. These high power subsidies encourage overuse of power and consequently of the inputs to power, resulting in high emissions levels. To make matters worse, coal is commonly used to generate power in the former Soviet Union, Central and Eastern Europe, China, and India. Moreover, this coal is often of low quality and has a high sulphur content.
Over the past few years, however, electricity prices have risen significantly in real terms in most countries. Reductions in fossil fuel subsidies have played an important role in this increase. Other factors include reduced subsidies to other inputs and a reduced willingness to use state funds to offset power companies' losses. This is encouraging from an environmental perspective, although the effects will be felt only in the long run and are dependent on a continued commitment to market reform.

OECD Countries

Among OECD countries, energy subsidies are primarily targeted to producers rather than consumers. Despite some downsizing of coal mines, total subsidies remained high in Germany, Japan, and Spain. The United Kingdom, however, adopted a vigorous coal restructuring program in the late 1980s, which reversed the steep rise in subsidies it experienced in the early 1980s. According to estimates for 1993, total energy subsidies to producers amounted to $9.5 billion, with Germany accounting for 70 percent of this total (IEA 1995). As a whole, therefore, industrial countries have been less successful at reducing energy subsidies than developing countries in recent years.

Effects of Subsidy Reform on Energy Use and the Environment

There is a clear negative relationship between energy prices and energy intensity, which is a simple indicator of energy efficiency. Energy intensity is defined as the ratio of energy use to GDP evaluated at purchasing power parity GDP. Prices explain roughly half of the differences in cross-country energy intensities, the other half being attributable to differences in climate, income level, and the composition of final output (Kosmo 1987).

Because the process of subsidy reform is a recent one it is too early to detect any resulting reduction in environmental damages. Studies of energy use following the oil shock of the 1970s indicate that the effect of prices on energy efficiency is likely to be substantial, although it may not be immediate. Energy intensity fell by 38 percent in OECD countries between 1971 and 1988. For developing countries various researchers have found that, in the long run, energy demand is likely to fall by half a percentage point for each percentage point price rise (Anderson 1995), although individual estimates vary from country to country (see, for example, Hope and Singh 1995; Julius 1986; Tybout and Moss 1992; Eskeland and others 1994).

Because coal is the dirtiest of the fossil fuels, the greatest environmental benefits would result from coal subsidy reforms. Eliminating coal subsidies in OECD countries alone would result in a reduction of global carbon dioxide emissions of about 1.5 percent (DOE 1989; Okugu and Birol 1992), while eliminating coal subsidies in Russia would reduce carbon dioxide emissions by 0.4 percent.

In some countries the possibility that removing subsidies on fossil fuel prices could cause consumers to use fuelwood instead provides a caveat to the expected environmental benefits. Increases in fuelwood consumption would accelerate deforestation, exacerbating problems of land degradation and habitat loss. However, fuelwood is a possible substitute for other fuels in a narrow range of usesprimarily household consumption for heating and cooking. Furthermore, the scope for substantial increases in fuelwood consumption by urban households would be limited by

space and transport cost considerations. A study of Indonesia found that in most areas of the country consumers' substitutability between kerosene and fuelwood was almost zero (Pitt 1985).

Energy subsidies are often claimed to have positive redistributional effects. If this is true, any environmental benefits derived from subsidy reduction might be offset by increases in poverty. Studies have shown, however, that the benefits of energy subsidies tend to accrue disproportionately to richer users. In Poland, for example, the wealthy spend a larger fraction of their income on energy consumption than the poor, indicating that subsidies would be regressive (Freund and Wallich 1995). Targeting cash relief to the poor through social assistance programs is preferable to energy subsidies. Another possible solution would be to provide vouchers, transfers, or lifeline pricing for a small block of a commodity such as natural gas.

Conclusions

Agricultural Input Subsidies

Pesticide Subsidies

Until recently pesticides were considered an important component of improved farming practices. In an effort to encourage farmers to adopt them, subsidies for pesticide use were widely adopted among developing countries. Subsidies were both direct and indirect. Partly as a result of these subsidies pesticide use has increased significantly in the past decades. In Indonesia, for example, pesticide use increased by more than one and a half times between 1975 and 1985.

Pesticide Use and the Environment

There is substantial evidence that pesticide use can pose important threats to the environment and public health. Common problems include groundwater contamination, public health problems, losses of nontarget crops and other species, and pesticide resistance. An estimated 10,000 people die and 400,000 suffer from acute pesticide poisoning annually in developing countries (Repetto 1985). In the Philippines prolonged exposure to pesticides has been found to cause chronic health problems for farmers, including eye, dermal, pulmonary, neurologic, and kidney problems (Antle and Pingali 1995). Pesticide residues on food can also have adverse effects on the health of consumers.

Pesticide Policies

Many developing countries heavily subsidized pesticide use in the 1970s and 1980s. According to a nine-country study (Repetto 1985), subsidy rates in the early 1980s ranged from 20 to 80 percent. Several countries, including Egypt, Indonesia, and Senegal had subsidy rates of more than 80 percent. Despite the high level of subsidy rates, however, expenditures on explicit subsidies tended to be relatively small compared to expenditures on fertilizer subsidies. In Indonesia annual expenditures on explicit pesticide subsidies during the 1980s were about $120 million, compared with about $500 million on fertilizer subsidies. In India annual pesticide subsidies were only $35 million, compared with almost $1,500 million for fertilizer subsidies.

Since the mid-1980s the extent of pesticide subsidies has been substantially reduced in many countries. Bangladesh was one of the first to elimi-

nate pesticide subsidies; fiscal problems forced it to do so in the mid-1970s (box 4.6). Indonesia eliminated most pesticide subsidies between 1986 and 1988 (box 4.7). The Philippines followed suit in 1988 and India in 1992.

Many African governments also moved to reduce pesticide subsidies in the late 1980s, often in the context of structural adjustment programs. Pesticide subsidies had often been provided to producers of export crops to stimulate production. Falling world prices for these crops was another factor that often led to subsidy reductions (Farah 1994). Togo, for example, phased out its pesticide subsidy rates of 100 percent for cotton producers beginning in 1988 (Kiss and Meerman 1991). Similarly, Cameroon abruptly reduced pesticide subsidy rates of more than 100 percent for cocoa producers following the collapse of the cocoa export market in 1990 (Farah 1994).

The trend toward removal of pesticide subsidies has also been observed in transition economies of Eastern and Central Europe and the former Soviet Union. For example, Poland completely abolished pesticide subsidies (which represented 1.1 percent of total agro-food-related expenditures) in 1991 (OECD 1995). In Latin America explicit subsidies have also largely been phased out. Indeed, in several countries domestic pesticide prices are now higher than border prices (Valdés and Schaeffer 1995a, 1995b).

Nevertheless, a variety of direct and indirect subsidies to pesticide use remain in many countries. Table 4.4 summarizes pesticide-related policies in a number of countries in 1993.

Although pesticides were once seen as a critical component of intensive agricultural production, a growing consensus is emerging that they may not only play just a minor role but may actually be detrimental. Several studies have shown that reducing pesticide use does not necessarily result in decreasing agricultural production. In Indonesia substantial reductions in pesticide use beginning in the late 1980s have been accompanied by an increase in rice production (see box 4.7). In cases where productivity does decline because of reduced pest control, the costs of lower yields are often largely offset by the gain resulting from improved farmer health (Antle and Pingali 1995).

In many cases pesticide use has been replaced by integrated pest management (IPM) techniques. IPM techniques attempt to manipulate the crop environment by taking advantage of its biodiversity to reduce the chances of damage. The actual techniques vary depending on the crop and the ecosystem, but they typically include use of insect-resistant varieties, changes to planting times and other operations to exploit insect life cycles, encouragement (or introduction) of natural enemies (biocontrol agents), and mixed cropping. Pesticide use, if any, is limited to reacting to particularly high levels of infestation, rather than prophylactic applications. A number of countries have made IPM a national policy, including Bhutan, China, Indonesia, Madascar, Lao People's Democratic Republic, and Vietnam, (Fleischer and Waibel 1993). The World Bank has been a strong supporter of IPM since the early 1990s.

Remaining Problems

Substantial strides have been made toward reducing subsidies on pesticides. Many countries have eliminated explicit pesticide subsidies, including Bangladesh, Egypt, Ghana, India, Indonesia, Pakistan, Vietnam, and most Latin American countries. Despite these improvements, many countries still implement policies that directly or indirectly favor pesticide use and impede the adoption of ecologically sound pest control techniques (table 4.4).

Through pest surveillance systems, outbreak budgets, and calendar spraying, governments still subsidize pesticide use indirectly and exert strong influences on farmers' decisions related to pesticide applications.

Agricultural credit requirements often conflict with efforts to reduce pesticide use as credit is often conditioned on use of specified amounts of pesticides (Thrupp 1990). In Costa Rica, for example, farmers had to prove they used pesticides to qualify for agricultural loans. In addition, some countries provide subsidized credit for pesticide purchases. In Côte d'Ivoire, for example, credit for pesticide purchases is available at rates of 4 to 5 percent below market rates (Adesina 1994).

To encourage pesticide use some importing countries charge lower tariffs on pesticide imports. Import tariffs for pesticides in Thailand, for example, are only 5 percent, compared with about 20 percent for machinery (Waibel 1990).

Box 4.6 Removing pesticide subsidies in Bangladesh
As in other green revolution countries pesticide use was an integral part of the high-yield variety technology package adopted by Bangladesh, which called for three scheduled pesticide applications. Use was further encouraged by subsidies. As a result pesticide use grew rapidly in the early 1970s.
Fiscal problems led to the subsidies being halved in 197374, however, and then removed entirely in 1978. Pesticide use fell dramatically in the wake of the reduction in subsidies. The treated area fell from 3 to 5 million hectares in 197174 to less than 1 million hectares two years later, and then further to around 0.5 million hectares after the complete elimination of subsidies (Duloy and Nicholas 1991).
Although total pesticide use has since recovered and now exceeds the levels of the early 1970s, per hectare use remains low by regional standards and only 10 to 20 percent of the area planted to high-yield rice is treated. The perceived high cost of pesticides has made farmers use them in a purely reactive way: pesticides are applied only when pest infestations are detected (Pagiola 1995).
Groundwater tests during 199495 in areas with a high potential for pesticide contamination found traces in only 13 percent of samples, and most were longer-lived organo-chlorines used in the past rather than the moderately persistent and less toxic organo-phosphates in current use (Pagiola 1995). The pollution record of other countries in the region that continued to subsidize pesticide use heavily well into the 1980s makes it clear that, for Bangladesh, removing pesticide subsidies was clearly a win-win reform.
Source: Pagiola 1995.

Countries with pesticide production often have low tariff rates on imported active ingredients and high rates on imported products. These discriminatory trade policies result in inefficiency in pesticide production and use.

Many donors and international agencies have become very cautious in providing pesticide assistance, and some have strongly supported IPM approaches. Nevertheless, problems remain with donations of pesticides from a few countries such as Japan according to Matteson and Meltzer (1995). Donated pesticides are often sold to farmers at heavily discounted prices.

Eliminating subsidies is only a first step in ensuring that pesticide use does not exceed socially optimal levels. Given the important negative externalities often associated with pesticide use, the principle of taxing pesticides is becoming increasingly accepted. Several OECD countries have levied taxes on pesticide use. Denmark raised pesticide taxes to as much as 37 percent of the retail price in 1996. Sweden has coupled high taxes on pesticides with subsidies to help farmers switch to pesticide-free farming techniques. No developing country government has yet undertaken the next logical step and taxed pesticide use. Indeed, a number of countries, such as the Philippines, waive sales tax on pesticides.

Fertilizer Subsidies

Total worldwide use of fertilizers measured in terms of the three main nutrientsnitrogen (N), phosphorus (P), and potassium (K)rose from 27 million metric tonnes in 1960 to 146 million metric tonnes in 1988 (figure 4.2). Growth has been especially rapid in the developing world, particularly in Asia. Fertilizers have been one of the driving forces in the growth of agricultural output. Only in recent years has the growth in world fertilizer consumption abated, largely as a result of reduced consumption in Eastern Europe and the former Soviet Union.

Fertilizer Use and the Environment

Positive Environmental Effects

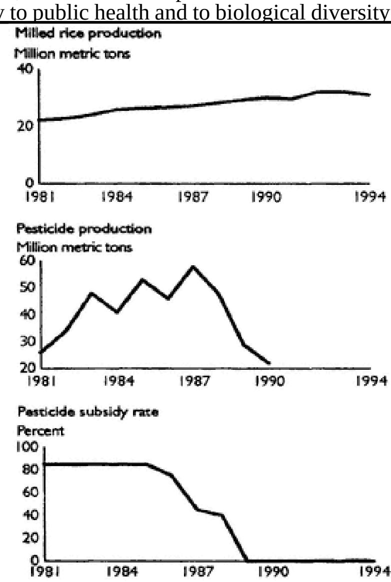
Box 4.7 Removing pesticide subsidies in Indonesia

Agriculture employs 50 percent of the labor force in Indonesia and accounts for about 20 percent of GDP. Rice is the most important agricultural product. Rice self-sufficiency has been the focus of agricultural policy since the 1960s. To increase rice output the government has aggressively promoted the use of high-yielding varieties (HYVs) and the associated use of fertilizers and pesticides. As a result the area planted to HYVs increased to more than 90 percent in 1990 and rice production doubled between 1970 and 1990. After having been the world's largest rice importer for years the country attained self- sufficiency in rice in 1985.

Prior to 1986 pesticides were an integral part of government efforts to boost agricultural production. Pesticide use was promoted in many ways, including direct subsidies on pesticide sales, government spraying, and favorable credit packages. The pesticide subsidy rate was about 85 percent in the early 1980s (Pincus 1994). Expenditures on pesticide subsidies reached 151 billion rupiah ($126 million) in the 198687 fiscal year. As a result of these policies domestic pesticide production soared from 6,000 metric tons in 1972 to 53,100 metric tons in 1985 (Pincus 1994) and substantial additional quantities were imported.

Massive use of pesticides caused considerable harm. Pesticide pollution was a major cause for concern in Indonesia's densely populated village communities, particularly where water for drinking and bathing was in limited supply. Problems were further compounded by the disposal of hazardous wastes produced by the pesticide industry. Ironically, heavy pesticide use also came to undermine the very purpose for which it had been promoted: stabilizing agricultural production. Targeted pests soon developed resistance to pesticides, leading to widespread pest resurgence problems. In addition pests such as the brown planthopper, which had not previously been considered a problem, became serious threats after overuse of pesticides killed their natural enemies. However, as the applications of insecticides went up, so did the brown planthopper infestation. A brown planthopper outbreak in 1976 resulted in the loss of a million tons of rice, an amount sufficient to feed more than 2.5 million people (Kenmore 1991).

These problems led Indonesia to drastically modify its pesticide policies in 1986 (see box figure 4.7). Many pesticides were banned, and integrated pest management (IPM) was officially adopted as a national policy. All direct subsidies on pesticides were eliminated by 1989, and the extent of indirect subsidies was substantially reduced. As a result of these changes pesticide use fell dramatically. Production dropped to 22,100 metric tons in 1990, while imports fell to a third of the mid-1980s levels. This reduction in use has been accomplished without adverse effects on rice production. Total milled rice production rose from 27 million metric tons in 1986 to 30 million metric tons in 1990. Although no data exist to quantify this effect, the reduction of pesticide use is also thought to have alleviated damage to the environmentparticularly to public health and to biological diversity.



Box figure 4.7
Effect of removing pesticide subsidies in Indonesia
Source: World Bank data; Pincus 1994; Pearson 1991.

Despite the improvements problems have not been entirely eliminated. Several indirect subsidies remainfor example, through the government's emergency outbreak budget, which provides government sprays or free pesticides in response to reported pest outbreaks. Many credit packages still require pesticide use. Various measures to protect the domestic pesticide industry also remain in place, and enforcement of the pesticide ban is weak.

Adverse Environmental Effects

Fertilizers can have adverse environmental effects if they leave the fields on which they are applied. By some measures only about 50 percent of fertilizer applications are taken up by crops, meaning that substantial quantities of nutrients escape into the environment. This can at times result in health problems. Nitrates leached from fertilizer can be

Table 4.4 Pesticide policies in selected countries, 1993

Country	*Sales below market price*	*Subsidized credit*	*Favorable exchange rate*	*Preferential tariff rate*	*Outbreak budget*	*Aid-in-kind donations*	*Adoption of IPM*
Asia							
Bhutan	Yes	Yes	No	Yes	Yes	Yes	Yes
China	No	n/a	No	No	Yes	Yes	Yes
Indonesia	No	No	No	No	Yes	No	Yes
Laos	Yes	Yes	No	Yes	No	Yes	Yes
Malaysia	No	No	No	No	Yes	No	Yes
Nepal	No	No	n/a	Yes	Yes	Yes	Yes
Sri Lanka	No	Yes	Yes	No	No	No	No
Vietnam	No	No	n/a	Yes	Yes	No	Yes
Africa							
Cameroon	Yes	Yes	No	Yes	No	Yes	No
Egypt	No	Yes	Yes	Yes	Yes	No	No
Ghana	No	Yes	No	Yes	Yes	Yes	Yes
Kenya	No	Yes	No	No	Yes	No	No
Madagascar	No	Yes	n/a	Yes	Yes	Yes	Yes
Malawi	No	Yes	n/a	n/a	Yes	Yes	No
Nigeria	No	Yes	No	Yes	Yes	No	No
Sudan	Yes	Yes	No	No	Yes	Yes	No
Tanzania	No	No	No	n/a	No	Yes	No
Latin America							
Brazil	No	No	n/a	No	No	No	No
Colombia	No	No	No	No	Yes	No	No
Costa Rico	No	Yes	n/a	Yes	Yes	n/a	n/a
Cuba	No	Yes	Yes	n/a	Yes	No	Yes
Peru	No	No	No	Yes	No	No	No

Source: Fleischer and Waibel. 1993.

carcinogenic, for example, and can cause blue baby syndrome. Unlike pesticides, however, the primary concern is not over possible health effects but over the ecological consequences of introducing large quantities of nutrients into ecosystems. This can result in degradation of water quality and eutrophication. Phosphorus-laden runoff from agricultural areas in central Florida, for example, are resulting in extensive damage to the ecosystem of the Everglades. Because the Everglades are naturally very low in phosphorus, most of its biota are very sensitive to phosphorus additions. Fertilizer use also contributes to climate change problems, since gaseous nitrogen losses add to total emissions of nitrous oxides.

Adverse Productivity Effects

Fertilizer Policies

Trends in Fertilizer Policies

Although the lack of data for many countries prevents calculation of total subsidies at the global level, the trend in total subsidies can be discerned. Fertilizer subsidies increased rapidly during the 1960s and 1970s, peaked in the late 1970s and early 1980s, and then started to diminish (table 4.5).

In the early 1970s explicit subsidy rates for fertilizers usually ranged from 25 to 50 percent of unsubsidized retail costs (Repetto 1988). For example, subsidy rates for urea in 196872 were 56 percent in Bangladesh (box 4.8), 50 percent in Chile, 36 percent in Indonesia, 50 percent in Nigeria, 47 percent in Senegal, and 81 percent in Uruguay. Many countries also provided additional indirect subsidies through favorable exchange rates, tariffs, and foreign exchange allocations, preferential domestic taxation, and subsidized credit. For example, credit for fertilizer purchases was interest-free in Brazil in the late 1970s; in Nicaragua fertilizer imports were subject to extremely favorable exchange rates.

Even though the goal of encouraging adoption of fertilizer use had long since been achieved in most countries, subsidies remained high through the early 1980s. Subsidy rates of 50 to 70 percent for fertilizers were common in the early 1980s (World Bank 1986). In 198384, for example, explicit subsidies for nitrogenous fertilizers were 36 percent in Burkina Faso, 61 percent in Iran, 33 percent in Pakistan, and 60 percent in Togo (Repetto 1988). High subsidies coupled with rapid growth of fertilizer use resulted in very high budgetary outlays (table 4.6). For example, Indonesia spent $1 billion on explicit fertilizer subsidies in 1984, Nigeria spent $270 million (32 percent of its agricultural budget) in 1985, and India spent more than $2.8 billion in 1988.

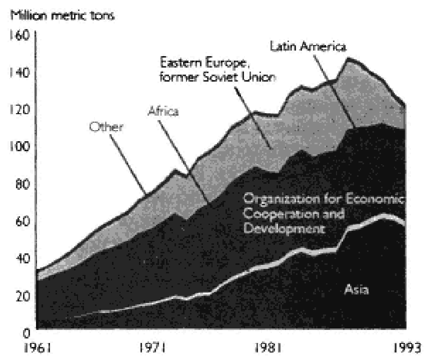


Figure 4.2
Trends in fertilizer consumption
Source: FAO data.

Fertilizer subsidies in many countries began to experience a reduction in the 1980s (Maene 1994; Isherwood 1996). Average unit subsidies on urea decreased in many countries (see table 4.5). Budgetary expenditures also tended to decline (see table 4.6). In Indonesia total subsidies fell substantially. Several countries, including Bangladesh, the Philippines, Sri Lanka, and most Latin American countries, have eliminated explicit fertilizer subsidies. This declining trend continues today, although it has levelled off in many countries. Iran is one of the few exceptions to this trend, having experienced an increase in total fertilizer subsidies.

In the centrally planned economies of the Eastern Bloc, fertilizers were allocated rather than sold, and were heavily subsidized. With the transition to a market economy fertilizer subsidies in these countries have been reduced or, in many cases, eliminated (Maene 1994). In OECD countries explicit subsidies on fertilizers have been rare; producer subsidies have generally taken the form of output rather than input subsidies. In fact, several countries are taxing fertilizer use (Maene 1994).

A variety of factors have prompted countries to reduce or curtail fertilizer subsidies:

Their financial burden was a major factor in many African and Latin American countries.

The need for improved efficiency has often been a motivation. Because of subsidies, fertilizers tended to be overused and misused. Moreover, the mechanisms required to implement subsidized input policiesoften based on government or parastatal distribution systemstended to become increasingly bloated and inefficient over time.

International organizations, including the World Bank and the IMF, and international donors have long advocated the removal of subsidies to correct price distortions and improve production efficiency. Subsidy reform has been a major component of structural adjustment programs.

The conditions created by the transition to market economies and the lack of financial resources were important factors in the centrally planned economies of the former Soviet Union and Eastern Europe.

Recent trends in fertilizer subsidies have not been uniformly downward, however. Fluctuations and even increases in subsidies have been observed. Many countries still provide direct or indirect subsidies. Governments have resisted removing subsidies for various reasons, including economic incentives, protectionism, social equity, or pressure by special-interest groups. In Nigeria fertilizer subsidies remain the single most expensive agricultural program, accounting for 31 percent of the government's budget allocation to agriculture. Fertilizer subsidies are reportedly being reintroduced in several countries of Central Europe and the former Soviet Union.

Table 4.5 Explicit subsidies on urea in selected countries, 197190
(1995 US$ per metric ton of urea)

Country	*197175*	*197680*	*198185*	*198690*
Asia				
Bangladesh	90	99	17	19
Indonesia	n/a	n/a	51	66
Iran	411	294	239	101
Pakistan	108	69	77	n/a
Oman	335	n/a	n/a	52
Turkey	164	n/a	n/a	55
Africa				
Burkina Faso	253	177	136	12
Nigeria	n/a	60	59	n/a
South Africa	38	20	n/a	n/a
Togo	367	299	200	99
Tunisis (*)	38	132	181	100
South America				
Venezuela	n/a	152	n/a	188
Eastern Europe				
Hungary	57	57	112	67
OECD				
Australia	90	42	12	n/a
New Zealand	84	73	16	n/a
Portugal	n/a	197	308	n/a
Spain	106	95	98	52

Notes: Because of missing observations in the FAO database, some values shown are for slightly different periods. The FAO ceased collecting these data in 1990.
(*) Data for subsidies on ammonium nitrate shown.
Source: FAO database.

Table 4.6 Average annual government expenditures on explicit fertilizer subsidies in selected Asian countries, 198294
(million 1995 US$)

Country	*198284*	*198597*	*198890*	*199193*	*1994*
Bangladesh	56	21	68	19	0
India	1,194	2,006	2,833	2,010	1,685
Indonesia	732	530	515	333	96
Iran	478	432	505	658	n/a
South Korea	106	387	15	n/a	n/a
Nepal	9	6	13	17	n/a
Pakistan	178	156	102	33	2
Philippines	48	46	20	0	n/a
Sri Lanka	64	44	12	0	n/a
Thailand	5	3	3	n/a	n/a

Source: FADINAP database, except Indonesia 199194 from Indonesia Center for Policy and Implementation Studies.

Environmental Effects of Subsidy Reform

Fertilizer use provides clear productivity benefits and, in many developing countries, often causes only relatively low levels of environmental damage. Because of this, the potential for win-win reforms is less marked than that for pesticides. The extent to which current subsidy reforms will result in environmental improvements is, therefore, difficult to predict. The environmental problems associated with overuse and misuse of fertilizers have seldom been systematically studied. Even where data exist, they are generally insufficient to determine the long-term impacts of changes in fertilizer use.

From the efficiency perspective the need to overcome farmers' risk aversion has often been cited as justifying subsidies. Infant-industry arguments have also been made for protection of domestic fertilizer industries. Whatever merit these arguments may once have had, they are clearly no longer applicable. After decades of experience, fertilizers have been widely accepted by farmers and the fertilizer industry is a mature sector in many countries. Poverty considerations are also seldom a factor, since fertilizer subsidies are an extremely inefficient way of aiding poor farmers, who account for only a fraction of total fertilizer use.

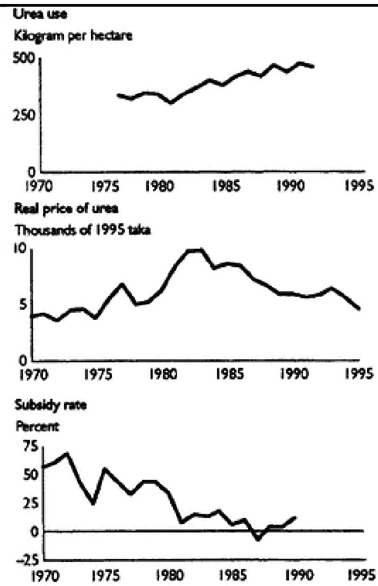
Irrigation Water Subsidies

The area irrigated worldwide grew by about 2 percent a year during the 1960s and 1970s, and by

Box 4.8 Reducing fertilizer subsidies in Bangladesh

Bangladesh is one of the poorest and most populous countries in the world. Agriculture is a dominant sector, accounting for 38 percent of GDP and employing 70 percent of the workforce. In the past decade agriculture has grown by about 2 percent annually thanks to widespread adoption of improved, intensified cropping practices. Increased fertilizer use has been a major component of this growth. Between 1971 and 1993 total fertilizer use increased from 0.3 to 2.3 million metric tonnes. Urea, which is produced locally from natural gas, is the main fertilizer used, with a 67 percent market share.

Until 1978 the government had a monopoly on fertilizer production, procurement, and distribution through two parastatals: the Bangladesh Agricultural Development Corporation (BADC) and the Bangladesh Chemical Industries Corporation (BCIC). Four basic types of subsidies existed in this period: a direct price subsidy when border prices exceeded government sales prices, an indirect production subsidy when exfactory prices exceeded border prices, an indirect distribution subsidy when distribution costs exceeded private sector costs, and a production subsidy through low-price sales of natural gas to urea producers.



Box figure 4.8
Effect of removing urea subsidies in Bangladesh
Source: Renfro, 1992; Bangladesh Bureau of Statistics, various years.

Although subsidies contributed to the promotion of fertilizer use, they imposed heavy financial burdens on the government. By the late 1970s fertilizer subsidies accounted for 4 percent of the national budget (Mokarrum 1994). The government's control of the fertilizer market also resulted in misallocation of resources and inefficient production and distribution. The BADC's marketing and distribution costs rose by 240 percent in 197378 even though sales increased by only 90 percent (Mokarrum 1994). In addition concern had arisen over environmental pollution resulting from fertilizer production and use, including the possible contamination of surface and drainage water and lake eutrophication (Karim n.d.; Huq and Wheeler 1993; Pagiola 1995).

In 1978 Bangladesh began experimenting with partial deregulation of urea sales. Retail prices were deregulated completely in 1983. The number of fertilizer retailers and wholesalers increased rapidly, and substantial competition soon resulted. In 1988 the government attempted to encourage further competition in the fertilizer wholesale market through the system of transportation discount points. Direct factory sales of urea to private wholesalers at the same price as charged to government agents were allowed in 1989. Since 199192 almost all urea has been marketed by the private sector. In parallel with price deregulation, subsidies for urea were gradually phased out by 1990.

The savings resulting from the removal of fertilizer subsidies were estimated at $294 million in 199093:$253 million from saving in fertilizer transportation and movement, $33 million from reductions in direct subsidies, and $7 million from procurement through private sector imports.

Despite the abolition of price control and the reduction in subsidies real prices for urea have declined over time thanks to improved efficiency in distribution, increased domestic production, and decreases in world urea prices in the mid-1980s. Together with a substantial increase in the area planted to improved varieties, this has resulted in a sustained increase in fertilizer use of 10 percent annually from 1970 to 1990.

about 1 percent a year during the 1980s and early 1990s, reaching about 250 million hectares. Three countriesChina, India, and Pakistanaccount for nearly half of the world's irrigated area. The United States and the former Soviet Union also have substantial irrigated areas. In recent years, however, growth in irrigated areas has occurred primarily in other countries.

Irrigation and the Environment

Although irrigation can result in substantial increases in ag-

ricultural production, it can also have substantial adverse environmental impacts, both on-site and off-site.

On-site impacts. Irrigation can result in substantially higher yields by guaranteeing the timing and quantity of water available to crops. It can also make crop production possible in dry seasons. Misuse or overuse of irrigation can, however, also lead to long-term damage to productivity because of salinization or waterlogging (Umali 1993).

Off-site impacts. Agriculture is the single biggest user of freshwater worldwide. Water use for irrigation often has important adverse effects on both the quality and quantity of water available to other uses. Return flow from irrigated fields often carries pesticides, fertilizers, and other pollutants. Management of water for agricultural purposes can substantially affect the timing, volume, and velocity of water flow and groundwater recharge, thereby altering natural lake, riverine, estuarine, and marine habitats. Water use for agriculture can also affect upstream habitats because aquatic systems are often altered far into their watersheds to regulate downstream water delivery.

Irrigation Subsidies

Irrigation subsidies have been pervasive in developing and industrial nations alike. Many irrigation systems have been built and operated by government agencies. Typically, water users are charged only a fraction of the cost of supplying water to them (table 4.7).

In many cases charges even fail to cover operations and maintenance (O&M) costs, and they almost never cover any of the substantial capital costs incurred in developing water collection and distribution systems (Repetto 1986; Tsur and Dinar 1995). Charges are often based on the area irrigated rather-than on the amount used, further reducing disincentives to overuse. For privately financed irrigation, energy for water pumping is often subsidized (for example, in India and the United States).

Extent of Subsidies to Irrigation

The massive underpricing of irrigation water has resulted in substantial overuse. The efficiency of water use has been extremely lowas little as 30 percent of water made available for irrigation in developing countries is actually consumed (Xie and others 1993). A study of eleven major irrigation systems in China showed that farmers often use more subsidized irrigation water than necessary for crop growth and substitute water for other inputs (Repetto 1986). Overuse of irrigation water has been a major factor behind the waterlogging and salinization problems being experienced in many countries.

Limited cost recovery has meant that extensive contributions from governments' public investment and current expenditure budgets have been necessary to maintain irrigation systems. The failure of charges to cover operations and maintenance expenses has often resulted in a long-term deterioration of irrigation systems. In Mexico the irrigated area declined during the late 1980s because of the dependence on subsidies (89 percent subsidy rate) and government spending cuts. Lack of maintenance funding in China has kept more than 930,000 hectares of irrigated farmland out of production since 1980. Worldwide an estimated 150 million hectares, more than 60 percent of the world's total irrigated area, need some form of upgrading to remain in good working order (Gleick 1993).

Although subsidies to irrigation have often been justified as being needed to assist poor farmers, in many instances it is medium-size and rich

farmers who have reaped most of the benefits (Briscoe and Garn 1994).

Summary

There has been substantial progress in reducing the heavy subsidies that once characterized pesticide and fertilizer markets in developing countries, and which have led to excessive and inefficient use of agrochemicals and consequent environmental damage. These problems, along with the subsidies' budgetary costs, have raised serious concern over the subsidy policy and led to the reduction of subsidies in many countries.

Compared with the situation in the early stage of their introduction, the use of fertilizers and pesticides has been widely accepted by farmers and the agrochemical sector today has become mature. There seems to be little ground for justifying the subsidies. Removing explicit pesticide subsidies should not be the last but rather the first step in correcting the policy and market failure. It is time for governments to move further toward complete elimination of subsidy policies.

The long-term effect of reductions in subsidies to agricultural inputs will also be affected by changes in other policies that affect agriculture. Despite the often high subsidies provided for agricultural input use, the vast majority of developing countries have until recently had policies that, on balance, discriminated heavily against agriculture. Resources were extracted from agriculture in a variety of ways: overvalued exchange rates, protection of competing sectors, price controls, and high direct taxation. A sample of eighteen developing countries found that transfers out of agriculture averaged 46 percent of agricultural GDP during 196084 (Schiff and Valdés 1992). These policies have substantially slowed agricultural growth, and many countries are gradually moving away from them. As agricultural activities become more attractive as a result, increased demand for agricultural inputs is likely to be induced. Total use of these inputs, therefore, may well increase even as subsidies for their use decline. This has occurred with fertilizers in Bangladesh, for example (see box 4.8). Nevertheless, input use will be lower than it would have been if subsidies had been kept in place while overall policies were reformed.

Table 4.7 Irrigation charges and unit costs in selected Asian countries

Country	*O&M costs ($/ha)*	*Total capital and recurrent costs ($/ha)*	*Water charges ($/ha)*	*Cost recovery ($/ha)*
Indonesia	33	387	26	78
Korea, Rep. of	210	1,523	192	91
Nepal	16	207	9	57
Philippines	14	166	17	121
Thailand	30	272	8	28
Bangladesh	21	375	4	18

Source: Repetto 1986.

Conclusions

In recent years substantial progress has been achieved in reducing the extent of policies on environmentally damaging inputs. Trends toward subsidy reduction are particularly marked in the energy sector, where total subsidies have been more than halved in the past 5 years alone.

Substantial scope remains for additional reductions in subsidies on environmentally damaging inputs in many countries. In others, however, most of the obvious and "easy" reforms have been accomplished, and additional reform efforts might require trade-offs between different objectives.

Removal of subsidy policies is not always sufficient to ensure that both efficiency and the environment improve. Additional reforms are sometimes needed to ensure that subsidy reform has the intended effect. This is seen most clearly in the case of energy subsidies in the transition economies of the former Soviet Union.

Even where progress is only partial, the reforms detailed in this chapter are likely to be good news for the environment. Although data to confirm and measure these effects are scarce, there are good reasons to believe that environmental damages are being reduced. This should not be cause for complacency, however. While subsidy reform will reduce environmental damage, it will remain excessive unless further, proactive steps are taken to discourage the use of these inputs. Removing subsidies is only the first step in the journey toward environmentally sustainable input use.

Technical Notes

The estimates of fossil fuel subsidies are based on a recent draft study carried out by the Pollution

Table 4.8 Estimated subsidies to irrigation in developing countries, 198393

Region	*Annual increase in irrigated land (million ha)*	*Capital cost per unit of irrigated land (US$ per ha)*	*Annual capital investment (million US$)*	*Annual O&M costs (million US$)*	*Total annual costs (million US$)*	*Annual irrigation subsidies (million US$)*
Africa	0.24	23,400	5,710	571	6,281	5,909
Latin America	0.28	11,600	3,271	327	3,598	3,386
Asia	2.28	5,300	12,058	1,206	13,263	12,480
Total	2.80		21,038	2,104	23,142	21,775

Note: Assumptions: operations and maintenance is 10 percent of annual capital investments; cost recovery is 65 percent of operations and maintenance.

Source: Irrigated land from FAO 1994; unit costs from Jones 1995 (adjusted to 1995 prices).

and Environmental Economics Division of the World Bank Environment Department (Rajkumar 1996). The study estimated subsidies for natural gas, coal, and a range of petroleum products for each of the nineteen countries in the sample (excluding Russia). Calculations were done separately for the industrial, power, and residential sectors.

Data Sources

Price and cost data were obtained primarily from sources within the World Bank and the International Monetary Fund, and from International Energy Agency reports, supplemented by data from various government and international organization sources.

Quantity data were obtained from the International Energy Agency. For petroleum products data on traded prices in world markets were used as border prices: Rotterdam spot prices for Europe, Singapore markets for Asia, New York prices for Latin America, Gulf prices for Africa and the Middle East. These prices were obtained from the International Energy Agency and the *Oil and Gas Journal*. For natural gas and coal more country-specific border prices were needed, given the variability across countries. These were obtained from internal World Bank sources and International Energy Agency reports. A complete list of sources is available in Rajkumar (1996).

Price data for the following were available only up to 1994: coal (Czech Republic, Russia, India), natural gas (Iran, Czech Republic), and petroleum products (China). A special effort was made to obtain data for 1996 in cases where significant changes occurred this year, for example, in Venezuela, where gasoline prices rose by more than 500 percent in April 1996.

To ensure consistency and relative accuracy, the data were cross-checked with energy specialists within the World Bank and with other available data sources. Nevertheless, there is a high degree of uncertainty associated with many data on developing economies.

Definitions

For each product in each sector the subsidy estimates are based on the difference between the reference price and the actual end user price, multiplied by the quantity consumed. If the reference price is less than the actual price paid, the subsidy is assumed to be zero.

The total subsidy estimates in table 4.3 and figure 4.1 were derived by summing subsidies across sectors and fuel types. The subsidy *rates* presented were derived by summing all subsidies and then dividing by total dollar consumption at reference prices.

Tradable Products

For readily tradable goods the reference price used was the border price, adjusted for (a) transport and distribution costs, estimated from data from countries with minimal market intervention (such as the United States) and adjusting for country-specific conditions with assistance from Bank energy specialists; and (b) excise, sales, value-added and other taxes on domestically sold goods, which were subtracted from domestic prices if they were imposed at the *end user level* and only on *domestic* sales (taxes that also apply to exports, such as excise taxes on natural gas in Russia, were not taken out).

This approach is not well suited to measuring short-run natural gas subsidies because the infrastructure necessary for exporting more (or at all) is lacking in many countries (for example, in Saudi Arabia). The border price is still a suitable reference price for measuring *long-run* implicit

subsidies, however. Estimates of natural gas subsidies in countries such as Saudi Arabia take capital investment in infrastructure into account, including it (as capital costs)in the transport/ distribution margin, which is subtracted from the border price.

Effects of Falling World Prices

Changes in measured subsidy rates are partly the result of falling world prices, which reduce the gap between domestic and border prices even if the former remain constant. To allow for this effect, 199596 subsidy rates can be re-calculated holding border prices at their 1991 levels (in real terms). The estimated 1995 net subsidy rates for petroleum products and natural gas would then be 19 percent and 48 percent in Central and Eastern Europe; 51 percent and 72 percent for oil producers; 12 percent and 14 percent for other countries; and 18 percent for petroleum products in Asia. The main qualitative difference between these numbers and those in table 4.3 is that natural gas subsidy rates for the oil producers and other countries rise slightly here rather than falling between 199091 and 199596, while natural gas subsidy rates for Eastern Europe remain almost unchanged. For natural gas in the other regions and for the other two fossil fuels, however, subsidy rates still fall on average. Thus, the qualitative results remain essentially unchanged, with some qualifications to be made for natural gas.

Nontradable Products

Exchange Rate

Where available, market rates as reported in the IMF *International Financial Statistics* were used; otherwise, official rates were used.

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PART TWO
EVOLVING INDICATOR THEMES

Chapter 5
Land Quality Indicators

Chapter 2 highlights the role of good quality agricultural land in terms of its asset value and income-generating capacity. This suggests the importance of developing appropriate methods to measure land quality. However, preliminary investigation reveals the complexity of developing meaningful indicators of land quality, particularly at a national level where averages generally have little meaning. It appears that work at the level, of (relatively homogeneous) agro-ecological zones or the local level is more promising.

The purpose of this chapter is to take stock of preliminary work that has been undertaken on land quality indicators (LQIs) and to describe planned work to be undertaken by the World Bank together with the Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the Consultative Group for International Agricultural Research (CGIAR).

In many developing countries fears that land degradation threatens food production capacity have stimulated projects and policies to encourage more sustainable land-use practices. Land degradation problems include soil erosion, salinization, nutrient mining, compaction, organic matter loss, deforestation and forest degradation, and pasture and rangeland degradation (Scherr and Yadav 1996). However, taking action to improve natural resource management is hampered by a shortage of reliable, easily accessible information on the nature and extent of land degradation problems and their productivity impacts. This has been a primary motivation for initiating the land quality indicators program (see box 5.1).

Box 5.1 The land quality indicators program
To better understand land degradation problems, a coalition of international agencies initiated the land quality indicators (LQI) program in 1994. This initiative seeks to develop a set of natural resource *indicators*: statistics or measures that help characterize the condition of natural resources related to land. The organizing agencies for the LQI program include the World Bank, the Food and Agriculture Organization (FAO), the United Nation as Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the Consultative Group on International Agriculture Research. Several other organizations, including the World Resources Institute (WRI), the International Food Policy Research Institute (IFPRI), and other centers of the Consultative Group on Agriculture Research (CGIAR) are also participating.
The LQI program is conceptually similar to earlier national and international efforts that led to the development of standardized indicators of economic and environmental performance. Gross national product, for example, is measured the same way throughout the world, facilitating comparisons across countries. Air and water quality are measured by standard indicators that provide an objective assessment that is applicable in widely differing countries and contexts. The LQI program seeks to develop a set of standardized indicators (mainly focused on the local and district levels) to provide concise, reliable information about the condition of land, including the combined resources of soil, water, vegetation, and terrain that provide the basis for land use (Pieri and others 1995).

Selecting Land Quality Indicators

The key natural resources that are influenced byand in turn influenceagricultural activity, are soils, surface and groundwater, pasture and range, forests and trees, and agro-biodiversity. For each resource policymakers and land managers are often interested in monitoring both quality and quantity and their changes over time.

The complexity of land resources poses challenges that make the development of standardized indicators more difficult than for air and water quality. Weather, terrain, and other biological and physical factors combine to determine production potential of land, which consequently varies by ecosystem. For example, production levels that are considered high for a desert ecosystem may be very low for a humid area. Likewise, all ecosystems are not prone to the same threats. For example, soil salinization is a prime concern in many irrigated areas, but is irrelevant in most tropical hillside environments. Accordingly, different LQIs may be needed for distinct agro-ecological conditions. The specific indicators that are ultimately selected by different users are likely to vary considerably, depending on the scale, ecozone, agricultural system, available resources, available data sources, and other factors.

Box 5.2 presents a set of pressure, state, and response indicators for selected land quality issues (see Adriaanse 1993 for a more detailed dis-

Box 5.2 Examples of soil-related land quality indicators for pressure (P), state (S), and response (R)

Soil erosion

P: Cultivated area in zones of high erosion potential or impact
Pasture areas grazed in zones of high erosion potential
Forest understory exploited in zones of high erosion potential
Density of roads in zones of high erosion potential
Area deforested in zones of high erosion potential
Area without perennial soil cover during critical erosive periods
Lack of vegetative protection of waterways

S: Annual soil loss (measured, or predicted by model)
Incidence of gullying
Sedimentation levels in rivers or behind dams
Deposit of sediment in coastal areas
Amount of silt deposited on agricultural lands
Area with soil depth reduced to less than 10 centimeters

R: Area protected by conservation practices or landscape features
Revegetation and structural protection of waterways
Farmers served by soil conservation programs
Farmers using selected soil conservation practices
Change in land use to more or less erosive practices
Total value of soil conservation programs
Operational area under soil management plans

Soil quality

P: Ratio of cultivated to cultivable land
Net nutrient extraction in cropland, pastures, and forests
Area under nonconservation tillage practices
Area under poor crop residue management

S: Level of organic matter, by soil type or area
Level of nutrients, by soil type, area, or use (direct measures or models)
Area occupied by indicator plants
Water-holding capacity
Land productivity adjusted for input use

R: Fertilizer and manure applications, by soil type or area
Area covered by sustainable nutrient applications
Farmers, groups, or area participating in soil improvement programs
Farmland abandoned
Change to crops with lower nutrient requirements
Adoption of conservation and zero tillage practices

Similarly detailed preliminary indicators of pressure-state-response have been identified for other characteristics (soil salinity and alkalinity, ground and surface water supply, water quality related to land management, pasture quality, forest area, forest quality, and agrobiodiversity) but are not shown here due to space constraints.

cussion of the Pressure, State, and Response Framework). These are examples only, and normally not all of these indicators will be relevant in any particular situation.

Theories of causality about land degradation are related mainly to human management. Some of these theories are not verified empirically; hence the selection of pressure indicators is an area for further research, and the current thinking presented here is preliminary. National population density, for example, is not used as a pressure indicator because increases in density do not directly place pressure on resources. Rather, it is land-use practices actually used that result in the pressure. People could be moving to cities or to nonagricultural occupations. Or the presence of more people may lead to more resource-conserving investment.

The state indicators were selected as representing the condition, at a point in time, of the resources that are of greatest economic, ecological, or social importance. The response indicators were designed to include both formal program responses and individual or household management responses, as well as other types of adjustments that result from the change in resource state (for example, changes in diet, changes in fuel use, emigration, or land abandonment).

Selecting Indicators

Policymakers (at local, project, national, or international levels) are the main audience for LQIs. Indicators should be easily understood and transparent. Together the set should tell a "story" about the pressure and response sequence and let policymakers know whether policies are working or not. Indicators should give reliable signals of important trends in the actual situation. They need to be comparable across time. It would be useful to have an indication not only of the "average" state, but also of variability around that average. In some cases it may be useful to use thresholds, that is, it may only be important to know whether the condition of a resource falls below a particular level. Nutrient balance is an example of such an LQI (see box 8.5).

An objective is to seek the lowest-cost indicators that serve the purpose. In some cases these may be surrogates or proxies of actual land quality variables. For example, certain plant species may grow only on degraded soils. Thus, the indicator for soil degradation might be the extent of area growing that indicator plant, which is fairly easy to monitor, rather than soil nutrient status, which is more expensive. Local people may have common indicators of natural resource conditions. Use of participatory methods to define and collect indicator information could serve not only to decrease the costs of monitoring, but also to engage local people more deeply in resource assessment.

The indicators presented in box 5.2 are in generic terms. A particular indicator, for example, "sedimentation levels in rivers," is likely to be important in many land quality monitoring schemes. However, the particular indicator chosen may vary, depending on the relative importance of that variable, and the degree of precision that monitors can afford or need to have. That is, the indicator may range from a qualitative assessment by river basin experts (high, moderate, low), to a quantitative measure of sediment levels behind important dams, to a measure of sediment levels in different parts of a river basin based on sophisticated sampling and instrumentation and transformed into an index of river-basin-wide status.

Interpreting Land Quality Indicators

The policy implications of changes in LQIs cannot be judged on the basis of individual indicators. Rather, the monitor must assess trends in sets of LQIs in order to determine whether or not the indicator is signaling a significant change. For this reason box 5.2 suggests a number of different indicators for pressure, state, and response for each land quality issue; the appropriate choice depends on the local situation, available data, and sensitivity to possible confounding factors that would affect interpretation.

LQIs should be interpreted in the context of broader trends in the region. A major increase in fertilizer use might be seen as a positive indicator of land improvement under conditions of stable agricultural land area. But if land expansion is taking place at a much faster rate than fertilizer use, then net nutrient depletion may still be occurring. Also, one would expect to see quite different problems and potentials in areas of the

same agro-ecozone that had different levels of population density and market access.

For these reasons contextual information must also be collected to interpret LQIs (box 5.3). The focus is on key population, economic, and land base characteristics. Wherever possible this informationas with the LQIsshould distinguish between different agro-ecological zones so as to tell a more accurate and policy-relevant story of land quality pressures, state, and response.

Testing the Land Quality Indicators Approach

Case studies were undertaken to see to what extent LQIs can be developed on the basis of existing data and to identify key issues for the development of LQIs and the direction in which we need to move in the future to improve them.

National-Level Case Studies

The World Resources Institute (WRI) explored the use of LQIs at the national level for three countriesHonduras, Niger, and Vietnamusing internationally available data sets. These depended primarily on FAO statistics and statistics collected by WRI for its annual report on the state of world resources.

Box 5.3 Examples of contextual information to assist with the interpretation of land quality indicators
Population Rural population density for total or arable land Rural poverty index
Markets Road density (all-weather, feeder) Degree of commercialization of agriculture Density of agricultural input outlets Real agricultural, livestock, forest input to output price ratio (for key products) Value of total production (agriculture, livestock, forestry) Farm size distribution (for example, Gini coefficient)
Land Area of cropland, pasture, forest Intensity of agricultural land use (for example, 'R' ratio) Agricultural land under irrigation Livestock population density Livestock feed resources Average yields for key products Land tenure categories

This search found only a limited number of indicators that could be used. The only pressure indicators available were related to changes in land use and levels of forest extraction and livestock population. With the exception of forest area and crop yield there were no data available from international databases to be used as state indicators.

Crop yield is a somewhat problematic indicator for land quality since yield has so many determinants. Given that the key land-quality policy question is to assess the extent to which yield changes are affected by changes in underlying land quality, relative to other factors, it is generally not appropriate. With the exception of fertilizer use for soil quality and the establishment of protected areas for forestry, no internationally available response indicators were identified. The preliminary conclusion from the case study work at the national level is that not many useful insights can be gained from existing information in international databases. However, there is much more national-level data available that could be adapted for international comparisons.

District-Level Case Studies

The International Food Policy Research Institute (IFPRI) explored LQIs at the district level for the Central Hillsides Region of Honduras and Jhabua District of India. Both regions are homogeneous agro-ecological zones in which IFPRI researchers had field experience. District data were drawn from national, subnational, and local sources. LQIs were developed for land quality problems identified to be most important in each region.

Information from Honduras showed that forest area declined by more than a third in the studied region between 1965 and 1982, although the proportion of forested area on farms remained quite stable. Protected areas, which cover over 8 percent of the land area, are mainly forested. Forest quality is a serious problem. Commercial logging concessions were stopped after 1992, and timber production is fairly low. Data from the Honduran Forestry Development Bureau, however, suggest a sharp increase in timber produc-

tion in the Department of Francisco Morazán after the 1993 Forest Law was enacted. Forest density is low over a large area (often reflecting transition to silvopastoral systems, usually with little management). Resin production is declining. A low but increasing proportion of resin collectors are using less damaging methods.

In the Jhabua district in India soil erosion appears to be widespread, as might be expected from the pressure indicators. However, no data are available concerning the extent of continuing soil erosion and little is known about the extent of soil conservation practiced in this area. Soil loss on eroded land is estimated to have reduced productivity by up to a third (Sehgal and Abrol 1994). Some evidence suggests that most soil conservation programs have had limited effectiveness, in which case they provide a poor indicator of farmlevel response (Pretty and Shah 1993). Decline in soil nutrients is a common problem when tropical forests with naturally infertile soils are cleared for agriculture. Originally, soil nutrients were restored through extended fallow periods. Over the last several decades, however, even shortterm fallowing has been nearly abandoned due to the high demand for land.

Fertilizer use is growing rapidly in Jhabua, but remains very low. Data on organic matter applications are not available. The overall trend in India is of declining manure applications due to the high value of dung for use as fuel. Limited data on the state of soil nutrients are available from measurements conducted by the National Centre for Human Settlements and Environment (1993) study, although the sample is small (only 22 observations for the whole district). Organic matter and nitrogen content are uniformly low, while phosphorus content is highly variable.

During these preliminary case studies it was not possible to estimate many of the indicators presented in box 5.2. Data on the state of land resources were very limited and usually taken from small samples. Vegetative cover data from remote sensing were found for both regions but had not been analyzed in a useable way. Response variables were widely found for responses related to government programs, NGO projects, and other formal interventions. With the exception of Agricultural Census data on selected practices and special one-time community and field surveys, however, there was little accessible information on farm-level response in terms of either resource management or adjustments in consumption or livelihood due to changes in the resource base.

Data Issues

The subnational case studies illustrated that there are data that could be mobilized for the development of LQIs. Many national agencies, development programs, projects, donors, and scientists regularly or irregularly collect data on different pressure, state, and response variables. Access to these data sets, however, is often difficult. Data collected by consultants and donors may be considered confidential or proprietary, and for some public agencies information is power, not to be widely circulated. Public agencies have weak archiving capacity, and important data sets are often found only with the individual who was in charge of collecting them. Data sets start and stop with access to funding.

Finding out the proper definition (and hence, interpretation) of particular indicators can also be difficult for subnational case studies, even for basic data sets such as the Agricultural Census. This is particularly important in the development of historical data sets, as definitions and data collection methods often change over time, affecting interpretation of trends.

An important contribution of the LQI program would be to identify a defined set of indicators, formalize responsibility to particular groups for the collection and reporting of information on an ongoing basis, and compilation at regular intervals for public access. Availability of such LQI series could substitute for much of the effort that currently goes into baseline and monitoring data collection for projects.

Existing Data Sources

Agricultural censuses and surveys provide a key source of data related to land quality, particularly

pressure and response variables, although they often need additional analysis. They also offer a potential for eventually integrating additional LQIs as part of ongoing national data collection programs.

Another source of data for LQIs is remote sensing. Satellite imagery can be interpreted to assess vegetative cover, moisture levels, forest density, agroforestry practices in farmland, and other variables. Aerial photograph series over time can be used to assess changes in land use, some land investments and land management practices, and changing spatial patterns.

Missing Data

A comparison of the LQIs available for the case studies and box 5.2 with the preferred LQI variables highlights several critical gaps. For certain types of *pressure variables*, few direct, indirect, or proxy indicators were found. Most important was the lack of data to link pressures (land-use, management) to particular types of land geographically. In Honduras and Jhabua it is critical for the assessment of erosion hazard to determine how much cropping takes place on the steeper slopes. But without georeferenced land-use information, even existing geo-referenced data sets on topography and land use potential cannot be used. A second category of missing information relates to biomass removals from pasture and forests and use and extraction of water.

Direct measures of the resource *state variables* are particularly weak. These are variables such as soil loss, sedimentation, organic matter, and groundwater levels that require technical monitoring. This does not mean that detailed, quantitative technical surveys are necessary; in some cases one can use low-cost proxy indicators (for example, number of communities reporting water quality problems, rather than direct sampling and laboratory analysis of water quality). Finally, a critical state variable is vegetative cover for assessing soil, pasture, and forest condition.

The main missing LQIs for the *response variables* are related to actual resource management practices by farmers or other users. While there are many proxies or qualitative indicators that might be applied to some of these variables, they still require field data collection through surveys, group interviews, or systematic observation points. If these are not done, then key LQIs cannot be constructed.

Further Development of Land Quality Indicators

Spatial and Geographic Issues

Land quality issues, by their nature, are geographically specific. "Average" fertility levels provide a poor basis for policy if in some areas soils are very fertile and elsewhere they are depleted. Identification of the "hot spots" for land degradation is especially important. The ecological function and impact of land management practices will differ depending on where in the watershed or forest these are used. New techniques for georeferencing data collected in the field, for analyzing remotely sensed images, and for analyzing "layers" of spatiallyexplicit data through geographic information systems, offer the potential for lower-cost and more powerful LQIs. As a matter of fact, LQI data are already being used to prepare land systems maps for agro-ecological zoning purposes. For example, in Indonesia both the World Banksupported National Master Plan for Forest Plantations and some Overseas Development Administration supported projects have resulted in the detailed mapping of soil suitability and erodability for most of Sumatra and Kalimantan. These data can be used for planning purposes.

Integrating LQIs at Different Scales

A critical challenge in the development of LQIs is their definition and integration at different scales. In this chapter we have principally addressed the LQIs needed for agro-ecological zones or district scales. Indicator data collected at local levels were aggregated for analysis at the higher scale. Yet one of the most important potential uses of LQIs is at the local or community level. Potentially,

data collected at this level could be relatively low cost and higher quality than data collected by disinterested regional agents. "Grassroots" indicators could prove to be inexpensive proxies for key LQIs.

Research Needs

Obtaining usable and reliable LQIs requires development and testing. In some cases this will mean testing different indicators against one another, in terms of effectiveness cost, and accuracy. In other cases studies will need to compare alternative measurement methods or assess the reliability of proxies. Conceptual and experimental work will probably be needed to sort out the sampling strategies for LQIs at different scales. Coordinated pilot efforts to develop LQIs for a range of agro-ecological zones, at various scales, should permit fairly rapid development of basic indicator sets. In the long run more basic research is needed to evaluate the relationships between particular pressure or response factors and the state of the resource and to identify biophysical and economic thresholds beyond which key land qualities can be expected to change qualitatively. The LQI process itself may help point to priority issues for these types of research. To maintain both the technical integrity of the indicators and their relevance for policymakers, the main research thrust for LQIs should remain interdisciplinary.

Institutionalizing Land Quality Indicators

The development, collection, analysis, and regular distribution of LQIs will require some reordering of institutional arrangements. Data collection for LQIs could be integrated in or "piggy-backed" onto already existing institutions such as census bureaus; household, farm, or community surveys; or watershed management monitoring. The analyses and reporting of the LQIs could then be achieved inexpensively through existing institutions. However, this would require training and national capacity building on sampling and data collection, as well as on data standards, data compatibility, and development and maintenance of computerized information systems.

Conclusions

Any new data collection effort must be carefully targeted to produce policy-useful indicators. Specifically, will the proposed indicator flag the need for a possible change in the type of intervention, the location of intervention, the target population for intervention, the target beneficiaries of intervention (for example, if externalities are the main policy issue) or the intensity of intervention? Ideally, LQIs would flag "hot spots" where land quality problems are having, or are likely to have, significant productivity, social welfare, or ecological effects.

Expectations about LQIs should be realistic: LQIs provide the raw data for analysis, but even when sophisticated indices are used, they do not provide analysis and interpretation. Internationally comparable national data do not, at present, provide useful LQIs. It is therefore sensible to start at the subnational level and identify the most relevant, reliable, and cost-effective approaches to indicator development. Aggregation to the national level would be the next step. Meanwhile, a meaningful framework for international comparison, on an agro-ecological zones basis, can be developed as lessons are learned from pilot efforts at subnational LQI development.

The process of developing LQIs also highlights shortcomings in available data and knowledge of production systems. As such the LQI approach potentially provides a useful framework for identifying new research priorities, and the potential context for applying research results.

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Chapter 6
Social Capital: The Missing Link?

Sustainable development has been defined as a process whereby future generations re ceive as much capital per capita asor more thanthe current generation has available (Serageldin 1996a, 1996b). Traditionally, this has included natural capital, physical or produced capital, and human capital. Together they constitute the wealth of nations and form the basis of economic development and growth. In this process the composition of capital changes. Some natural capital will be depleted and transformed into physical capital. The latter will depreciate, and we expect technology to yield a more effident replacement. This century has seen a massive accumulation of human capital.

It has now become recognized that these three types of capital determine only partially the process of economic growth because they overlook the way in which the economic actors interact and organize themselves to generate growth and development. The missing link is social capital. At this broad level of conceptualization there is little disagreement about the relevance of social capital. There is, however, no consensus about which aspects of interaction and organization merit the label of social capital, nor in fact about the validity of the term *capital* to describe this. Least progress has been made in measuring social capital and in determining empirically its contribution to economic growth and development. This chapter will address each of these issues in turn. 1

The Concept of Social Capital

Case 1: The high growth rates of the East Asian "miracle" economies, relative to other parts of the world, can only in part be explained by conventional factors such as investments in human and physical capital and technology. Government policies provided an enabling environment, characterized by institutional arrangements and organizational designs that enhanced efficiency, exchange of information, and cooperation between government and iridustry (World Bank 1993; Stiglitz 1996).

Case 2: In a study of Italy Putnam argues that the higher density of voluntary associations among people in northern Italy explains the region's economic success relative to southern Italy, where such associations are less frequent (Putnam and others 1993).

Case 3: After the 1991 fall of Somalia's government civil disorder prevailed and incomes declined throughout most of the country. An exception was the port city of Boosaaso, where a local warlord organized a security force and a council of clan elders with support from local people. Trade flourished and incomes improved (Buckley 1996).

Case 4: In Gujarat, India, violent confrontations between local people and government officials over the way forests were managed led to economic stagnation. After communities were mobilized and joint forest management was instituted, conflicts declined and land productivity and village incomes rose (Pathan and others 1993).

Each one of these cases displays an aspect of social capital and its contribution to economic growth.

The term *social capital* has found its way into economic analysis only recently, although various elements of the concept have been present under different names for a long time. The economic literature on the role of institutions, which goes back at least to the 1920s, is especially relevant. The focus on institutions has been revived recently in the "new institutional economics" literature. In the political science, sociological, and anthropological literature social capital generally refers to the set of norms, networks, and organizations through which people gain access to power and resources, and through which decisionmaking and policy formulation occur. 2 Economists have added the focus on the contribution of social capital to economic growth. At the microeconomic level this is seen primarily through the ways social capital improves the functioning of markets. At the macroeconomic level institutions, legal frameworks, and the government's role in the organization of production are seen as affecting macroeconomic performance.

The most narrow concept of social capital is associated with Putnam (Putnam 1993; Putnam and others 1993). He views it as a set of "horizontal associations" between people: social capital consists of social networks ("networks of civic engagement") and associated norms that have an effect on the productivity of the community. Two empirical presumptions underlie this concept: networks and norms are empirically associated, and these have important economic consequences. While originally this concept of social capital was limited to associations having positive effects on development, recently it has been relaxed to include groups that may have undesirable outcomes as well, such as associations with rent-seeking behavior (for example, the Mafia in southern Italy) and even militia. The key feature of social capital in this definition is that it facilitates coordination and cooperation for the mutual benefit of the members of the association (Putnam 1993).

This relaxation of the concept brings it a big step closer to operationalization and measurement. In principle it is fairly straightforward to count civic associations, their membership, and the number of times they meet. However, if such associations are only considered as social capital if they achieve desirable outcomes, this implies that somehow agreement must be obtained on what constitutes desirable outcomes. Further, it needs to be determined whether each association strives in effect for such an outcome. In practice there are likely to be major judgment and consensus-building problems associated with constructing a list of desirable outcomes and the effort may well not be feasible in most settings.

A second and broader concept of social capital was put forth by Coleman (1988),3 who defines social capital as "a variety of different entities, with two elements in common: they all consist of some aspect of social structure, and they facilitate certain actions of actorswhether personal or corporate actorswithin the structure" (p. 598). This broadens the concept to include vertical as well as horizontal associations, and also the behavior among other entities such as firms.4 Vertical associations are characterized by hierarchical relationships and an unequal power distribution among members. Clearly, this wider range of associations covers a wider range of objectivespositive as well as negative. Coleman is explicit about this: "A given form of social capital that is valuable in facilitating certain actions may be useless or even harmful for others" (p. 598). In fact, this view of social capital captures social structure at large, as well as the ensemble of norms governing interpersonal behavior.

A third and most encompassing view of social capital includes the social and political environment that enables norms to develop and shapes social structure. In addition to the largely informal, and often local, horizontal and hierarchical relationships of the first two concepts, this view also includes the more formalized institutional relationships and structures, such as government, the political regime, the rule of law, the court system, and civil and political liberties. This focus on institutions draws on North (1990) and Olson (1982), who have argued that such institutions have an important effect on the rate and pattern of economic development.

How Does Social Capital Affect Economic Outcomes?

There is growing evidence that social capital, under any of the three definitions, can have an impact on development outcomesgrowth, equity, and poverty alleviation. Associations and institutions provide an informal framework to organize information sharing, coordination of activities, and collective decisionmaking. Bardhan (1995) has argued that what makes this work is peer monitoring, a common set of norms and local-level sanctions. The well-known case of the Grameen Bank in Bangladesh illustrates how these factors can be used to overcome the poor's lack of access to credit markets. However, Bardhan also warns against overstating the role of local institutions: local overlords may find it easy to capture local institutions, externalities of development may surpass the working area of local institutions, and they may have little or no revenue-raising capacity. Hence what is needed is a balanced view of the role of the central, state, and local-level institutions. This suggests that three definitions of social capital are not really alternative views, but rather complementary dimensions of the same process (box 6.1).

Information Sharing

Group-based lending schemesfrom tontine in West Africa to the Grameen Bankwork because members have better information on each other than banks do. In general, information problems can be particularly severe in capital markets. One response was the so-called Deliberation Councils in Japan and Korea, which managed competition among firms for credit and foreign exchange in a transparent process that encouraged cooperative behavior and information sharing among firms by taking away incentives for rent-seeking behavior (World Bank 1993; Campos and Root 1996). The rule of law and a well-functioning court system (elements of social capital in its broadest definition) also contribute to reducing uncertainty by enforcing contracts and thus providing a priori information to contracting parties about the penalties for noncompliance. In the absence of effective courts many informal associations internalize this policing role for their members. A striking example is that of diamond merchants, who often trade millions of dollars worth of diamonds with a handshake. However, failure to deliver will irrevocably lead to expulsion from the groupand all members realize this. Unfortunately, this mechanism also

Box 6.1 Three views on social capital: common features
The three views on social capital broaden the concept from mostly informal and local horizontal associations to include hierarchical associations and formalized national structures, such as government and the rule of law. Yet they share several common features:
All link the economic, social, and political spheres. They share the belief that social relationships affect economic outcomes and are affected by them.
All focus on relationships among economic agents and how the formal or informal organization of those can improve the efficiency of economic activities.
All imply that "desirable" social relationships and institutions have positive externalities. Because these cannot be appropriated by any one individual, each agent has a tendency to underinvest in social capital; hence, there is a role for public support of social capital building.
All recognize the potential created by social relationships for improving development outcomes but also recognize the danger for negative effects. Which outcome prevails depends on the nature of the relationship (horizontal versus hierarchical) and the wider legal and political context.

works for groups pursuing "undesirable" outcomeswhich makes criminal mafias more efficient as well.

The information-sharing role of social capital is of key importance for poverty alleviation. The case of mutual credit groups is one important example. These groups permit the poor to overcome one of their main constraints, namely access to credit. The poor also generally have limited ability to cope with risk and hence are more vulnerable to income fluctuations. Access to insurance against future calamities is an important aspect of their survival strategy. As with credit, the poor can usually not access the formal insurance market, and local associations can provide an informal substitute. Often this occurs within a kinship context and consists of a series of mutual obligations and rightsthe rural-tourban migrant sends money back to his village of origin, but can count on food shipments from the village if he encounters hard times. A farmers' cooperative agreeing to share resources in case of a harvest failure is another example. Donor agencies concerned with poverty alleviation can enhance the effectiveness of their strategies by stimulating the formation of social capital as part of these strategies. Nevertheless, it needs to be pointed out that mutual credit and insurance groups have limitations. In particular, they are vulnerable to groupwide shocks (for example, weather problems), which more formal credit and insurance mechanisms would be able to diversify against.

Coordination of Activities

Associations reduce opportunistic behavior by creating repeated interaction among individuals, which enhances trust (Dasgupta 1988). This "backward-looking" motivation for trust has been discussed in the social psychology literature. Trust can also be "forward looking" and based on the perception of retaliation in case of untrustworthy behavior. This basis for trust has been the subject of game theory. It is not always necessary (though often preferred) that interaction among individuals occurs in the same activity where a risk for opportunistic behavior exists. For example, repeated credit transactions among the members of a tontine will strengthen trust, reduce uncertainty about repayment behavior, and in effect reduce transaction costs overall. However, members of a soccer club who regularly play together may still be more inclined to lend money to each other than to strangers, even though here the potential penalty is less: exclusion from the soccer club may have less serious consequences than exclusion from the tontine. A cohesive association creates trust7 and changes, in a way, the identity and the objective function of the economic agent: utility of the group is partly or wholly substituted for personal utility, and it is the former that is maximized. Although this can occur in horizontal and vertical associations, the creation of trust and reciprocity is more likely in horizontal groups, especially those based on kinship or other dense networks (for example, based on gender, ethnicity, or caste). For that reason, for example, the Grameen Bank as well as many informal rotational savings and credit associations rely primarily on groups of women.

One implication of a trust-based functioning of networks and associations is that it is helped by stability of membership and damaged by mobility. Adevelopment path characterized by massive rural-to-urban migration thus runs the risk of eroding social capital. Rural associations may be thinned out by departing members and lose critical density. Urban areas may not readily provide a suitable environment for recreating these associations. However, in some cases migrants have formed urban groups (often along ethnic

lines or by common region of origin) to share information about available jobs and to channel this information back to their place of origin to help prospective migrants. Like migration, involuntary resettlement due to dams or other development projects can damage social capital.

Ironically, the efficiency of markets itself may also undermine the existence of networks in the long-term. Large anonymous markets can be more efficient than networks because the best buyer or seller may not be part of the network. If the development path is supported by a solid court system and contract enforcement, anonymous markets will replace the "named" transactions within networks over time, with gains for all participating economic agents. If one adheres to a narrow definition of social capital, this will be registered as a decline of social capital. But in the broader concept the same phenomenon will be seen as substitution of one form of social capital (the rule of law) for another (horizontal associations). This provides one reason why a broader definition of social capital seems preferableto better understand the social dynamics that accompany economic development.

Collective Decisionmaking.

This is a necessary condition for the provision of public goods and the management of externalities to market processes. It is a basic raison d'être for government. However, just as not all government decisions are in the best interest of their constituencies, local and voluntary associations do not always effectively maximize their joint utility. The extent to which they do this depends upon how well they address the information and incentive problems discussed earlier. One important aspect of this is equity.

There is some evidence that local institutions are more effective at enforcing common agreements and cooperative action when the local distribution of assets is more equal and the benefits are shared more equally. This then provides a "local" case of how efficiency and equity go together: better sharing provides an incentive for better coordination in managing local public goods, which increases productivity for everyone.

A Caveat.

A word of caution is necessary following this discussion. Social capital is no panacea for all market failures or impediments to development due to information, coordination, or collective decisionmaking problems. There are many examples of local associations that have made a positive difference. However, by themselves these associations may not always matter. If a village lacks economic opportunities, credit associations may not be able to raise incomes. This is simply to say that social capitallike natural, physical, and human capitalhas limited value if not combined with other forms of capital. One important attribute of social capital is that it can make the other types of capital and their productive combination more efficient. We return to this point in the next section.

Macro-Level Social Capital.

Civic associations promote efficient market outcomes by sharing information, aligning individual incentives with group objectives, and improving collective decisionmaking. This microfocus on markets is, however, only part of the story. Even if social capital is defined only at the microlevel (the narrow definition, of horizontal associations, or the intermediate definition, which includes hierarchical associations), it must be recognized that market outcomes are influenced by the macroeconomic and political environment as well. The latter can be an enabling environment, enhancing the effect of civil associations (as was arguably the case in the East Asian success stories) but the macro environment can also damage or undo the effect of local-level social capital. Just as it makes little sense to assess a given investment project without looking at its sector as a whole and the relevant macroeconomic policy environment, it makes little sense to consider local associations in isolation.

The ways in which social capital affects macroeconomic outcomes have been investigated in the "new institutional economics" framework associated with North, and with the "aggregated social capital" argument associated with Olson. The basic argument is that differences in per capita incomes across countries cannot be explained by the distribution of productive resources per capita: land and natural resources, human capital, and produced capital (including

technology). However, countries also differ in institutions and other forms of social capital and in public policies. These determine the returns that a country can extract from its other forms of capital. Olson argues that low-income countries cannot obtain large gains from investment, specialization, and trade (even if they have a large resource base) because they lack the institutions that enforce contracts impartially and secure property rights over the long run, and because they have misguided economic policies.

The importance of macro-level social capital is illustrated dramatically in some of the transition economies of Eastern Europe and the former Soviet Union. The sudden disappearance of government from many social and economic functions has led to a collapse of trust and forced people to rely on local networks and informal associations. Richard Rose's "new democracies barometer" has attempted to measure this phenomenon (Rose 1995b). One effect is the withdrawal of people from the "official" economy and the reliance upon multiple informal economies to satisfy most needs. Informal activities include growing food, repairing houses, and exchanging help with friends. While in a well-functioning market economy these activities may be a hobby or a reflection of friendship, in transition this "social economy" exists out of necessity. In Ukraine, for example, three-fourths of the households are involved in such activities (Rose, 1995a). In Russia the transition has led to what Rose has called an "hourglass society" (Rose 1995c). At the base there is a rich social life, consisting of strong informal networks relying on trust between friends and on face-to-face interaction. The Russian proverb, "A hundred friends are worth more than a hundred rubles," epitomizes the importance of these networks. At the top there is also a rich political and social life among the elite, who compete among themselves for power and wealth. However, the links between top and base are very limited and are characterized by civic distrust by the base. Fewer than one in three Russians expect fair treatment by the police or their municipal office (the post office is the most trusted institution). It is difficult to conceive of sustainable economic growth in Russia without a change for the better in the linkages between micro- and macro-level institutions.

Is It Capital?

The examples given so far make it clear that social capital is an input into the development process together with the other forms of capital. However, it is also an output of this processa feature it shares with human capital. Education is worth pursuing for its own sake, and a welleducated population is an important outcome of successful development. Likewise, many people would agree that a rich network of civic associations and a well-functioning set of government institutions are worth having, independent of their effect on future economic growth. Human and social capital thus share the attribute that they are simultaneously a consumption good and an investment. The critical difference is that education can be embodied in one individual and can be acquired by one individual regardless of what other people do. By definition social capital can only be acquired by a group of people and requires a form of cooperation among them.

This gives social capital an inevitable public good character and has implications for its production (Coleman 1988, 1990). In particular, like all public goods, it will tend to be underproduced relative to the social optimum unless the group responsible for its production can internalize the externality involved. This is why horizontal associations, characterized by equitable power sharing among members, tend to be more successful at generating social capital. Members are more likely to contribute because they have a better chance of obtaining their fair share of the benefit.

Clearly then, in most cases it is not costless to produce social capital. It requires resourcesespecially time. The amount of social capital that will be produced is therefore in part a function of the opportunity cost of time and the expected return from the social capital (that is, the extent to which an economic agent will enjoy the public good that is created). Which group is best suited to producing social capital depends largely on the scope of the created externality and thus the size of the group needed to internalize it effectively and avoid free riders: in the case of tontine it is local; in the case of the rule of law it is national and the central government needs to play the essential role. However, as an externality, social capital can come to be a by-product of other pro-

duction processes. For example, if the workers in a factory develop associations for leisure activities, which in turn reduce crime in the neighborhood, the "cost" of bringing people together and developing trust is largely absorbed in the factory's production process. Certainly, the cost is less than if those associations were to be created by people not knowing each other through a common workplace.

While there is a growing body of empirical evidence on the benefits of social capital (see next section), there are very few data on the cost side. In part this has to do with the difficulties of measuring social capital. It is easier to determine the cost of a machine or building, because it is well defined, than the cost of creating an association or a certain level of trust. However, investment decisions for social capital, like any form of capital, require a comparison of costs and benefits. This comparison is done implicitly by the individuals who set up or join an association, but governments, donors, or other institutions who wish to invest in social capital may well want to make more explicit calculations. As a first step this will require improved operational definitions of social capital.

The process of producing economic growth requires the combination of different types of capital. Social capital is one of them, but it has a unique feature in that it also enhances the efficiency of the combination process itself. In Putnam's (1993) words: "Social capital enhances the benefits of investment in physical and human capital" (p. 36). In other words it is not just an input into the production function, but it is also a shift factor (or exponent) of the entire production function. As such it is more akin to technology.

The application of social capital in development is not a distribution-neutral process. The better organized segments of society may well succeed in affecting economic policy to their own advantage and to the detriment of other groups or even to society at large. There can be significant concentrations of social capital in some communities with few ties to other communities. Social capital accumulation can be segmented along spatial or ethnic lines (Fox 1995). In principle there is thus no guarantee that enhancing social capital will lead to a more equitable society. This is similar, of course, to what has happened historically when human capital accumulation started: initially, when education was an elite privilege, it led to increased inequality of economic outcomes. The more the acquisition of education became universal, the more the distribution of economic benefits became equalized. Although this has not yet been demonstrated empirically, the same process is likely to happen with social capital. The more widespread it is, the more likely it will contribute to achieving equity.

Although, as we have argued, social capital can promote and sustain economic development in many ways, it should be emphasized that the historically and cross-sectionally strong correlation between human capital acquisition and levels of development has not yet been demonstrated empirically for social capital. No country has achieved sustained economic growth without high levels of education, but some highly developed economies have low and arguably declining levels of social capital, as measured, for example, through rising crime rates, declining family and kinship cohesion, and falling trust in government, and participation in the political process. Analysis by the Inter-American Development Bank suggests that in some Latin American countries the paths of economic development have so weakened prior social and institutional relationships that the resulting potential for social conflict may undermine sustainable economic growth. Such situations underline the need for interventions aimed at offsetting eroding social capital and creating new forms of social capital conducive to sustainable development.

Measuring Social Capital and Its Impact

Measurement presupposes that one can define fairly well what needs to be measured. As the previous section indicated, definitions of social capital vary greatly. This makes it inherently difficult to propose a list of indicators for social capital. They will have to evolve as the conceptual definition and, more important, the operational definition of social capital are developed. Meaningful use of indicators requires a conceptual framework within which they can serve to assess a current state, to measure linkages between policy and outcome variables, and to assess policy

Box 6.2 Desirable properties of indicators
The following is a nonexhaustive list of properties that indicators should possess. Indicators must: Be developed within an agreed on conceptual and operational framework Be clearly defined and easy to understand Be subject to aggregation (from household to community, from community to nation) Be objective (be independent of the data collector) Have reasonable data requirementseither available data or data that can be collected at limited cost and within the capacity of the country's statistical apparatus Have "ownership" by users Be limited in number Reflect input, process, or outcome (or, as used in the environment literature, pressure, state, response).

options (box 6.2). Such a framework is further advanced for the narrower definitions of social capital (micro-institutional in focus) than for the broader definitions, which attempt to link institutions at the macrolevel with economic outcomes. One can thus expect to define a more suitable set of indicators for the notions of social capital that focus on horizontal and hierarchical local associations. Of course this does not imply that actual data exist more abundantly at that level. Practically, the selection and development of indicators for social capital can proceed along two lines: (1) according to the breadth of relationships and institutions involved; and (2) according to the types of impact social capital has on the development process, in which the key dimensions are growth, equity, and poverty alleviation.

For the narrowest concept of social capital, one can inventory civic associations and their attributes (number of members; frequency of meetings; dimensions of membership along ethnic, kinship, or other lines; type of decisionmaking). In practice such inventories are rarely available, and one typically gains insights into them only through anthropological or sociological case studies, which tend to have a limited geographical focus. The value of such studies lies primarily in analyzing the dynamics of creating associations (how, why, and by whom are they created?) and their effectiveness. As such they are a complementary effort to that of inventorying associations.

Work is currently under way at the World Bank to collect data for a profile of local institutions in twenty countries. The context is how decentralization can help in implementing effective rural development strategies and whether it results in better targeting to the poor. The study aims to collect data on the institutions that function at the local level in the provision of various services (health, education, agricultural extension, water supply, forestry). These institutions include nongovernmental organizations (NGOs) as well as the local political and administrative organization. In three countries (Bolivia, Burkina Faso, Indonesia) this profile will be further detailed and supplemented with data at the household level. Specifically, the extent of household participation in different local organizations, and the way in which the organizations contribute to different dimensions of household well-being will be explored through a household survey. In order to find out which associations have the most impact on development outcomes and how they do so, detailed information on the associations will be collected: type of organization (formal or informal), degree of internal homogeneity (by gender, ethnicity, occupation), membership requirements, and the type of services provided. The availability of measures of economic and social outcomes, at both the village and the household level, will make it possible to test empirically hypotheses regarding the impact of social capital on poverty, effectiveness of public programs and projects, and access to health, education, and credit.

For the intermediate conceptualization of social capital, which includes hierarchical associations, the same indicators of associations can be used, except that they now cover a wider range of social relationships. In the macro conceptualization, legal and judicial systems and aspects of government functioning (such as the ability to enforce contracts) all become part of social capital. This approach solves, in part, the measurement problem because the social norms and networks are anchored in an institution or other "visible" structure that can be identified.

Clearly, to capture the full scope of social capital, measurement has to occur and indicators need to be developed at the micro and macrolevels. At the microlevel the impact of social capital is to be assessed primarily by the ex-

tent to which the association or institution contributes to making more efficient market outcomes possible (by reducing information or incentive problems) or to providing the "optimum" amount of public goods (by making collective decisionmaking more efficient). Obviously, it is very difficult to measure this empirically since so many different factors affect market outcomes simultaneously, but this problem is really external to the definition and measurement of social capital per se. An analogy: it is possible to measure land even if it is difficult to measure how much the land contributes to value added in agriculture.

Significant and growing evidence exists that local associations and networks have a positive impact on local development and the well-being of households. Work in India has shown that such social capital enhanced the ability of the poor to allocate resources efficiently and increased their resilience to hazards (Townsend 1994). A study of 750 households from 45 villages in Tanzania suggests that social capital makes a significant contribution to household welfare. Social capital was measured by membership in groups and networks. Multivariate regression analysis established that village-level social capital was a key contributor to household welfare even after taking into account the size of household, male schooling, female schooling, household assets, market access, and agro-ecological zone. In some cases, the effect of village-level social capital outweighed that of market access or female schooling. On the other hand household-level social capital appeared to be less significant than village-level social capital (Narayan and Pritchett 1996).

Social capital can also improve the quality of education. A study of U.S. schools showed lower dropout rates in religious schools in tight communities than in other public and private schools, even after controlling religion and household financial position (Coleman 1988). In a similar vein the breakdown of networks can lead to crime and violence. A study of urban communities in Ecuador, Hungary, the Philippines, and Zambia showed that depletion of economic assets led to lower involvement in community organizations, weaker informal ties among residents, and increased crime and violence (Moser 1996).

There is much evidence that local associations play a key role in environmental management, especially where common property resources (water, forests) are concerned. This has been especially well documented in the case of irrigation and water supply projects. In Côte d'Ivoire, for example, rural water supply improved significantly after responsibility for maintenance was shifted from the national water distribution company to community water groups. Breakdown rates were reduced from 50 percent to 11 percent at a third of the cost. However, these resuits were sustained only in villages with a high demand for water and where well-functioning community organizations already existed (Hino 1993). Experiences with water user associations in countriesas diverse as Pakistan and the United States, have indicated that sustainability depends on empowering of the participating farmers to negotiate with the relevant water authority and the installation of a framework that clearly sets out rights and benefits as well as duties and responsibilities (Meinzen-Dick and others, 1995; Narayan 1995; Ostrom 1995). Because the formation and maintenance of a water user group (or any group) demands effort and resources from the participants, the sustain- ability of a group is further enhanced when the stakes are high, as in the case of Côte d'Ivoire, where the demand for and value of water are high.

Regarding forests, we cited earlier the role played by community groups in Gujarat to end violence over forest management issues and to develop a joint approach between government and local people (Pathan and others 1993). In a remote area of Zimbabwe a small community took over management of wildlife resources. They negotiated the revenue-sharing process and division of responsibilities with government. The results have been better wildlife protection and increased revenue from safaris and tourism for both the local community and the government (Scoones and Matose 1993). As in the case of water associations, the keys to success include clear rules of membership, accountability, and sanctioning developed jointly between the local community and the central authority (Narayan 1995).

The links between civil society and government also affect the outcomes of government programs. A study of municipal government in

northeast Brazil showed how the creation of relationships between civil servants and local associations enhanced the effectiveness of municipal programs. When the staff of a Cerea health program focused on building trust with clients in the communities in which they worked, the quality and impact of the program increasedmore families were served, and infant mortality declined (Freedheim 1988).

The garment industry in Brazil and Chile is an example of the role of professional associations in solving information and incentive problems (Stone and others 1992). Brazil has a complex regulatory system, laws are sometimes inconsistent with one another, and courts are very expensive. For day-to-day operations business has to rely on informal alternatives to govern transactions with customers or suppliers, especially when credit is involved. Brazilian garment entrepreneurs worked out an effective informal credit information system, which places a premium on an untarnished reputation. Nevertheless, contracts remain insecure and are frequently renegotiated, even up to the very moment of delivery. Brazilian entrepreneurs must therefore adopt risk-reducing strategies, such as producing only noncustomized items and reducing the size of orders, which ultimately hurts the expansion of business. In contrast, in Chile legal simplicity and consistent enforcement of contracts have led to a more secure contracting process and very few renegotiations. This has reduced the default rate on debt. This case study clearly suggests that there is a limit to the extent to which informal associations can replace the rule of law and a formal court system. This underlines both the role of social capital in making business possible and the role of government in providing an enabling environment. Simplicity, transparency, and consistency need to be the key features of this environment. A study of Peru further illustrated how the sheer complexity of laws and regulations can undermine their effectiveness and provide strong disincentives to economic agents to adhere to formality. In Peru it led to the shifting of economic transactions to an informal sector not protected by formal law, but functioning thanks to informal substitutes (de Soto 1989).

Research also shows that the impact of social capital can be indirect. Rural economic organizations in Bolivia succeeded in pushing up producer prices in local markets so that members as well as nonmembers benefited (Tendler and others 1982). This impact depends, however, on the nature of the organization. In Bolivia and Ecuador rural organizations enhanced the poor's access to markets and government institutions, but the membership principles and barriers to entry of each organization influenced who did and did not benefit from the links with government agencies (Bebbington 1996). More generally, Olson has shown how strong lobbying organizations can benefit their own members, but can have adverse impacts on economic development through special interest group influence on policymaking.

Evidence on the positive impact of hierarchical associations is more limited and ambiguous. In Nigeria such groups reduced food insecurity by giving poor people moral entitlements on which to draw during famine years (Watts 1983). In the case of Boosaaso, Somalia, cited at the beginning of this chapter, hierarchical clan-based and intergenerational relationships became the means by which local stability and security were ensured, which resulted in a big upturn of economic activity.

At the macrolevel social capital becomes the fourth category of capital in the production function (with physical, natural, and human capital). Its contribution to economic growth, investment, or equity can then be assessed in two ways. A first approximation is obtained from accountingtype production function models, which explain GDP growth as a function of growth of labor, capital, and technology. After accounting for physical and natural capital, a "residual" is obtained that lumps together social and human capital. Separating social from human capital requires a direct estimation of human capital. This has not yet been done successfully. The growth accounting models routinely rely on enrollment figures, but this has been criticized. In principle the advantage of the residual approach is that it identifies the contribution of social capital in its entirety (at least if one accepts the assumption that growth is a sole function of the four identified factors of production). An example of this approach is the earlier cited East Asian Miracle study, which found that growth accounting models could only explain 17 to 36 percent of the difference in

growth performance between EastAsia and other parts of the world (World Bank 1993). 8

An alternative method is the direct estimation of the impact on growth, investment, or equity of specific components of social capital. There is a rapidly growing body of literature that has attempted to do this, often focusing on the political or democratic aspects of society. Indicators include measures of political instability (government changes, coups); Gastil's measures of civil and political liberty; measures of expropriation risk, corruption, enforcement of contracts and property rights; and measures of political and economic discrimination and social disintegration (crime, suicide, riots, illegitimacy, divorce, and so on). Box 6.3 contains a partial list of such variables, which have been used in cross-country analyses and are therefore available for a number of countries.

One study of twenty nine countries included direct measures of trust and civic cooperation (taken from the World Values Survey) in a crosscountry growth equation, and found that each variable had a significant positive effect, after controlling for other determinants of growth. The importance of trust was found to be greatest in low-income countries, where it is assumed to operate as a substitute for formal institutions that enforce property rights and contracts (Knack and Keefer 1996).

Analyses of cross-country data have also been undertaken in which the regression model includes the political regime as an explanatory variable. Civil and political liberties were found to have a positive correlation with growth, while repressive regimes yield lower growth rates (Scully 1988; Grier and Tullock 1989; Barro 1989). Political instability has also been associated empirically with lower growth. However, these correlations have failed to support conclusively a causal model and competing theories abound. For example, it has been argued that freedom enhances market efficiency and economic performance, while others claim that rapid growth requires controls and reduced freedom. Still others see freedom affecting growth mainly through investment behavior (de Haan and Siermann 1996). Political factors can influence not only national economic performance, but also that of development projects. A study of World Bankfinanced projects showed that in countries with the best civil liberties the economic rate of return of these projects was significantly higher than in the countries with the worst civil liberties, after controlling for a variety of other determinants of project performance. However, political regimes (democracy versus non- democracy) and political liberties did not play a significant role in project performance (Isham and others 1995).

Economists often argue that government's main economic role is the enforcement of property rights and the management of externalities to economic processes (including public goods). It stands to reason, therefore, that economic growth is likely to be hampered when these functions are not properly undertaken. Some of the transition economies are a case in point, because they have not yet had sufficient time to establish a well-functioning and well-integrated legal framework and judicial system to enforce contracts and property rights. Likewise, the management of externalities is more of a challenge in a market economy than in a controlled economy (where, by definition, they are internalized since the government controls the economic processes that generate them). Some empirical studies have found that variables measuring contract enforcement, expropriation risk, corruption, and quality of government bureaucracy are powerful explanatory factors of growth rates, in some cases with effects as strong as those of education (Knack and Keefer 1995). Furthermore, countries with formal institutions that effectively protect property and contract rights provide a more conducive environment for trust and civil cooperation to develop (Knack and Keefer 1996).

Other studies have gone beyond the political and government factors and looked at the effects of social integration and disintegration on economic performance. Again, the transition economies of Eastern Europe and the former Soviet Union provide some powerful evidence of the catastrophic interaction that can occur between economic and social decline. The trouble is that here too, to cite Klitgaard and Fedderke (1995), "there is no agreed upon theory to apply." Hence, investigations are largely inductive, seeking for meaningful correlation. The evidence so far seems to indicate that good economic performers score higher on some dimensions of social integration

Box 6.3 Indicators of social capital
The following indicators have all been used in empirical studies. Indicators of horizontal associations take a microperspective and typically have been collected for analysis within a country. The other sets of indicators have been calculated at the national level and have been used in cross-country research
Horizontal associations · Number and type of associations or local institutions · Extent of membership · Extent of participatory decisionmaking · Extent of kin homogeneity within the association · Extent of income and occupation homogeneity within the association · Extent of trust in village members and households government · Extent of trust in trade unions · Perception of extent of community organization · Reliance on networks of support · Percentage of household income from remittances · Percentage of household expenditure for gifts and transfers · Old-age dependency ratio in
Civil and political society · Index of civil liberties (Gastil, Freedom House) · Percentage of population facing political discrimination · Index of intensity of political discrimination · Percentage of population facing economic discrimination · Index of intensity of economic discrimination · Percentage of population involved in separatist movements · Gastil's index of political rights · Freedom House index of political freedoms · Index of democracy · Index of corruption · Index of government inefficiency · Strength of democratic institutions · Measure of "human liberty" · Measure of political stability · Degree of decentralization of government · Voter turnout · Political assassinations · Constitutional government changes · Coups
Social integration · Indicator of social mobility · Measure of strength of "social tensions" · Ethnolinguistic fragmentation · Riots and protest demonstrations · Strikes · Homicide rates · Suicide rates · Other crime rates · Prisoners per 100,000 people · Illegitimacy rates · Percentage of single-parent homes · Divorce rate · Youth unemployment rate
Legal and governance aspects · Quality of bureaucracy · Independence of court system · Expropriation and nationalization risk (currency/M2) · Repudiation of contracts by government · Contract enforceability · Contract-intensive money

and stability of social institutions but not on others. Those aspects of social integration linked to the political process seem to matter most, which is in line with the previously discussed studies focusing explicitly on the political regime (Klitgaard and Fedderke 1995).

One of the most disruptive forms of social disintegration is ethnic conflict. It destroys physical capital, disrupts the economy, deteriorates human capital, and dissolves social capital. More than half the world's low-income countries have experienced conflict during the past ten years. Of those countries, thirty have had more than 10 percent of their population dislocated, and in ten countries 40 percent of the population has been dislocated. Ethnicity-based conflict is emerging as a key factor contributing to Africa's economic decline. Studies have suggested that ethnic di-

versity may lead to increased civil strife and political instability. Ethnically fragmented societies are prone to competitive rent-seeking behavior by the different ethnic groups and have difficulty agreeing on public goods like education, infrastructure, and good policies. The role of ethnic diversity in affecting growth performance has been quantified in a cross-country study of SubSaharan Africa (Easterly and Levine 1995). The study controlled for a wide array of growth determinants, such as initial income level, schooling, political stability, and monetary, fiscal, trade, exchange rate, and financial sector policies. It also included measures of infrastructure development, cultural diversity, and economic spillovers from neighbors' growth. Yet the study found that ethnic diversity independently accounted for approximately 35 percent of Africa's growth differential with the rest of the world. When the indirect effects on policies were also considered, this figure rose to 45 percent.

The indicators of social capital used in these studies all represent quantitative or qualitative measures of social capital, but without any attempt at direct valuation. Only the "residual" approach derived from growth accounting models is an indirect valuation method. While we have argued that social capital affects market outcomes and macroeconomic outcomes, the absence of a market for social capital, due to its public good character, makes valuation inherently difficult. 9 However, valuation is inevitable if social capital is to be seen as a final or intermediate economic output and to be included in the national accounts. One of the innovations of the 1993 United Nations System of National Accounts (SNA) was the inclusion of satellite accounts that incorporate the depletion of natural resources and selected environmental costs. This makes possible the calculation of "environmentally adjusted net national income" and so-called "genuine saving" (the residual of production minus consumption, depreciation of produced assets and drawing down of natural resources). The key purpose is to recognize that GDP will overstate economic gain if output is achieved by depleting natural capital (Serageldin 1996a, 1996b; Hamilton and Lutz 1996). Similarly, if economic growth severs social relations and depletes social capital, "genuine" growth will be lower than the standard GDP aggregate will suggest. Useful lessons can be learned from the environment accounts for the valuation of social capital. It is likely that the construction of a satellite accounting system for social capital would present the most feasible way of linking social capital to the SNA. The key account is the capital account, which must meet the following identity:

Closing stock	=	opening stock
	+	production of capital
	-	consumption of capital
	+	revaluation of capital.

The latter account adjusts the value of assets due to price changes. Progress on the environmental accounts was only made possible after inventories of national capital stocks were measured and progress was made on valuing differing types of natural capital. The same lines of inquiry will be needed for social capital before advances will be possible toward an integrated system of social and economic accounting.

Finally, it should be pointed out that a number of authors purposely blur the distinction between social and human capitaltaking both to be embodied in people and hence using indicators about people as opposed to measures about institutions or associations. The context is the concern with social welfare or human development. In this context many conventional human capital indicators are given social connotations. For example the U.S. President's Council on Sustainable Development (1996) lists access to education and health care as indicators of social equity, and the percentage of population attending college as a measure of participation in decisionmaking. Likewise the United Nations Development Programme's Human Development Index has been used as a measure of social development. In effect, social indicators are used (almost) synonymously with social capital indicators. This approach, of course, enhances greatly the number of available measures of social capital, but this direction of operationalizing social capital is not consistent with the definitions of social capital discussed earlier in this chapter.

Role of Donors

It has been argued in this chapter that certain forms of social capital can have strong positive

effects on economic growth and can contribute to creating sustainable development. At the same time warning was given that an inappropriate path of development can destroy social capital, setting off a vicious circle of social and economic decline. There is thus clearly a role for government in promoting "desirable" forms of social capital. The public good nature of social capital further underlines this role, as does the fact that the functioning of government itself is a part of social capital in its broadest sense.

It is logical therefore to ask what the role is of donor agencies that are concerned with developmentnational as well as international, public and privatein creating or stimulating the creation of social capital. The World Bank has recently examined its own potential role, concluding that it needs to increase the extent to which it takes social relationships and local and national networks and institutions into account in its project design and policy advice. Five areas were identified for action.

Do Your Homework, Do No Harm

The Bank needs to better understand existing social capital in a country prior to developing policies and as part of the process of project design. Assessments of social capital could be combined with poverty and social assessments, and would identify existing institutions, social relationships, and networks that contribute to growth and poverty alleviation, and also those that impede it. Such assessments would prevent projects from weakening existing positive social capital and suggest ways to strengthen it.

Use Local-Level Social Capital to Deliver Projects

Existing associations and organizations can be called upon to take part in the delivery of a project. This has the potential to improve beneficiary targeting, reduce project cost, and enhance the sustainability of projects by increasing "ownership." Furthermore, the participating institutions can become strengthened due to their involvement, thus enhancing social capital. This will require care in the selection of organizations so that they are truly inclusive of the intended beneficiaries (especially the poor) and have objectives in line with the project.

Create Enabling Environments

The scope for effective use and strengthening of social capital depends critically on the nature of the wider political and policy environment. The latter can encourage or discourage local organization and provide incentives or disincentives for people to participate. An enabling environment is characterized by general good governance, enforcement of property rights, an independent judicial system, a competent and transparent bureaucracy, and mechanisms to promote dialogue and resolve conflict among economic agents.

Invest in Social Capital

Direct investment in social capital means direct support to existing and emerging organizations. In practice, nongovernmental organizations and local government may often be in the best position to do so, given that most civic associations are small and local. National or international donors can support international NGOs and confederations of local associations. Participatory processes in project design often contribute to social capital building by inducing the formation of local user groups.

Promote Research and Learning

As this chapter illustrated earlier, the measurement of social capital and the empirical assessment of its contribution to achieving growth and equity objectives is only just beginning. Such work, including new data collection, needs to be promoted further. Research is also needed on the most appropriate strategies for working with local organizations. Finally, the micro-macro linkage between social capital and macro- economic performance needs to be explored further conceptually as well as empirically.

Notes

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1. It is *not* our objective, however, to provide a full literature review.

2. Some social scientists claim that the term *social capital* has been coined only to make the underlying concepts acceptable to economics. Economists reply that institutions and other aspects of social capital have always been present in economic analysis.

3. Coleman has been credited with introducing the term social capital into the sociological literature in his 1988 article, "Social Capital in the Creation of Human Capital," *American Journal of Sociology*. However, Loury introduced the concept of social capital into economics in 1977 in an analysis of racial inequality, to describe the social resources of ethnic communities.

4. This concept of social capital leans closely to the treatment of firms and other hierarchical organizations in institutional economics, where the purpose of the organization is seen as to minimize transaction costs (Williamson 1985, 1993).

5. Applications of game theory to economics, as well as the literature on the economics of information, have attempted to address such situations.

6. It needs to be pointed out that the existence per se of a group (such as a water user group) does not imply social capital. It is the mechanism underlying the group's ability to enforce group norms that constitutes the social capital in that setting.

7. According to Putnam, it is preferable to speak about trustworthiness rather than trust. Dasgupta considers that trust is merely confidence in an expected outcome (based either on past experience or on anticipated contract enforcement). For further discussion of trust see Gambetta (1988) and Fukuyama (1995).

8. There are dissenting views on the role of social capital in the explanation of East Asian growth rates. Some authors argue that most or even all of these growth rates can be explained by increased mobilization of resources (increases in labor force participation rates, education, and investment in physical capital) (Krugman 1994). Others, relying on endogenous growth models, argue that the low-income inequality that characterized the East Asian economies was in itself an important stimulus for growth (Birdsall and others 1995). For a recent review and interpretation of the evidence see Stiglitz (1996).

9. One aspect of social capital is routinely valued and traded in the market, namely, the "goodwill" of a corporation. Essentially, goodwill is the network of clients and suppliers of the corporation.

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Chapter 7
Poverty and the Environment: Pieces of the Puzzle

What is the relationship between poverty and the environment? Does poverty lead to environmental damage? If so, in what ways? Do environmental problems exacerbate poverty? If so, to what degree? How do poor people respond to environmental problems? What policy instruments are available to address poverty and environmental problems together? To what degree are there synergies between addressing poverty and environmental problems, and to what degree are there trade-offs? Although much has been written about the relationship between poverty and the environment, so far most of these questions remain largely unanswered.

As interest in the linkages between poverty and environment and awareness of their importance has grown, partial and preliminary answers to many of these questions have begun to emerge. This chapter reports on the results of several recent World Bank studies that shed some light on these important issues. While these studies provide certain valuable pieces of the puzzle, however, many others remain missing. Much remains to be done before the overall picture becomes clear.

Poverty and the Environment

Much has been written about the relationship between poverty and the environment. The poor are thought to be both victims and agents of environmental damage.

Environmental damage tends to affect the poor particularly severely for several reasons. First, they tend to rely heavily on fragile natural resources for their livelihood. Poor people, almost by definition, have few assets. Much of their wealth, therefore, derives from their own labor and any natural capital that they have access to. Since they often have little education, their human capital tends to have a low return, making any natural capital all the more important. However, the poor often only have access to poor-quality and fragile natural resources, and their claim to these resources is often tenuous. Poor people also tend to have fewer ways of responding to environmental problems. Polluted areas where land is cheap or free may be the only areas they can afford to live in. They are also less likely to have the resources to buy bottled water when sewage and industrial waste are polluting the drinking water.

The poor are also thought to be important agents of environmental damage. With little other land available to them, poor farmers may resort to cultivating steeply sloped erosion-prone hillsides or to clearing tropical forests. Inability to afford other fuel sources may make them cut down trees at unsustainable rates. High discount rates may make them value short-term benefits far ahead of long-term losses. Whether, in what ways, and why poor people might act in ways that are damaging to the environment remain important, but generally unanswered, questions.

The relationship between poverty and the environment is likely to vary considerably from case

to case, especially since a host of other important factors, including government policies, institutional structures, and the specific characteristics of the environmental and natural resources involved, will also vary substantially from case to case. No easy generalizations on the relationship between poverty and the environment are likely, therefore. Rather, detailed case studies are necessary. The difficulty of understanding the relationship between poverty and the environment is compounded by the scarcity and poor quality of available data.

This chapter presents the results of ongoing research undertaken by the World Bank on a number of aspects of the relationship between poverty and the environment:

Are the poor more likely to deforest?

Do environmental problems result in higher fertility, inducing a vicious cycle of rising population pressure, increasing poverty, and growing environmental problems?

Are the poor able to respond to pollution?

Poverty and Deforestation: Lessons from Mexico and Indonesia

In many parts of the world shifting cultivation by poor farmers is thought to be the most important cause of deforestation (Reardon and Vosti 1995). Although logging may play a catalytic role, most tropical deforestation is thought to result from conversion to agriculture. Actors at the forest frontier include very poor, subsistence-oriented shifting cultivators; smallholders growing export crops; large, commercial farmers and ranchers; and government-sponsored tree crop or timber estates.

Mexico

During the 1980s about 19 million hectares were deforested in Mexico, an annual deforestation rate of about 2.9 percent. A recent study uses socioeconomic and physiogeographic data for 2,400 municipalities to examine the factors behind this high rate of change in forest cover (Deininger and Minten 1996). The results suggest that poverty is associated with higher levels of deforestation. As can be seen in figure 7.1, municipalities with higher levels of poverty lost a greater proportion of their forest cover during the 1980s. Other factors, such as crop price supports and the availability of extension services, also play important roles, however. Figure 7.1 shows that in areas with a higher density of government maize-purchase depots (which indicates higher maize prices) the level of deforestation is higher at all poverty levels. Data for subgroups of municipalities provide additional insights. Poverty is the major pressure on deforestation in municipalities where pastures comprise more than half of agricultural area. Conversely, in areas with high initial levels of forest cover (more than 70 percent in 1980), poverty is not a significant factor influencing changing forest cover, and it is in fact commercial motives that pose the primary threat.

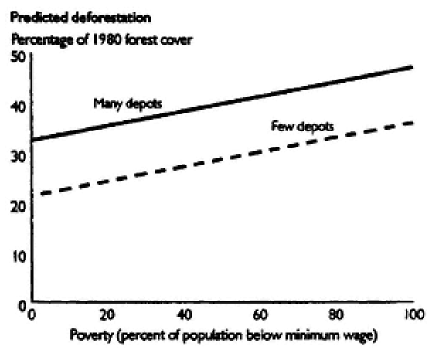

Figure 7.1
Effect of poverty on predicted deforestation in Mexico, 198090
Source: Deininger and Minten 1996.

Indonesia

Estimates of deforestation in Indonesia range from 300,000 to 1 million hectares a year. Even at the lower figure deforestation is cause for concern because Indonesian forests are disproportionately rich in biodiversity. Much deforestation is associated with the establishment of large palm oil or pulpwood plantations or with shifting cultivation. Although there is considerable logging, it is often thought that the resulting threat to deforestation arises less from clear-cutting than through increased access to these areas for shifting cultivators. Shifting cultivators are usually assumed to be subsistence-orientedpoor cultivators seeking

to meet their basic food requirements by extensive cultivation into the forest fringes. To determine the extent to which poor subsistence farmers affect deforestation, a recent study examines crop choice at the forest frontier using village census data (Chomitz and Griffiths 1996). Crop choice has implications for the nature of deforestation, its relation with poverty, and appropriate policy responses.

Evidence from this study suggests that export-oriented tree crops play an important role in deforestation relative to subsistence-oriented shifting cultivation. The share of households engaged in shifting cultivation at the forest frontier is surprisingly small. Even in high deforestation areas of Kalimantan, only 36 percent of households are shifting cultivatorsand some of these households may be using shifting cultivation to produce export-oriented crops. Conversely, the proportion of households at the forest frontier cultivating tree crops ranges from near half to more than three-quarters on all major outer islands except Irian Jaya. Rubber is the dominant smallholder crop, with coffee, cocoa, and coconuts being important in some parts of the country. Some coconut cultivation, however, may be for subsistence consumption rather than for sale in the market.

The importance of tree crop cultivation in deforestation trends indicates that a more nuanced approach to deforestation might be required, as some tree cropsincluding jungle rubber, one of the most important smallholder tree cropstend to be less damaging than other agricultural land uses. Conversion of forest to jungle rubber is less damaging to biodiversity than cultivation of either field crops or monoculture tree crops, since jungle rubber tends to preserve a significant amount of biodiversity of the primary forest and can relatively easily convert back to natural forests.

Poverty, Environment, and Population: Is There a Vicious Cycle?

In many areas children contribute to the household through the collection of firewood. As population pressure results in scarcer fuelwood, do families respond by having more children, or fewer? If the benefits of additional children outweigh the costs of childrearing to the household, deforestation might result in greater population growth and a vicious cycle is likely. A recent study of common property forests and fertility in Pakistan attempts to address these questions using data from the 1991 Pakistan Integrated Household Survey (Filmer and Pritchett 1996).

The study finds that the likelihood of a family having had a child in the last five years increased as the households' perception of problems with firewood supply increased. Similarly, households living further away from wood sources also had a higher likelihood of having had a child in the last five years. These results seem to support the hypothesis that environmental degradation may lead to higher fertility. However, firewood prices have a negative impact on fertility, which provides counter-evidence to this hypothesis. The same patterns hold when the data are disaggregated by region, except for the Sindh region. There, the data show a strong positive correlation between fertility levels and firewood scarcity, supporting the "vicious circle" hypothesis.

These results are consistent with the findings of Cleaver and Schreiber (1994) that deforestation rates are positively related to fertility in thirty-eight African countries, although in this study as well this effect was small and not always significant.

Poverty and Informal Regulation of Industrial Pollution: Lessons from Asia

abatement and mitigation (Hettige and others forthcoming).

Bangladesh

A study of manufacturing plants in the fertilizer and wood pulp sectors in Bangladesh suggests that community pressure has apparently been quite effective in many instances (Huq and Wheeler 1993). The technical level of most plants was largely exogenous, because many were financed by foreign aid and, as such, reflected the environmental standards of the donors. Community pressure often resulted in responses such as monetary compensation for damage to fisheries and paddy fields and installation of end-of-pipe treatment equipment. However, in areas where other sources of employment were scarce, plants faced little community pressure even if they were clearly identifiable as important polluters.

Indonesia

An analysis of the level of water pollution emissions in Indonesia based on a large sample of data from Indonesian factories (Pargal and Wheeler 1995) indicates that pollution intensity was substantially higher in poorer, less-educated communities (figure 7.2). This differential appears to be too large to attribute to preferences alone and indicates that the ability to pressure polluting firms may be important in explaining the observed difference in abatement performance.

China

Analysis of variations in the enforcement of the Chinese pollution levy system leads to similar results (Wang and Wheeler 1996). Although a countrywide uniform levy is set by the Chinese National Environmental Protection Agency (NEPA), enforcement varies widely across provinces. Moreover, provinces can legally augment (but not undercut) the national standard with NEPA's permission. Analysis of panel data for twenty nine provinces between 1987 and 1993 indicates that China's pollution levy has been effective in promoting reduction of water pollution. The study also finds that collection rates for provincial levies are significantly affected by the severity of local environmental problems (for example, pollution loads and the size of the exposed population) and development indicators such as income and education. The correlation with income and education reflects both higher willingness and ability to pay for environmental quality and greater enforcement capacity in more highly developed regions.

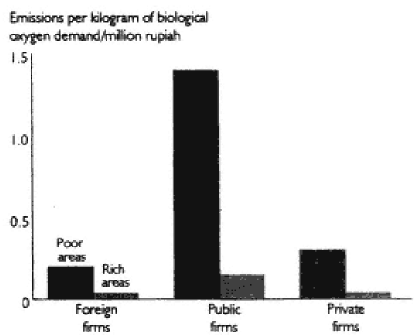

Figure 7.2
Emissions intensity of firms in rich and poor areas of Java
Source: Pargal and Wheeler 1995.

The evidence from these studies suggests that the level of income and education of communities surrounding industrial plants are powerful predictors of the effectiveness of informal regulation in controlling emissions. Several reasons have been advanced to explain this (Hettige and others 1995). First, poor communities may be less aware of environmental risks because of their lack of access to various channels of information and their lower levels of education. Second, and more controversial, it has been suggested that poor communities may be more willing to trade off environmental quality for increased employment. Third, poor communities tend to be less able to bring effective pressure to bear on polluters because of factors such as illiteracy, lack of resources, or lack of influence over government officials.

Lessons and Conclusions

The studies reported here are helping to build up a more detailed and sophisticated understanding of the relationship between poverty and the environment. They are only small pieces of the over-

all puzzle, however, and much more work remains to be done before we can be confident that we understand the relationship between poverty and the environment.

The studies reported on in this chapter provide mixed support for the hypothesis that poverty leads to environmental degradation. Evidence from Mexico and Indonesia suggests that deforestation is related to poverty, but many other factors are also involved. In Indonesia tree crops seem to be a more important factor behind deforestation than subsistence cultivation. Some of the households planting tree crops are undoubtedly poor. But is the deforestation they cause a reflection of their poverty or of the economic incentives driving the production of those crops, which are common to all households?

There is also mixed support for the notion that environmental degradation results in higher fertility. This appears to be the case for deforestation in Pakistan's Sindh region. In Pakistan as a whole, however, the available evidence is inconclusive. If nothing else, this example illustrates the notion that the relationship between poverty and the environment is case-specific and that generalization is dangerous.

The studies of urban pollution in Asia suggest that although the phenomenon of informal regulation is a real and important one, poorer communities are less able to bring the necessary pressure to bear on polluters and, therefore, live in more polluted environments.

While these studies yield important insights and can, to an extent, inform appropriate policy actions, they certainly do not provide universally applicable explanations of the relationship between poverty and the environment. They do reinforce the importance of analyzing the precise nature of the relationship, and highlight the important role for indicators of environmental quality in tracking changes over time.

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Chapter 8
International Progress in Indicator Development

The development of useful environmental indicators requires not only an understanding of concepts and definitions, but also a good knowledge of policy needs. In fact, the key determinant of a good indicator is the link from measurement of some environmental conditions to practical policy options. Environmental indicators can be used at both the international and the national level as a tool for state-of-the-environment reporting, measuring environmental performance, and reporting on progress toward sustainable development. At the national level they can also be used for clarifying objectives and setting priorities.

The World Bank is mainly a user of indicators, not a developer. It builds on various worldwide indicator efforts and data sets, which are the subject of this chapter. Pioneering work by the Organisation for Economic Co-operation and Development (OECD) on a conceptual framework, namely the pressure-state-response model, has influenced the indicator activities of a number of countries (such as Canada, Denmark, Finland, France, Hungary, Japan, the Netherlands, the United Kingdom, and the United States; and various international organizations (for references see section on selected indicator publications at the end of this chapter).

Whereas some of the measures mentioned in this chapter have been developed recently as "indicators," others, like nutrient balances, have been used in the field for a long time but are only now being used in a broader sense. As another example model-based support to global and regional conventions, requiring formally defined quantitative outcomes, has bred useful indicators such as a measure for determining when critical loads have been exceeded (Hettelingh and others 1995). Integrated assessments such as the upcoming *Global Environmental Outlook* (see also Swart and Bakkes 1995; UNEP forthcoming), or the evaluation of the Fifth Environmental Action Plan of the European Union (European Environment Agency 1995) typically feature sets of indicators that are derived from current best practice.

The indicators presented in this chapter are grouped according to the degree to which they condense information. The three major categories of indicator efforts are atomistic, individual indicator sets; thematic indicators; and systemic indicators. The presentation is selective (not comprehensive) and the examples are chosen to illustrate the various approaches being tried.

Individual Indicator Sets

Of the three programs discussed here the first two (the OECD and United Nations Department for Policy Coordination and Sustainable Development (CSD) programs) offer a logical framework and a multitude of potential indicators that users can select from according to their needs. In contrast the third program (in the United Kingdom) is an example of a large set that is intended

to be used in its entirety to give a rounded picture of sustainable development within a country.

Programs with large lists of indicators typically do not define benchmarks against which the indicator values should be compared. This is not to say that their promoters do not acknowledge the essential role of benchmarks in the construction of an indicator. Indeed, some programs with large lists do make an effort to compare indicator values to pre-existing objectives such as air quality guidelines or commitments to international conventions. The U.K. program is a case in point. However, for a majority of the potential indicators no ready standards exist.

The joint program of the United Nations Environment Programme, the United Nations Development Programme, the Food and Agriculture Organization and the World Bank on land quality indicators (LQIs) is another example of the "large list" approach to indicators (see chapter 5). One of the reasons the LQI program suggests so many candidate indicators is that land management has to be tailored to local conditions ranging from pasture quality to waterlogging (Pieri and others 1995). Box 5.2 shows the menu from which the user can select LQIs.

Organisation for Economic Co-operation and Development Indicators Program

The OECD initiated a specific program on environmental indicators in 1990 following a request at the 1989 G-7 summit. This program produced the following results:

Agreement on a common terminology and conceptual framework for all OECD countries (for example, the pressure-state-response model and the core themes)

Identification and definition of a core set of indicators on the basis of three major criteria: policy relevance, analytical soundness, and measurability

Measurement of these indicators for a number of countries

Regular use of these indicators in the OECD's analytical work and environmental performance reviews.

The results of this work, in particular the conceptual framework using the pressure-state-response model, have influenced similar activities launched by a number of countries and international organizations.

The approach adopted by the OECD and its member countries relies on the assumption that there is no unique set of indicators, and that the appropriate set depends on its particular use and the different needs of the users. This has led to the development of a core set of environmental indicators that are linked to the monitoring of environmental progress and the measurement of environmental performance. These are supplemented by various sets of sectoral indicators to help improve the integration of environmental concerns into sectoral policies. The OECD core set is of limited size (around forty core indicators) and covers a broad range of environmental issues.

Commission for Sustainable Development Indicators Program

Another example of the "menu approach" is the United Nations-sponsored program of the Commission for Sustainable Development (CSD) on indicators (DPCSD 1996). The CSD program has developed methodology data sheets drafted by twenty one international organizations. Each methodology data sheet provides guidance on the indicator's significance, how it is calculated, its scientific background, and potential data sources. These serve as guides for countries interested in building their own capacity in the measurement and reporting of indicators.

The menu is very large and at present contains 142 indicators. The program is in the early stage of development and it hopes to arrive eventually at a much smaller set of indicators for each subject area.

The structure of the CSD indicator menu may well be as important as the specific indicators proposed. It uses the conventional pressure-state-response framework and expands it to encompass not only environmental but also social, economic, and institutional issues, all of which are important for sustainable development.

Above all the ongoing CSD program has succeeded in bringing together many international organizationsranging from various UN bodies to nongovernmental organizationsto lend their expertise to the program. Sixteen countries 1 have volunteered to test the indicators developed by this program, and their experience will provide essential guidance for future development of the program.

United Kingdom

The preliminary set of indicators developed for the United Kingdom (UK Department of the Environment 1996) also features a large number of indicatorsa total of 118. The compilers have systematically related indicators to key issues and objectives of sustainable development. In all, 21 "families" of issues have been distinguished. This has been combined within a pressure-state-response framework, much like in the OECD and CSD programs. Box 8.1 discusses the use of indicators in grappling with the issue of road transport and the environment in the United Kingdom.

Future work will focus on reducing the number of indicators. However, priority is given to disaggregating information on pressures so as to show people where they can make a difference. For example, the indicator for energy intensity would be broken down to show where gains have led to an improvement in the overall trend (for example, changes in industrial energy consumption) and where problems remain (for example, road transport and domestic energy consumption). An even more rigorous effort in this direction is Eurostat's program that aims at pressure indices (see box 8.2). In addition the U.K. program tries to satisfy the needs of environmental managers who rely heavily on information about the state of the environment.

Thematic Indicators

Many countries tend to a "mid-size" approach in terms of information reduction in the construction of environmental indicators. This thematic approach involves developing a small set of indicators for each of the major issues in environmental policy. In fact, the examples that were discussed for the menu approach also structure the indicator array by recognized policy issues. The CSD program does so in terms of Agenda 21. However, many practitioners have gone a step further and are now supplying policymakers with smaller sets of indicators. The U.S. Agency for International Development (USAID) has compiled such a set for each of its program objectives to evaluate the environmental performance of its development program (USAID 1995 and 1996).

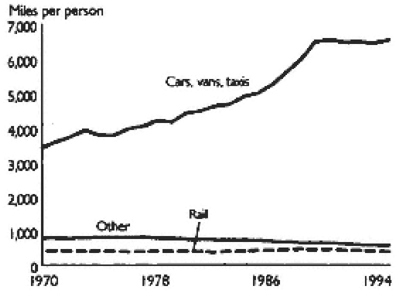
Examples of the thematic approach are presented in table 8.1: indicator sets from Canada the Netherlands, and the Nordic countries. (The Nordic Environmental Indicators are compiled for Denmark, Finland, Iceland, Norway, and Sweden.) All three approaches are based on the pressure-state-response scheme, in combination with a list of established policy themes. Moreover, all three approaches come from countries with extensive experience with the use of indicators in policy formulation. Given this similarity in background and analytical framework, it is interesting to note the differences in the indicator collections.

First, as shown in table 8.1, there is variation in the overall structure. The Canadian indicator collection is grouped using a systems approach at a highly aggregate level (for example, life support systems). The Dutch and the Nordic sets are structured by policy themes. Within this primary structure all three apply a breakdown along the causality chain and distinguish among indicators for pressure, state, and response. In this chain the Canadian collection has additional indicators for *impacts* of environmental changes. It is easy to speculate that this difference reflects, at least in part, the degree to which the indicators play a formal role in reporting to political bodies. Although the Canadian indicators program is linked to the national Green Plan, the Dutch and Nordic sets discussed here have been designed for official reporting. 2 The Dutch structure primarily reflects important processes (such as flows of pollution). The Nordic indicator collection is partly structured by processes and partly by resources, such as fish and forests. These sorts of variations reflect differences in national endowment, problems, and tradition. Nevertheless, however complex the background, the resulting lists and structures apparently provide an adequate fit for national or regional needs and possibilities.

Second, in the three indicator sets different indicators have been chosen to monitor progress for similar environmental issues. For example, urban environmental quality in the Nordic set is exclusively represented by indicators for *pressure* by traffic. In the Canadian set a *state* variable, the measure for determining when ambient air quality objectives have been exceeded, forms the indicator under the corresponding theme. The Canadian set does provide indicators for trans-

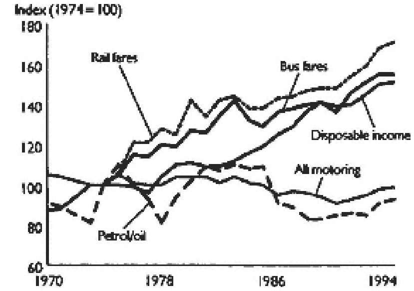
Box 8.1 Trends in passenger road transport in the United Kingdom

A. Passenger miles per head by vehicle



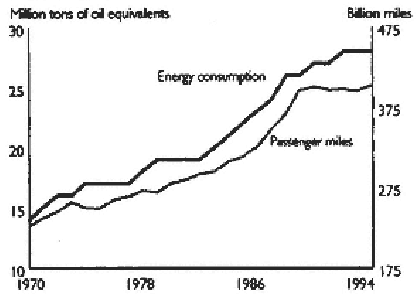
Since 1970 the amount of car travel has almost doubled to an average of 6,500 miles per person per year, while travel on other road passenger vehicles, mainly buses and coaches, has reduced to less than 600 miles per person per year.

B. Real price of different modes of transport



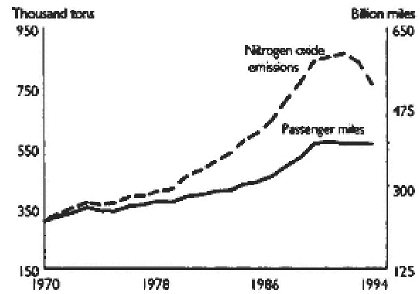
Since 1974, the real price of rail and bus fares has increased faster than the 50 percent growth in real disposable incomes. The real cost of motoring has fallen, making car travel much more affordable. Changes in price and mode of transport illustrate the difficulty in distinguishing pressures from responses.

C. Passenger transport energy consumption and miles traveled



Over the last twenty years, there has been no improvement in fuel efficiency in passenger transport, despite increases in efficiency of individual vehicles. Fuel use for road transport (passenger and freight) has risen by nearly 90 percent since 1970, and now accounts for a quarter of energy consumption.

D. NO_x emissions from road passenger transport



NO_x emissions from road passenger transport are now more than two and a half times higher and have outstripped growth in actual traffic. Recently, emissions have declined due to increased use of diesel cars and an increase in road fuel duty. The downward trend will continue because of the introduction of catalytic converters for new cars.

Source: U.K. Department of the Environment 1996.

port, but because it clusters stressors and stressed systems at a much more general level, it does so under a separate category not narrowed down to urban traffic. The Dutch set notably does *not* include urban air quality. This is because the policy themes and indicators focus on pressures. 3

Forests are another area in which one sees more similarity between the Canadian and the Nordic sets. This close correspondence is as expected, given the similarity in forest cover between Canada and the Nordic region. Both sets include *pressure* (harvesting) indicators. On the

Box 8.2 Environmental pressure indices
The Statistical Office of the European Union (Eurostat) is conducting a large-scale project to systematically relate trends in environmental pressures to activity levels in the various sectors of the economy. Panels of national and sectoral experts will formulate indicators. Other projects are scheduled to devise methods to supply the required statistical series and coefficients, and the panels will assign weights to aggregate the expected 50 to 100 indicators into a pressure index for each of the-ten themes of the Fifth Environmental Action Plan of the Union (European Commission 1996).
In total between 100 and 200 experts will be involved, spread over fourteen countries. The project is now about half completed. The most striking result thus far is the overwhelming number of different indicator proposals put forward by sectoral experts.
Although it is unlikely that such a massive effort and its updating can be afforded by other countries, its formal structure does highlight several important steps: first, the different roles for experts to identify indicators in each policy field and the information needed to compile them; and second, the weighting that is required to aggregate different measures into an aggregate index.

response side, reforestation is used as an indicator in the Canadian set but not in the Nordic set because reforestation with a narrow selection of commercial species is not a good indicator of adequate responses.

In recent additions to the Dutch set, forest area is included as an indicator of forest state. However, in this case key pressures on forests are not harvesting but acid deposition, human-induced drought, and excess nutrients. Indicators for all three are included in the Dutch set, but not specifically for forests.

Third, the Dutch set is smaller than the other two. In order to provide parliament with a one-dimensional performance rating on progress toward the objectives of environmental policy, the set has been narrowed to one indicator per theme (selected from pressure or state variables), allowing explicit comparison with predetermined goals.

What do these differences tell us? Obviously, the same basic approachthe "common gene"can lead to the selection of different indicators depending on the policy link. This appears to be the case even between countries that could be classified as similar in many respects.

The differences between the three comparable indicator sets of table 8.1 suggest at least two objective reasons why users and suppliers of environmental information reach different solutions in different countries. First, the environment is different between countries, and indicators will vary to reflect these differences. Second, because policy needs change over time, different indicators are required to respond to these new needs.

Another example of the thematic approach is the just-published *World Development Indicators* (WDI) report of the World Bank (1997). Grouped into a number of discrete sections, the WDI contains indicators on economic, social, environmental, and institutional variables. The environment section, for example, contains nine tables with approximately forty indicators (box 8.3). A major advantage of the WDI is the ability it provides to link economic, social, and environmental indicators in a common database (covering about 150 countries).

Systemic Indicators

Systemic indicators have been designed to derive one number to indicate whether a complex system is in difficulty. Such indicators are the most ambitious in terms of information reduction. Other names for systemic indicators include "portfolio indicators" and "synoptic indicators" (Rump 1996). Hammond and Adriaanse use "aggregate indicators" (Hammond and others 1995), although aggregation is often not the precise method applied. An analogy from medicine is to human body temperature: if it deviates from the normal value, something is probably wrong. Once the indicator has dentified a potential problem, further analysis is needed to find out the precise nature of the problem.

The wealth and genuine savings indicators, presented in some detail in chapters 2 and 3 of this report, belong to this category of indicators. They are good examples of systemic indicators that have useful policy implications: persistently negative savings or declining total wealth per capita clearly indicate that the development of the country as a whole is not sustainable. However, the opposite, positive saving and constant or

Table 8.1 Examples of thematic indicator sets

Nordic countries	*Netherlands*	*Canada*
Climate change	Climate change	Life support systems
Emissions of carbon dioxide	Weighted emissions of	Climate change
Global mean temperature	greenhouse gases	Stratospheric ozone
Annual mean temperatures in the Nordic Capitals	Ozone layer depletion	Toxics in the environment
Changes in the use of fossil fuels	Weighted emissions of	Biodiversity
Ozone layer depletion	CFC's and halons	Human health and well-being
Consumption of ozone-depleting substances	Eutrophication	Urban air quality
Total ozone	Weighted gross loads of	Urban water
Targets for reduction of ozone-depleting substances	nitrogen and phosphorus	Natural resource
Eutrophication	Acidification	sustainability
Net supply of commercial fertilizer and manure	Weighted emissions of	Marine resources
Algal chlorophyll	ammonia, sulfur dioxide	Forests
Light penetration	and nitrogen oxides	Agricultural soils
"Winter green" crop land	Acidifying deposition	Energy consumption
Connection to chemical waste water treatment plants	Dispersion of toxic	Influencing factors
Acidification	substances	Transportation
Deposition of acidifying substances	Weighted releases of	Waste generation/
Area where the critical load for sulfur has been exceeded	priority substances,	production
Quantity of lime used	radioactive substances and	Population growth and
Toxic contamination	pesticides	lifestyle patterns
Cadmium in moss	Disposal of solid waste	
Heavy metals	Mass dumped	
Organic hazardous substances	Disturbance of local	
Collection of Hg, Cd, and PCB	environments	
Urban environmental quality	Fraction of the population	
Number of private cars and light commercial vehicles in the capitals	reporting nuisance from odor or noise	
Number of persons in the capitals who are exposed to noise from road traffic	Sectoral indicators	
Number of vehicle-kilometers of public transport in the capitals	Contribution to above indices from the following sectors:	
Biodiversity	Agriculture	
Total kilometers of road per unit of land	Manufacturing	
Endangered and vulnerable species	Refineries	
Protected areas	Electricity production	
Cultural and natural landscapes	Transport	
Forest ditches and drained land	Consumers	
Total wetland area		
Restoration of wetlands		
Waste		
Quantity of household waste per capita		
Share of municipal waste that is deposited on landfills		
Forest resources		
Removal in relation to increment		
Changes in standing volume		
Forest planting and sowing		
Fish resources		
Taxation		
Fishing mortality		
Spawning stock development		
Quotas		
Source: Statistics Norway 1995.	*Source:* van Esch, S. A. draft 1996.	*Source:* Environment Canada 1996.

growing wealth, does not necessarily guarantee sustainabilityalthough the chances are better.

Other examples of systemic indicators include the materials balance approach and the nutrient balances approach.

The Materials Balance Approach

Materials balance sheets have been developed in industrial countries as a way to screen a country's economy for pollution "leaks" that would lead to

Box 8.3 The World Bank's 1997 *World Development Indicators* (WDI)
The main sections of the WDI are the following:
People
Environment
Economy
States and markets
Global linkages.
The tables and indicators presented in the environment section are:
Land use and deforestation; land area; rural population density; cropland, permanent pasture, and other land as a percentage of total land area; total forest area; annual deforestation
Protected areas and biodiversity: nationally protected area; total number and threatened species of mammals, birds, and higher plants
Freshwater use: per capita freshwater resources; annual freshwater withdrawals; freshwater withdrawals by agriculture, industry, and domestic use; percentage of rural and urban population with access to safe water
Energy use: production and use of commercial energy; annual and per capita use of commercial energy; use of traditional fuels; growth rate and per capita production of electricity
Energy efficiency, dependency, and emissions: real GDP per unit of energy use; net energy import as a percentage of commercial energy use; total carbon dioxide emissions per capita and per unit of real GDP
Urbanization: urban population; urban population as a percentage of total population; average annual growth rate of urban population; population in urban agglomerations of a million or more; population in the largest city as a percentage of total population; percentage of urban population with access to sanitation
Traffic and congestion: number of vehicles per 1,000 people; number of vehicles per kilometer of road; road traffic volumes in million vehicle-kilometers; number of people killed or injured per 1,000 vehicles
Air pollution: emissions and ambient concentrations of suspended particulate matter and sulfur dioxide
Government commitment: status of country environmental profile; national conservation strategy; biodiversity profile; compliance with Convention on International Trade in Endangered Species of Wild Flora and Fauna; participation in climate change, ozone layer, chlorofluorocarbon control, and law of the sea treaties.
Source: World Bank 1997.

an accumulation of a dangerous pollutant in the environment. Typically this approach dealt with persistent groups of compounds, like lead compounds. One-off studies were conducted to help identify priorities for pollution control policies. Statistics Netherlands built up considerable experience with these studies during the late 1970s and 1980s.

Later developments have widened the application of the materials balance approach. Most significantly, as pollution management became more operational, it needed routine and timely measurement of its impact. And indeed, once the key factors in a country's balance of copper compounds, for example, had been identified, estimating the annual load of copper compounds to the county's soils became a matter of routine rather than a special study.

In addition, a much more aggregate form of materials balances has been developed at the Wuppertal Institute in Germany. This approach groups together all inputs that go into the production of a given commodity on a mass basis. This provides a rough-and-ready way to compare how much "environment" goes into different products and lifestyles.

A related effort is highlighted in box 8.4. The World Resources Institute, in conjunction with the Wuppertal Institute, the Netherlands Ministry of Housing, Spatial Planning and the Environment and the National Institute for Environmental Studies, Japan Environment Agency, have detailed trends in material throughput in their respective countries.

The Nutrient Balances Approach

Relative to many other environmental indicators, more experience exists with the use of nutrient balancesalthough most of the literature relates to land quality at the field level. Nutrient balances belong to the broader materials balances family of indicators. They come in slightly different forms, depending on whether the issue is nutrient loss from soils (as in the case of Kenya) or excess nutrients brought into the environment (as in the Netherlands). In both situations nitrogen is often taken as representative of all nutrients.

Box 8.4 Indicators of material flows

Many of the materials removed, moved, and processed to support industrial economies are not captured in conventional economic accounting. Those accounts do not make explicit many activities that require environmental modifications or uses of natural resources that have potential environmental impacts. For example, measures such as the Gross Domestic Product (GDP) do not include the movement or processing of large quantities of materials that have no (or even negative) economic value. An understanding of the environmental consequences of economic behavior requires physical accounts of the material basis of that behavior. In a unique collaboration the Wuppertal Institute in Germany, the National Institute for Environmental Studies in Japan, the Netherlands Ministry of Housing, Spatial Planning, and Environment, and the World Resources Institute in the United States have developed new physical accounts of the material basis of their industrial economies that parallel traditional economic accounting (World Resources Institute 1997).

They propose a new summary measure, the Total Material Requirement (TMR) of an industrial economy. The TMR is the sum of all the material that is moved or extracted from the environment in support of the economy. Some of this material enters the economy as a commodity, but much of it is never seen in economic accounts. These are called "hidden flows." These hidden flows, which are associated with extractive activities, harvesting of crops, and infrastructure development (for example, soil erosion, overburden, dredging, and excavation) are immense. In the four countries studied, from 55 to 75 percent of the TMR arises from these hidden flows. National accounts in physical terms are required to routinely document such uses of natural resources and their potential environmental effects.

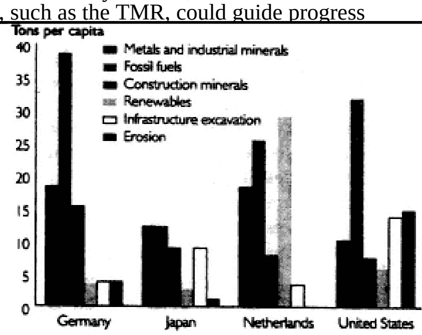
But natural resources are frequently extracted in one country, transformed into products in another, and consumed in a third. So a significant portion of the natural resource use that supports a nation's economic activity can occur outside its borders. Of these four countries, the United States is largely self-sufficient in natural resources due to its size, but in the other three countries the foreign proportion of the TMR is between 35 to 70 percent. These industrial countries gain the benefits of resources while the environmental cost of their production falls on others, often on developing countries.

Box figure 8.4.1
Total material requirement, annual flows per capita

The TMR takes into account both hidden flows and foreign components of natural resource use, as well as direct inputs of natural resources into the economy. Even when normalized to a per capita basis, the TMRs of modern industrial economies are enormous. In 1991 the TMR per capita of these four countries ranged from 45 to 85 metric tons of natural resources per person. Over the 20 years of the time series (box figure 8.4.1) there was a surprising trend toward convergence of these quantities even though the details of those material flows differed significantly (box figure 8.4.2).

A parallel set of physical accounts provides the basis for the construction of new indicators that combine both physical and economic information. In particular it allows the construction of measures of an economy's material intensity in a way that is more comprehensive than traditional measures, incorporating as it does both hidden and foreign components (box figure 8.4.3). The results for these four countries shows a clearly declining pattern of materials intensity, supporting the conclusion that economic activity is growing somewhat more rapidly than natural resource use.

Ultimately, sustainable development will require a closer understanding of how the economic and environmental aspects of human activity interact, as well as actions based on such understanding. Indicators of physical flows, such as the TMR, could guide progress



Box figure 8.4.1
Total material requirement, annual flows per capita

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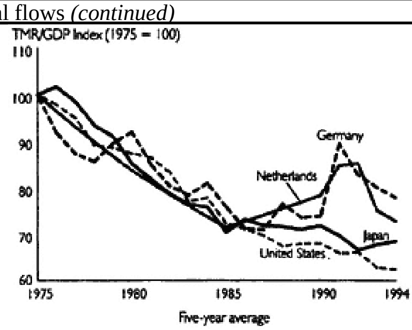
Box 8.4 Indicators of material flows *(continued)*



Box figure 8.4.3
Overall material intensity (TMR/ GDP) Index

toward more efficient use of natural resources. Since what leaves the industrial system as wastes is closely related to the volume of material inputs, policies that reduce the use of primary natural resources not only diminish extraction pressures, but also wastes and pollution. Similarly, policies that make natural resource use more efficient or increase recycling lower environmental impacts over the entire materials cycle.

Further work is anticipated that will provide examples of indicators for the entire materials cycleadding outputs, including products and waste; continuing to harmonize definitions and methods; developing detailed indicators of the material cycle within economic sectorsthat would also be useful to policy makers; and expanding the number of countries, both industrial and developing, using these indicatorsadding a global reach to the understanding of material flows.

In most parts of the world, including Africa and some regions of Latin America, the major concern is with nutrient depletion: more nitrogen is carried off with crops than is brought into the soil ("fixed") by natural processes and supplemented through chemical fertilizer and manure. This reduces soil fertility and leads to declining yields (see the discussion on land quality indicators in Honduras in chapter 5). The appropriate indicator in this situation is the fraction of nitrogen in the soil that is lost annually. An example for Kenya is given in box 8.5. The beauty of this indicator is its transparency, which makes it easy to compare with predetermined acceptable nutrient levels. In addition, it can be applied to scales other than the national scale, and it is an easy way to evaluate economic and environmental scenarios by their effect on the nutrient balance.

The Netherlands has one of the best known (and most extreme) cases of nutrient excess. The core of the problem is industrial-scale cattle and pig farming that has developed rapidly since the 1960s, driven by European Union price guarantees for meat, and the ample availability of animal feed from outside the European Union (mainly from Latin America, Thailand and the United States). Nutrient balances have been used to identify the resulting pollution problems caused by intensive husbandry, and this information has helped place the issue on the political agenda (see box 8.5).

The history of nutrient balances in the Netherlands illustrates some important, general points. To begin with, a ten-year-long standoff delayed official publication of nutrient balancesthe obstacle being determining the standards that would represent an acceptable nutrient load. Eventually, publication of a range of balances revealed that there was a problem by any standard.

Furthermore, once public debate broadened, the original calculation scheme was significantly simplifiedaccepting some information loss in return for timeliness and transparency. The simplification made it possible to use a single indicator for reporting to parliament on the performance of this aspect of environmental policy during the previous year.

The lesson from this review of experience with nutrient balance accounts is that the approach can be used in situations of nutrient deficiencies as well as nutrient surplus. More generally, it illustrates how indicator definitions can evolve with the changing needs of policymaking.

Conclusion

Box 8.5 Nutrient balances

Operationalizing a nitrogen balance for Kenya

The fraction of nitrogen in the soil that is lost annually can be estimated using the following simplified scheme from Smaling (1993 and 1996) and Stoorvogel and Smaling (1990).

Fraction lost = (out-in)/stock where "out" is nitrogen in harvested product, "in" is nitrogen in mineral fertilizers, and "stock" is nitrogen in soil.

a. Average maize yield	1,460 kg/ha	(FAO 1993)
b. Nitrogen content in maize (out)	25 kg/ha	(Stoorvogel and Smaling 1990)
c. Total fertilizer consumption	95,000 tons	(FAO)
d. Average nitrogen content of fertilizer	20 percent	
e. Total nitrogen consumption	19,000 tons	(c*d)
f. 25 percent of fertilizer to maize	4,750 tons	(0.25*e)
g. Area under maize	1,200,000 ha	(FAO data)
h. N fertilizer to maize (in)	4 kg/ha	(f*g)
i. Average stock of nitrogen in soil in maize-growing areas1	3,750 kg/ha	

The fraction lost can therefore be calculated as follows: (25-4) /3,750 = 0.0056. Based on the following tentative classification suggested in Smaling (1993), nitrogen is being lost from Kenyan soils but not at an alarming rate.

Fraction lost < 0	Enrichment
0 < Fraction lost 0.005	Equilibrium
0.005 < Fraction lost < 0.01	Slightly alarming
0.01 < Fraction lost < 0.05	Moderately alarming
0.05 < Fraction lost < 0.2	Severely alarming
0.2 < Fraction lost	Very severely alarming

Nitrogen balance for soil and groundwater in the Netherlands, 1990 (van Eerdt and others 1996)

In contrast nitrogen balance for soil and groundwater in the Netherlands, as illustrated below, features a considerable accumulation of nitrogen. This can be traced to import of feed and use of artificial fertilizers.

Input (million kgs of N)		Output (million kgs of N)	
Animal manure2	486	Withdrawal by harvested crops (including grass)	456
Artificial fertilizers	412	Volatilization of ammonia	53
Sewage sludge	5	Denitrification	330
Atmospheric deposition	161	Leaching and surface runoff toward inland waters	124
Wastes	31	Accumulation	173
Other	41		
Total	1,136	Total	1,136

Notes:

1. For this illustration the following soil types and nitrogen contents have been assumed for area under maize:

50% ferralsols, acrisols	0.1% N = 2,500 kg. N/ha
50% luvisols, nitisols, phaseozems	0.2% N = 5,000 kg. N/ha

2. Excluding the amount of ammonia that volatilizes during manure-spreading and finds its way back to the soil via atmospheric depositions (43 million kilograms of nitrogen).

ernment of Canada, the Netherlands, and Scandinavia (Porter 1995). These pioneering countries continue to refine their indicator methods and adapt them to the evolving needs of policy and environment management. Meanwhile, many examples of implicit or explicit indicator work are developing in regions with different backgrounds (Australia, the Baltic states, Japan, Latin America, the United Kingdom, and the United States). In other countries the uses of indicators are begin-

ning to be studied (southern Africa and some Mediterranean countries).

International programs like that of the CSD of the United Nations, and of the OECD, with its expanding membership, are contributing to this proliferation of empirical methods to underpin environmentally sustainable development policies. The resulting indicator sets clearly exhibit a "common gene" (Hammond and others 1995) that is manifest in a number of dimensions: the use of a pressure-state-response framework, sometimes expanded to pressure-state-impact-response; policy issues as a structuring element, with linkage to targets represented in all sorts of variants; and emphasis on the provisional character of the first-edition indicator sets. The UNEP is now undertaking an ambitious effort to apply indicators for environmentally sustainable development in global and regional scenario analysis (UNEP forthcoming 1997) and others may follow suit (DPCSD forthcoming).

The various programs also feature common methodological problems. Almost all programs report difficulties with *response indicators*. This has prompted fresh initiatives to expand the development of indicators (and the underlying database) and to extend field testing to a wider number of countries.

Notes

1. These include Belgium, Bolivia, Brazil, Canada, China, Costa Rica, Czech Republic, Finland, Germany, Hungary, Malaysia, Morocco, South Africa, the Netherlands, Ukraine, and Venezuela.

2. To the Dutch parliament and to the Nordic ministers of the environment, respectively.

3. Urban air quality does figure in official reporting that encompasses the formal indicators.

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