20

Sustainable Development

The path to development followed by today's advanced economies was fueled by technologies intensive in their use of energy and natural resources and prodigious in their production of environmental pollutants. Is this the same path today's poor countries must follow? What are the potential conflicts between development and the environment? According to scientist Jared Diamond, the potential consequences of such a conflict include nothing short of societal collapse.[1] Citing both ancient and recent examples, Diamond argues that unintended ecological suicide ("*ecocide*") was a primary cause of the demise of major civilizations throughout history, ranging from the Maya to the Vikings to modern-day states like Somalia and Rwanda. Diamond elaborates,

> The processes through which past societies have undermined themselves by damaging their environments fall into eight categories, whose relative importance differs from case to case: deforestation and habitat destruction, soil problems (erosion, salinization, and soil fertility losses), water management problems, overhunting, overfishing, effects of introduced species on native species, human population growth, and increased per capita impact of people. . . . The environmental problems facing us today include the same eight that undermined past societies, plus four new ones: human-caused climate change, build up of

[1]Jared Diamond, *Collapse: How Societies Choose to Fail or Survive* (London: Penguin Books, 2005). Diamond defines *collapse* as "a drastic decrease in human population size and/or political/economic/social complexity, over a considerable area, for an extended time" (p. 3).

toxic chemicals in the environment, energy shortages, and full human utilization of the Earth's photosynthetic capacity.[2]

Concerns about the Earth's ability to support continued human development date back at least to the eighteenth century. In 1798, British economist and demographer Thomas Malthus, in his famous *Essay on the Principle of Population*, predicted that continued population growth would bring the world to disaster. Malthus based his analysis on two premises: "That food is necessary to the existence of man," to which Malthus applied the assumption that the production of food would grow arithmetically, and "That the passion between the sexes is necessary and will likely remain nearly in its present state," from which Malthus extrapolated that population would grow geometrically.[3] He concluded "The power of population is so superior to the power of the Earth to produce subsistence for man, that premature death must in some shape or other visit the human race."

Some recent thinking has echoed Malthus. In 1972, the Club of Rome published *The Limits to Growth*, a report by a team of analysts based at the Massachusetts Institute of Technology. This study predicts that "If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next 100 years." Among other projections, the report suggests that, based on then-current reserves, the world would exhaust its supply of oil by 1992.

While these and other dire predictions have so far proved false, the question of whether today's developing countries can (or should) follow a historical development path similar to that followed by today's advanced countries, with potentially serious environmental impacts, remains valid. The depletion of both renewable and nonrenewable resources, especially fossil fuels, and the threat of environmental damage pose challenges on a scale unimaginable in the time of Malthus. Concern over the sustainability of economic development and growth has expanded to emphasize global climate change. Scientists point to increasing atmospheric concentrations of **greenhouse gases** such as carbon dioxide (CO_2), which may dangerously raise global surface temperatures by trapping solar radiation in the earth's atmosphere. As we discuss in the final section of this chapter, the potential negative consequences of global warming for development are immense. Various forecasts indicate potential reductions of grain yields of up to 50 percent in Africa, extinction of valuable plant and animal species, increased disease and water stress, and the displacement of millions of poor residents of low-lying coastal zones as the melting polar ice caps cause sea levels to rise. There are even widely expressed fears that the entire nation of the Maldives, a

[2]Diamond, *Collapse: How Societies Choose to Fail or Survive*, pp. 6–7. By "photosynthetic capacity," Diamond is referring to the limited capacity of Earth to support crop growth. He cites calculations that by the late 1980s, humankind had either used, wasted, or diverted about half of the Earth's capacity to produce crops.

[3]An arithmetic progression is 1, 2, 3, 4, 5, 6; a geometric progression is 1, 2, 4, 8, 16, 32.

collection of 1,200 coral islands in the Indian Ocean, 80 percent of which rise no more than one meter above sea level, could simply disappear by the year 2100.

WILL ECONOMIC GROWTH SAVE OR DESTROY THE ENVIRONMENT?

The relationship between economic growth and the environment is complex and dynamic. One important mediating variable is technology. When Malthus foretold of "premature death" for the human race, he excluded the possibility that technical change in agriculture would boost productivity, permitting food supplies to outpace population growth.[4] Technical change also affects the efficiency with which we use renewable and nonrenewable resources as well as the level of environmental damage caused. Increased automobile fuel efficiency and the more recent development of electric cars are only two among many examples of how technical change can help reduce environmental impacts. Our assumptions about the role and pace of technical change are critical in shaping our conclusions about whether economic growth is good or bad for the environment.

The relationship between levels of pollution and levels of income is generally thought to follow an inverted-U shape, with pollution rising as income increases from low levels but falling once income passes some intermediate level. Because this inverted-U pattern is similar to the relationship between inequality and national income famously posited by economist Simon Kuznets (introduced in Chapter 6), this empirical relationship between pollution and national income is called the **environmental Kuznets curve.** This relationship is depicted in Figure 20–1 as the "conventional EKC." Economist Susmita Dasgupta and colleagues describe the basic intuition underlying this relationship,

> In the first stage of industrialization, pollution in the . . . world grows rapidly because people are more interested in jobs and income than clean air and water, communities are too poor to pay for abatement, and environmental regulation is correspondingly weak. The balance shifts as income rises. Leading industrial sectors become cleaner, people value the environment more highly, and regulatory institutions become more effective.[5]

Statistical estimations of this relationship have suggested that pollution peaks at levels of income per capita between $5,000 and $8,000, and declines as income grows above that range.

[4]The Club of Rome's *Limits to Growth* (New York: Universe Books, 1972) study recognized the potential impact of technical change but assumed that its pace would be insufficient to overcome ensuing environmental constraints.

[5]Susmita Dasgupta, Benoit Laplante, Hua Wang, and David Wheeler, "Confronting the Environmental Kuznets Curve," *Journal of Economic Perspectives* 16, no. 1 (winter 2002), 147.

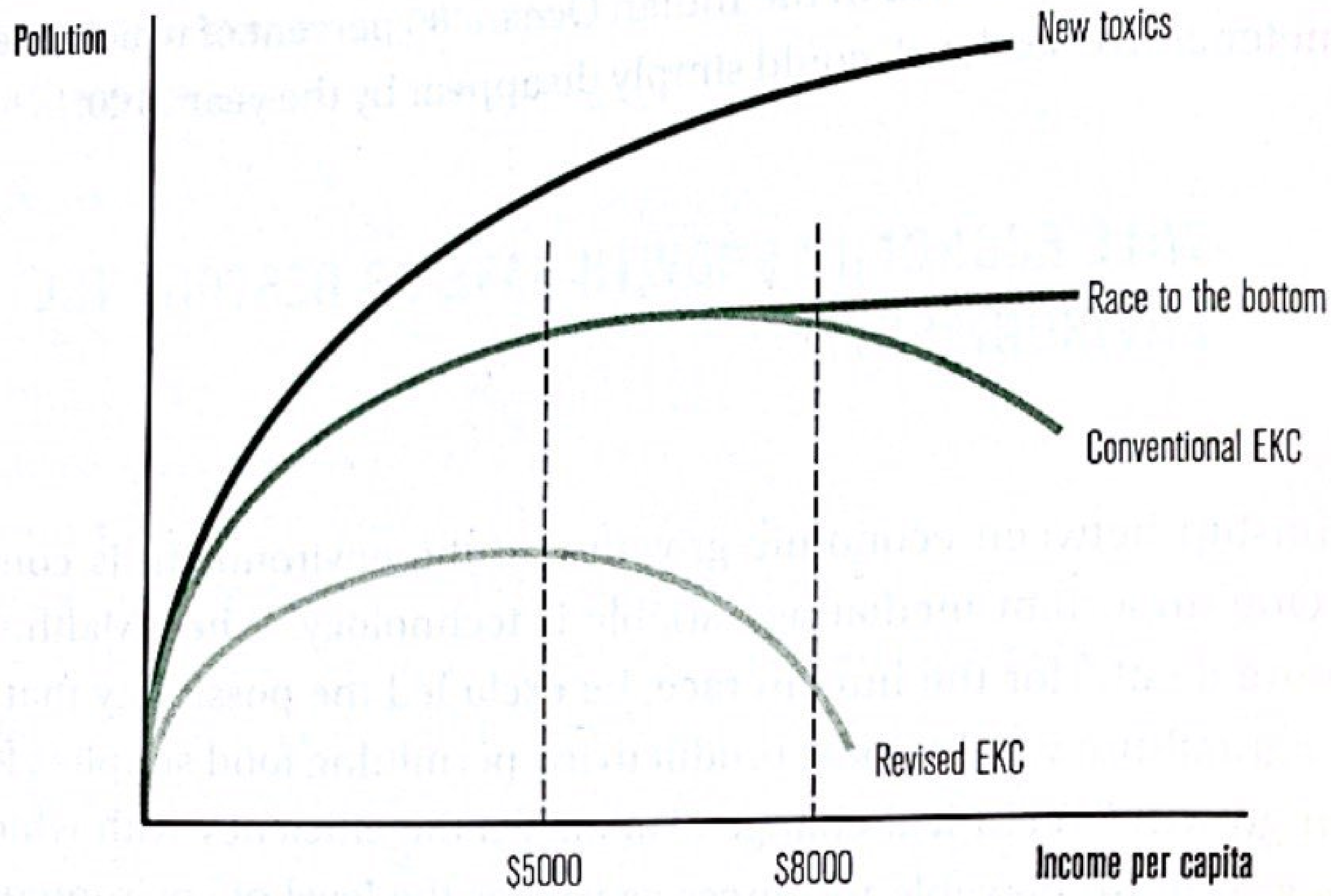

FIGURE 20-1 Potential Paths for the Environmental Kuznets Curve (EKC)

Source: "Confronting the Environmental Kuznets Curve," by Smita Dasgupta, Benoit Laplante, Hua Wang, and David Wheeler. *Journal of Economic Perspectives*, Vol. 16, No. 1, Winter 2002: 147–168, p. 148. Reprinted by permission of the American Economic Association.

Dasgupta notes, however, that estimates of the conventional environmental Kuznets curve have been criticized as misleading snapshots of a dynamic process. If, for example, free trade and globalization create a "race to the bottom", as countries compete by lowering their environmental standards, then the curve may simply flatten out (as depicted in Figure 20-1). Or if income growth and industrialization merely create new environmental hazards, it's possible that the environmental Kuznets curve could rise over time (the "new toxics" path). Conversely, Dasgupta and colleagues cite recent and more optimistic evidence that the environmental Kuznets curve has been shifting downward as growth becomes less polluting and the turning point occurs at increasingly lower levels of income (the "revised EKC"). Thus the relationship between pollution and economic growth remains a subject of debate, one with high stakes, given that current income levels in most of the developing world remain far below the turning point of even the "revised" EKC.

Moreover, we cannot simply infer that increasing levels of income *cause* pollution to first rise and then fall. Alternative explanations for the inverted-U pattern include the natural progression from clean agrarian to polluting industrial to clean service sector domination of the economy, the beneficial effects of greater institutional development and better public policies in advanced economies, and advances due to technical change. It has also been suggested that wealthier countries have reduced their pollution levels by exporting their pollution-intensive production activities to developing countries. If true, this would call into question the ability of today's poor countries to follow the inverted-U pattern, suggesting a path similar to the "race to the bottom" or even the "new toxics." If it were simply the case that economic growth automatically reduced pollution, we would have little else to worry about in the long run, and policy makers could focus exclusively on promoting growth. This is not the case. The fact that earlier predictions of environmental catastrophe proved overly dire is no guarantee against future environmental catastrophes.

Diamond (along with many economists), skeptical about the environmental Kuznets curve, poses this choice more starkly, asserting,

> because we are rapidly advancing along this non-sustainable course, the world's environmental problems *will* get resolved, in one way or another, within the lifetimes of the children and young adults alive today. The only question is whether they will become resolved in pleasant ways of our own choice, or in unpleasant ways not of our choice, such as warfare, genocide, starvation, disease epidemics, and collapse of societies.[6]

The first step in assessing the sustainability of development lies in defining what we mean by *sustainability* and thinking about how to measure it. How will we recognize sustainable development when we see it? What is it in particular that is to be sustained?

CONCEPT AND MEASUREMENT OF SUSTAINABLE DEVELOPMENT

Among the myriad academic and popular definitions of sustainable development, the most widely cited is that of the World Commission on Environment and Development (commonly known as the Brundtland Commission, 1987), which defined it as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[7] While highlighting the notion of intergenerational equity, the Brundtland Commission's concept of sustainable development remains vague, and in particular fails to define "needs." For instance, "needs" might be interpreted to require the maintenance of only a bare minimum standard of living, though most of us might hope for more than such a low standard for our children. The Brundtland Commission's definition is also vague with respect to the question of what it means for future generations to meet their needs. This concept could imply that the well-being of future generations remains above some (undefined) minimum standard, that future well-being be equal to present well-being, or that each generation's well-being be equal to or greater than the well-being of the previous generation. Recent discussions of sustainable development by economists

[6] Diamond, *Collapse: How Societies Choose to Fail or Survive*, 498.

[7] World Commission on Environment and Development. *Our Common Future* (Oxford: Oxford University Press, 1987), p. 43 (also known as the Brundtland report).

have tended to define a sustainable path as one along which intergenerational well-being does not decline.

Operationalizing the standard that the well-being of future generations not decline requires a clear definition of well-being and some means of measuring it. For instance, in Chapter 2 we addressed the question of happiness as a measure of well-being, with the paradoxical finding that happiness is not monotonically tied to income. In practice, economists often use income as a proxy for the level of development. For the purpose of measuring the potential well-being of future generations, however, we need to expand that concept to equate well-being with the economy's **wealth**. Economists have shown that the only way for intergenerational well-being not to decline is for per capita wealth not to decline. Non-declining wealth *per capita* requires that the growth rate of wealth be greater than or equal to the growth rate of population.[8] But what do we mean by *wealth*?

This concept of sustainable development requires a broad concept of wealth. Economics Nobel Laureate Kenneth Arrow and colleagues define wealth as "the social worth of an economy's entire productive base. Because the productive base consists of the entire range of factors that determine intergenerational well-being, we . . . refer to wealth as *comprehensive wealth*."[9] **Comprehensive wealth** (also referred to as **total wealth**) is made up of **produced capital** (buildings, roads, machinery and equipment), **natural capital** (minerals and fossil fuels, forests, agricultural land, and protected areas), and **intangible capital** (a broad category that includes human, social, and institutional capital).[10] Comprehensive wealth differs from the more familiar concept of gross domestic product (GDP) in a critical way that highlights the concept of sustainability: GDP includes, besides the production of goods and services, the value of asset liquidation as part of national output. When Chile or Zambia mine and export copper, the depletion of this natural resource counts toward each nation's GDP, but growth based on the depletion of natural resources may not be sustainable. This type of resource use diminishes comprehensive wealth.

Measuring the different categories of capital is a challenge. The value of each type of capital is a function of its price, yet we observe prices only for goods and services that are traded in markets. This is a special problem in the case of natural capital for which markets are often missing. Water is an example of a vital and limited natural resource, the majority of which is used as an input for agriculture. Often there

[8] The growth rate of any ratio is the growth rate of the numerator minus the growth rate of the denominator. Wealth per capita is the ratio (wealth to population). Thus the growth rate of wealth per capita is the growth rate of wealth minus the growth rate of population. If the population growth rate exceeds the growth rate of wealth, then wealth per capita declines.

[9] Kenneth J. Arrow, Partha Dasgupta, Lawrence H. Goulder, Kevin J. Mumford, and Kirsten Oleson, "Sustainability and the Measurement of Wealth," National Bureau of Economic Research Working Paper 16599, Cambridge, MA: NBER, December 2010, p. 2.

[10] This discussion draws on World Bank, *The Changing Wealth of Nations, Measuring Sustainable Development in the New Millennium* (Washington, DC: World Bank, 2011).

is no well-defined market for water use. Yet, depletion of water resources is a major concern, and the failure to price water to reflect its opportunity cost may exacerbate this depletion. The damage caused by air and water pollution, including the damage to human health, is also difficult to value precisely. Various ecosystem services (such as the supply of wild foods, cultural and recreational uses, and the aesthetic value of natural landscapes) also often lack market prices and are difficult to incorporate explicitly in wealth accounting. The same is true for such public goods as biodiversity and carbon storage. In part because of even more severe challenges to measurement, intangible capital is typically measured as a residual, the difference between total wealth and the sum of produced and natural capital. Total wealth is calculated as the present value of future consumption that is sustainable. In making these estimates, the World Bank applies a discount rate of 1.5 percent over a period of 25 years. This calculation of total wealth is thus independent of the value of the three forms of capital, allowing intangible capital to be calculated as the residual.

Table 20–1 provides wealth and per capita wealth data for different country groups in 1995 and 2005. Global wealth between these years increased by 34 percent. Over that same period, global population increased by 17 percent, resulting in a 17 percent increase in global wealth per capita. The largest absolute increases in per capita wealth were in the high-income nations, but every income group experienced gains. Table 20–1 also provides insights into both the composition of total wealth and changes in that composition as a function of income level. Intangible capital makes up the largest category of wealth at all levels of income and in both years. Yet there is a clear pattern of change in the composition of total wealth: low-income countries rely substantially on natural capital compared with high-income countries, with most of the difference lying in the relative proportions of intangible capital. This cross-sectional pattern is also apparent over time, as increased wealth in the low-income countries is associated with a shift in the composition of total wealth from natural capital to intangible capital. This decreasing reliance on natural capital as a component of total wealth is consistent with the structural transformation introduced in Chapter 16. Thus, notes a World Bank study, "For countries dependent on nonrenewable natural capital, transforming natural capital to other forms of wealth is the path to sustainable development."[11]

For many developing countries fortunate enough to have large endowments of natural resources, it is precisely the failure to make this transformation that threatens the sustainability of their development paths. Nigeria provides a prime example of this problem. Oil has dominated Nigeria's economy since the discovery in the late 1950s of the country's enormous reserves, accounting for nearly all of its export revenue and over one third of GDP. The government of Nigeria has financed much of its operations with oil revenue, continually drawing down this nonrenewable resource. Yet, Nigeria remains poor and underdeveloped relative to its potential because it has

[11] The World Bank, *The Changing Wealth of Nations*, p. 6.

failed to transform its natural capital into either manufactured or intangible capital (such as a more highly educated labor force). Indeed, there is a simple rule of thumb (known as the **Hartwick rule**) that suggests that a sustainable development path for countries that depend on nonrenewable resources requires the rents from those resources to be continually invested rather than consumed.[12] Nigeria is hardly alone among developing countries in having depleted its endowment of natural resource abundance while failing to develop accordingly. In addition to other oil exporters, such countries as the Democratic Republic of the Congo, Zambia, and Zimbabwe have all failed to develop to the potential available through their natural resource endowments.[13] In contrast, diamond-rich Botswana has been among the world's fastest-growing economies. Mexico and Peru have also succeeded in transforming natural capital into manufactured capital.

The tradeoffs are somewhat more complicated for countries in which the natural capital endowment is based on renewable resources, such as forest land. In these cases, property rights and other supporting institutions can play important roles in limiting harvests to sustainable levels. Deforestation in the Amazon exemplifies the overexploitation of a renewable natural resource. In this, and many other cases, the overutilization of renewable resources happens because the lack of market prices for such resources often leads them to be undervalued and threatened. The reliance of low-income countries on natural capital comes with the risk that the depletion of natural capital may cause permanent losses of biodiversity and other ecosystem services.

SAVING FOR A SUSTAINABLE FUTURE

Comprehensive wealth defines the current generation's well-being and constrains the well-being of future generations. A sustainable path of development (a path along which the well-being of each generation is at least equal to that of the previous generation) requires the creation of wealth at a rate at least equal to the rate of population growth. Wealth creation results from savings and investment over time. From one period to the next, the increase in comprehensive wealth equals **adjusted net saving (ANS)**, sometimes called **genuine saving**, defined as "gross national savings adjusted for the annual changes in the volume of all forms of capital."[14] We can measure countries' ANS by starting with the familiar concept of gross saving (S), which is simply total income minus total consumption. Maintaining wealth requires saving

[12]Specifically, the portion of the rents that should be invested under the Hartwick rule is equivalent to the depreciation of the capital stock, a proportion that approaches the full rent as the resource becomes progressively depleted.

[13]Chapter 18 discusses the pitfalls associated with countries' reliance on natural resource exports for their trade strategy.

[14]The World Bank, *The Changing Wealth of Nations*, p. 37. The only theoretical difference between the increase in comprehensive wealth and adjusted net savings is that the former includes capital gains (which arise from changes in the real price of assets).

sufficiently to offset depreciation of existing assets. In standard national accounting, this idea is captured by measuring **net saving (NS)**, defined as gross saving minus the depreciation of made capital (D_m):

$$NS = S - D_m \qquad [20\text{-}1]$$

But focusing on depreciation of only made capital is too limited, and in principle the concept should be expanded to include depreciation of natural capital (D_n), including the depletion of energy stocks, dwindling mineral assets, and damage from air pollution. This gives rise to the measurement of ANS:

$$ANS = S - D_m - D_n \qquad [20\text{-}2]$$

This corrected definition of net saving suggests that, if enough is saved each year to cover the depreciation of both made and natural capital, the economy can sustain its wealth and its level of consumption. In principle, this idea could be extended to include other assets as well, including human capital, knowledge, and social assets. However, measurement difficulties and lack of data make this extension difficult in practice, so we restrict our discussion here to made and natural capital. We can interpret ANS as an indicator of sustainability of an economy's development path. If ANS is declining (particularly if it is declining over consecutive years), this indicates that the economy's path is unsustainable, that it's depleting the productive base on which the welfare of future generations depends. Because some forms of capital are inevitably excluded from the calculation of ANS, its interpretation in practice requires caution and judgment. Research by economists Susana Ferreira, Kirk Hamilton, and Jeffrey Vincent has shown that ANS does predict future economic performance in a cross section of countries, but only if ANS is adjusted to account for the depletion of natural resources.[15]

Figure 20–2 illustrates ANS trends by developing region since 1970. While the data indicate substantial variability, several broad observations stand out. Both East Asia and South Asia have high and increasing rates of ANS compared with Latin America (for which the rate of ANS has been relatively low but positive over time) and sub-Saharan Africa (for which the rate of ANS has been low, trending downward, and negative after 2005). The unsustainable path reflected for sub-Saharan Africa is dominated by large oil-exporting countries, such as Nigeria, which (as noted above) fuels its economy through the gradual depletion of its oil reserves without converting that natural capital into other forms of capital. The positive trends in East and South Asia are dominated by the large and rapidly growing economies of China and India, which by comparison have relied less on the depletion of natural resources and more on the expansion of their stocks of physical and human capital. Box 20–1 extends the

[15]Susana Ferreira, Kirk Hamilton, and Jeffrey Vincent, "Comprehensive Wealth and Future Consumption: Accounting for Population Growth," *World Bank Economic Review* 22, no. 2 (2008), 233–48.

FIGURE 20-2 Adjusted Net Saving for Developing Regions, 1970–2008

Data exclude particulate emission damage.
Source: World Bank, "World Development Indicators," http://databank.worldbank.org.

analysis of ANS as an indicator of sustainability to incorporate the effects of population growth, illustrating these concepts with the case of Ghana, where ANS was positive while ANS per capita was negative.

To summarize, the concept of sustainable development has been defined in numerous ways; yet the most popular definition, that of the Brundtland Commission, highlights the requirement that consumption by today's generation must be accompanied by sufficient conservation of resources so as not to reduce the consumption potential of future generations. Knowing whether we are meeting this standard requires clear definitions and specific metrics. Economists' efforts to measure the sustainability of development have focused on net saving as an indicator of whether resource use by the current generation is expanding or contracting the potential creation of wealth by future generations. Experience to date is mixed. While some countries and regions have succeeded in rapidly expanding the potential wealth of future generations, others have been consuming rather than investing their resource base. These latter regions thus appear to be following unsustainable development trajectories. In many cases, the unsustainable depletion of natural resources and environmental damage through pollution are a result of market failure. The following section defines and illustrates this concept.

BOX 20-1 THE MALTHUSIAN EFFECT OF POPULATION GROWTH ON ADJUSTED NET SAVINGS IN GHANA

Adjusted net savings (ANS) is a concept that we can use to measure sustainability. As developed in the text, ANS tracks changes in a country's comprehensive wealth. Sustainability requires that wealth be nondecreasing from one generation to the next; yet from a welfare perspective, wealth must be measured per capita. If the population is growing, then maintaining per capita wealth at a constant level requires that comprehensive wealth grows at the same rate as population. From this perspective, it is entirely possible that development would not be sustainable in the per capita sense, even if comprehensive wealth is increasing. In other words, a negative rate of ANS reduces both total and per capita wealth; yet the converse is not necessarily true—a positive rate of ANS need not imply increases in wealth per capita. Some countries may add to their total wealth but not enough to compensate for population growth. To determine whether the rate of ANS is sufficient to increase wealth per capita, we must adjust that rate to take account of population growth. This requires subtracting from ANS the amount by which ANS must increase each year simply to keep up with population growth—the so-called **Malthusian term**. If the remaining difference is positive, then wealth per capita increases. If the remaining difference between actual ANS and the amount of ANS needed to maintain per capita wealth is negative, then wealth per capita decreases. This difference is the **adjusted net saving gap**. As a percent of gross national income, this saving gap tells us how much the rate of ANS would need to increase to keep wealth per capita constant over time.

Ghana provides an example of a country in which comprehensive wealth grew absolutely but fell per capita. Measuring saving and wealth in per capita terms requires a small modification to the accounting framework developed in the chapter. Because most of what we termed intangible capital consists of human capital (and is thus reflected in the population itself), we must exclude intangible capital from our calculation of comprehensive wealth per capita to avoid double counting (now that population enters the formula directly). For lack of data, we also exclude the value of carbon emissions per capita from our calculation of ΔANS.

The table on the following page details the calculation of changes in wealth per capita in Ghana for the year 2000, when Ghana's population grew by 1.7 percent. The left-hand column of the table decomposes tangible wealth per capita into its subcategories. The right-hand column shows the composition of adjusted net savings, subtracting the consumption of fixed capital and resource depletion from the sum of gross national saving and educational expenditures. Ghana's ANS per capita was \$16. The Malthusian term equals the population growth rate times comprehensive wealth per capita, or $0.017 \times \$2022 \approx \$34$. Even though Ghana's ANS per capita was positive, the country's per capita wealth fell by $\$16 - \$34 = -\$18$. Stated differently, the growth rate of Ghana's total wealth was $\$16/\$2022 = 0.8$ percent which was less than the 1.7 percent rate of population growth. This suggests an unsustainable long-run trajectory for Ghana.

Tangible wealth ($ per capita)		Adjusted net saving	
Subsoil assets	65	Gross national saving	40
Timber resources	290	Education expenditure	7
Non-timber forest resources	76	Consumption of fixed capital	19
Protected areas	7	Energy depletion	0
Cropland	855	Mineral depletion	4
Pastureland	43	Net forest depletion	8
Produced capital	686		
Total tangible wealth	2,022	Adjusted net saving	16
Population growth	1.7%	Δ Wealth per capita	−18

Source: Table 5.1 from The International Bank for Reconstruction and Development. The World Bank: *Where is the Wealth of Nations? Measuring Capital for the 21st Century*, 2006. Reprinted with permission.

MARKET FAILURES

The term *market failure* describes situations in which market prices deviate from scarcity values and individuals and companies make decisions that maximize their own profits but cause losses for others and society as a whole. A central theme of this chapter is that, within a single country, correcting those market failures and establishing properly working, efficient markets can be among the most powerful and effective mechanisms to promote efficient resource use, reduce environmental degradation, and generate sustainable development. At first blush, that proposition may seem counterintuitive. The point, however, is that environmental degradation often occurs because market participants do not take into account the full costs of their actions on the environment. For example, prices of goods produced in a factory may not include the costs to society of the air pollution generated by that factory. Government policies and interventions aimed at incorporating these costs into market decisions help improve environmental outcomes, make markets work better, and bring broader benefits to society.

Prominent among the market failures affecting resources are externalities—*costs* borne by the population at large but not by individual producers and *benefits* that accrue to society but cannot be captured by producers (see also Box 5–1). The most important externalities are those caused by the depletion or degradation of natural resources, including the environment. If resources are depleted at rates faster than they can be replenished or substituted by human-made capital, development will be unsustainable, either nationally or globally. If markets fail in this fundamental way, how can they promote sustainable development? To resolve this apparent conflict, we first need to analyze in greater depth the reason that markets fail to allocate natural resources efficiently.

EXTERNALITIES AND THE COMMONS

During the eighteenth century, as the Industrial Revolution began in England, cows still grazed on the commons of many villages in England and its American colonies. The essence of a village commons was **open access**, free of charge, to any member of the village. The first villagers to take advantage of open access had ample grazing for their livestock; their only cost was the time it would take to herd their animals to the commons, allow them to graze, and herd them home. But the amount of land was fixed and soil fertility and climate limited the quantity of grass. As more villagers used the commons, the grass became sparse, so the animals took longer to feed or, in the case of open rangeland, herders were forced to travel farther to find forage, so that everyone's costs rose. The rising average cost to each herder eventually discouraged grazing on the commons. But the new entrants did not have to pay compensation for the rising costs imposed on each of the previous entrants and more grazing took place than was in the interests of the village as a whole. Eventually, because no one incorporated the full cost of their grazing into their decisions, overgrazing destroyed the commons as a useful source of feed for everyone.

The dilemma of the commons is a widespread phenomenon, applicable to any limited resource to which access is unlimited. Grazing on open range, whether in the U.S. West or the African savanna, has the same outcome. Open access to timberlands or access at fees well below the social cost results in overlogging and the destruction of native forests in Brazil, Ghana, Indonesia, and many other tropical countries. Open access to fishing grounds in the North Atlantic, in Peru's Pacific waters, and in some inland lakes in Africa has already depleted fish stocks beyond their ability to regenerate. Free use of water from a stream benefits upland farmers, who have first access to the water, at the expense of downstream farmers, who get less water. Even traffic congestion in cities like Bangkok, Mexico City, and New York fits the description of a common property: City streets, to which access is free, are the common resource; each new vehicle causes worse traffic jams, forcing all previous entrants into longer, more costly commutes.

The earth's environment is composed of several common resources: air and the atmosphere, fresh water and the oceans, the earth's soils, and the diverse plant and animal species that live in this biosphere. Access to the environment typically is free. When manufacturers and farmers vent their waste into the air or water or create toxic dumps in the ground, they create health problems for the affected population, reduce the value of land in the affected area, destroy recreational potential, and generally reduce the welfare of people who value a clean environment. When lumber companies cut down a rain forest, they destroy the habitat of plant and animal species that are of value to others, including local populations that may harvest them or citizens or tourists who simply like to see them. Deforestation in the tropics significantly reduces biodiversity, perhaps eliminating potential new sources of pharmaceuticals or industrial products as well. They also may alter local climates, change patterns of water availability to surrounding farmers, and cause soil erosion. When we include the environment as a common resource, then much private activity generates external costs and market failure becomes a very general phenomenon. On a grand scale, we might think of the earth's entire atmosphere as a commons beset by the negative externality of greenhouse gas emissions, resulting in global climate change.

External costs and benefits are at the core of the common resource problem. A new producer creates higher costs for all previous entrants or all producers impose external costs on the general population. In either case, in the absence of regulation, taxes, or property rights for environmental quality, external costs are not borne by the producers who cause them and the prices of their products do not reflect the social costs of production. Thus more of these resource-depleting or -polluting goods and services are produced and consumed than would be the case if prices reflected external costs. Hence societies pollute more than their people would choose if markets reflected all social costs.

Figure 20–3 shows this process. In a market with competitive producers, the supply curve *S* represents private marginal costs, PMC. Market equilibrium occurs at price P_1 with output Q_1. But, if this is a polluting industry, the external costs make the social marginal cost, SMC, higher. If these costs were reflected in the market, the price would jump to P_2 and demand, and therefore output, would be reduced to Q_2. As less of the offending product is grown or manufactured, there would be less environmental degradation.

Designing responses to problems of the commons requires a closer look at what we mean by *the commons*, more formally referred to as **common-pool resources (CPRs)**. CPRs have two characteristics: It is difficult to exclude anyone from using them, and use by one person reduces the availability of that resource for use by others. Potential solutions to the types of problems noted earlier depend more specifically on the nature of property rights governing the CPR. Most of the problems of CPRs arise when property rights are defined as open access regimes, where there

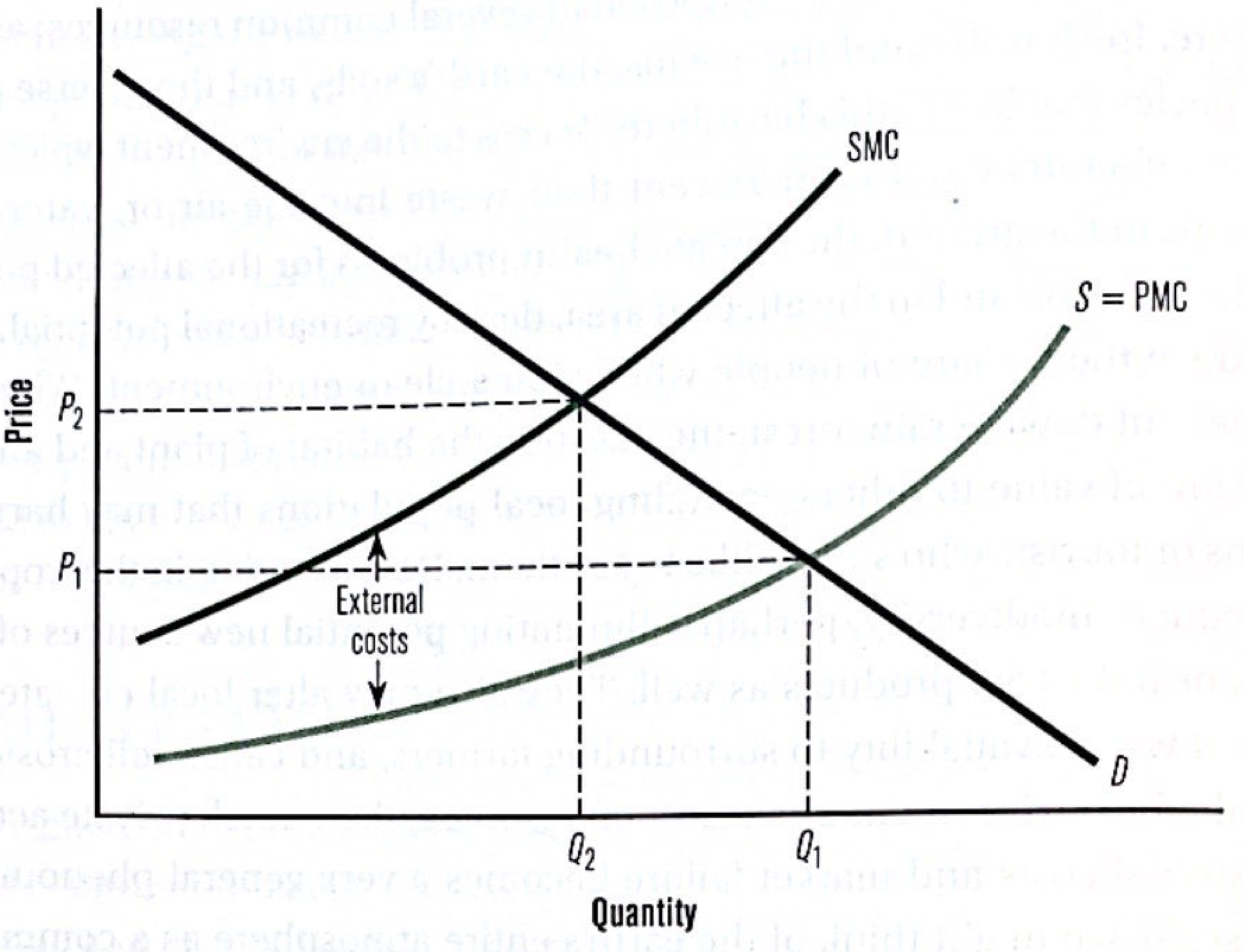

FIGURE 20-3 External Diseconomies

Polluters impose costs on others. If these external costs were reflected in the firms' costs, the social marginal cost curve (SMC) would prevail, the market price would be P_2, and output would be Q_2. But because the firms do not bear these costs, their private marginal cost curve (PMC) is lower, so more of the polluting product (Q_1) is produced and consumed.

are no property rights at all. Yet, other CPRs may be characterized by the existence of group property rights, individual (or firm) property rights, or government property rights. In such settings, tragedies of the commons are not inevitable. Economics Nobel Prize winner Elinor Ostrom shows that a wide range of institutions for governing and managing CPRs can, and have, evolved for CPRs that are not simply open access resources. Farmer-managed irrigation systems in Nepal are one among many examples of locally determined rules for conserving natural resources. Ostrom and colleagues find that particular settings are most conducive to the evolution of successful informal rules for managing CPRs. These settings are environments where the resource degradation is not yet too severe and where users have good information about conditions, situations in which users depend on the resource as a main source of their livelihoods and are interested in sustainability of the resource, and settings in which national governments facilitate local organization (rather than attempt to impose rules from outside the community).[16]

[16]Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (New York: Cambridge University Press, 1990). See also Joanna Burger, Christopher B. Field, Richard B. Norgaard, Elinor Ostrom, and David Policansky, "Revisiting the Commons: Local Lessons, Global Challenges," *Science* 284, no. 5412 (April 1999), 278.

POLICY SOLUTIONS

The market failures that lead to overexploitation of natural resources stem from external costs that are not borne by producers. Even in a well-functioning market economy, externalities require government intervention to make markets work better and to reach efficient market outcomes. Governments can bestow property rights on private users, regulate access to common resources, impose taxes (or pay subsidies) that reflect external costs (or benefits), and issue tradable access rights. There is also recent experience with informal regulation by local communities in the absence of formal government regulation. We discuss each of these options in turn.

PROPERTY RIGHTS

Common properties generate external costs because no one owns or controls the right to exploit them. For some resources, a simple solution would be to confer ownership, which economists call **property rights**, on a single individual or company. As long as the owner is a profit-maximizer and sells output in a competitive market, the socially optimal outcome is achieved without further government intervention. Property rights, to be effective, must be exclusive and well defined, leaving no doubt to the owners and possible competing claimants about what has been conferred and to whom. Rights need to be secure, so that the risk of loss through legal challenge or expropriation is reduced and enforceable through the judicial system. Ownership must be valid over a long-enough horizon that the owners have a stake in the long-term, sustainable exploitation of the resource. Longevity converts the resource into an asset for the producer, who can reap the benefits from investments in improving and sustaining its productivity. And the rights must be transferable, so the owner can realize the benefits of the resource asset by selling the property at any time.

The implications of clearly assigned property rights for market-based pollution abatement were formalized in 1960 by Nobel economist Ronald Coase. The **Coase theorem** posits that under certain circumstances (in particular, zero transaction costs), clear assignment of property rights leads bargaining in free markets to attain optimal levels of externalities. It is important that the Coase theorem also suggests that this result is independent of the specific allocation of those property rights.[17] A stylized example of the Coase theorem could be a situation in which an upstream factory dumps effluent waste into a river, which then flows downstream and destroys a fishery. When the river itself belongs to neither the factory nor the fisherman, this negative externality persists. The Coase theorem suggests that if either the factory or the fisherman is assigned property rights to the river, free bargaining between the two parties will result in the optimal level of pollution.

[17] R. H. Coase, "The Problem of Social Cost," *Journal of Law and Economics* 3 (1960), 1–44.

GOVERNMENT REGULATION

As an alternative to conveying private property rights, governments themselves can act as the owners of common resources and directly regulate their use. Governments can limit the quantity of a hunter's kill, a fisher's catch, a logger's haul, a rancher's herd, or a polluter's emissions. And they can regulate the kinds of equipment that can or must be used: Some kinds of fishing nets, boats, or navigation equipment have been banned; hunters may be restricted in their choice of weapons; polluters are required to install equipment that scrubs gas emissions and treats wastewater.

Quantity regulations raise two issues. First, how do the regulators know the optimal levels of access and output? If property rights can be conveyed, efficient outcomes are approached through market forces and no government judgments are needed. But if regulation replaces the market, regulators need to estimate the characteristics of both producers' costs and users' demand for the products of a common resource. To get a sense of these information requirements, consider the regulation of air pollution. The external costs of pollution are manifest in the reduced welfare of others: poor health, unsightly environment, lower property values, fewer and more expensive recreational possibilities, and possibly reduced productivity and income. If these costs could be measured, they would be depicted by a curve such as marginal external cost (MEC) in Figure 20-4, which shows the marginal external cost of pollution (measured along the horizontal axis). Those who believe that the costs of pollution are higher than normally recognized or who put a high premium on reducing pollution argue,

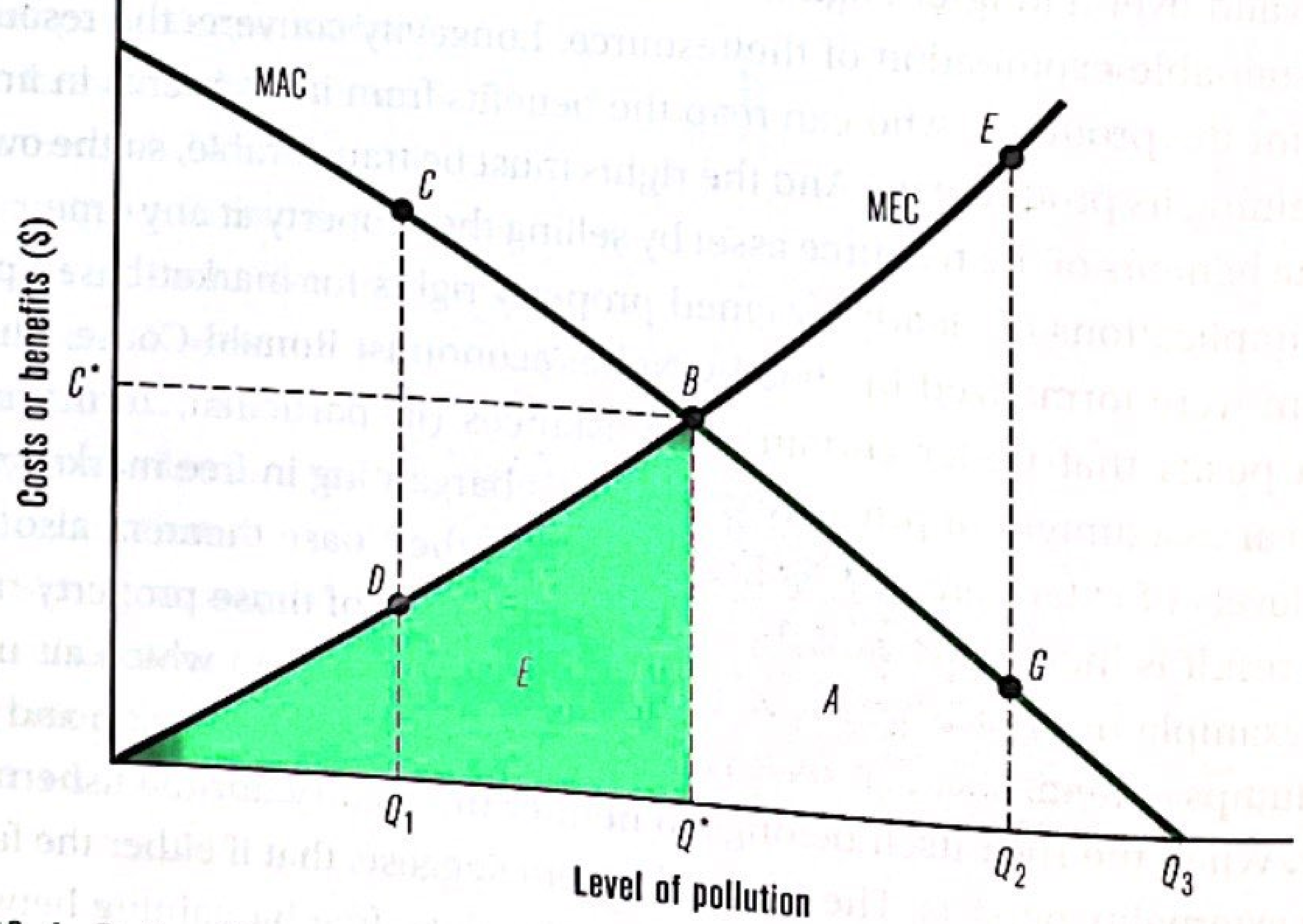

FIGURE 20-4 Optimal Level of Pollution
The marginal external cost of pollutants, borne by the population, is given by MEC; the marginal cost of abatement, borne by the firm, is MAC. The total cost to society (area $E + A$) is minimized and pollution is optimal at Q^*, where MEC = MAC.

in effect, that the MEC curve should be shifted up. Wherever it is located, any reduction in pollution (a movement to the left on the horizontal axis) means a reduction in the cost to society from pollution or, equivalently, an increase in the marginal external benefit of abatement.

However, there is a cost to abating pollution. The polluting firm, say, a petrochemical plant, can reduce its effluents either by changing its production process, installing abatement equipment such as gas scrubbers and water treatment plants, or reducing output. The marginal cost of abatement (MAC) function traces these marginal abatement costs. At any point along MAC, the cost shown is that of the lowest-cost method of abatement. Moving from right (high pollution) to left (lower pollution), MAC rises because it becomes increasingly costly to clean up air or water the stricter are the standards or the lower the level of contamination. It is important to recognize that these costs of abatement, although borne by the petrochemical firm, also are costs to society because they involve either less consumption of petrochemicals or savings spent on abatement that otherwise might have been spent on investment in other goods or services people want. These abatement costs thus have equal weight to the benefits gained by reducing pollution.

Society's (and government's) aim should be to minimize the combined costs of pollution and its abatement. This is achieved at Q^* in Figure 20–4, where MEC = MAC. At this point $Q_3 - Q^*$ of pollution has been abated (assuming for convenience that Q_3 is the maximum amount of pollution), and Q^* of pollution remains. Because these are marginal cost curves, the total external cost of pollution is the area E under MEC from 0 to Q^*. And the total cost of abatement is given by the shaded area A under the MAC curve between Q^* and Q_3. With less pollution, such as Q_1, the marginal abatement cost exceeds the marginal external cost of pollution and the total cost of additional abatement, the area of the trapezoid Q_1Q^*BC, exceeds the net gain from reduced pollution, Q_1Q^*BD. If more pollution is permitted, such as Q_2, the additional external cost, Q^*Q_2EB, exceeds the reduced cost of abatement, Q^*Q_2GB.

Therefore, society is better off with some pollution than with none, because abating the last unit of pollution is expensive relative to its benefits. Similarly, society gains from some exploitation of natural resources, even nonrenewable ones. But how do the regulators, who wish to achieve this optimal level of pollution, know what it is? To find Q^*, they have to know all the external costs of pollution, as a function of the levels of contaminants in the air, water, and soil. In addition to these estimates of direct economic costs, finding Q^* requires having a method for estimating the values people place on environmental amenities such as clean air, water, and soil. The costs in some cases are substantial. A recent collection of studies from the World Bank estimate the costs of environmental degradation in the Middle East and North Africa.[18] As summarized by country and by resource category in Table 20–2, these costs are

[18]Leila Croitoru and Maria Sarraf, eds., *The Cost of Environmental Degradation: Case Studies from the Middle East and North Africa* (Washington, DC: World Bank, 2010).

TABLE 20-2 Cost of Environmental Degradation in the Middle East and North Africa (percent GDP)

	ALGERIA	EGYPT	LEBANON	MOROCCO	SYRIA	TUNISIA
Air pollution	1.0	2.1	1.0	1.0	1.3	0.6
Lack of access to water supply and sanitation	0.8	1.0	1.1	1.2	0.9	0.6
Land degradation	1.2	1.2	0.6	0.4	1.0	0.5
Coastal zone degradation	0.6	0.3	0.7	0.5	0.1	0.3
Waste management	0.1	0.2	0.1	0.5	0.1	0.1
Subtotal	3.6	4.8	3.4	3.7	3.3	2.1
Global environment (CO_2 emissions)	1.2	0.6	0.5	0.9	1.3	0.6
Total	4.8	5.4	3.9	4.6	4.6	2.7

GPD, gross domestic product.

Source: Leila Croitoru and Maria Sarraf, eds., *The Cost of Environmental Degradation: Case Studies from the Middle East and North Africa* (Washington, DC: World Bank, 2010).

estimated to range from approximately 3 percent to 5 percent of GDP. Various studies of the cost of environmental degradation in China suggest a figure up to 13 percent of GDP. Such studies, however, confront a range of limitations (data in particular), and their results are generally not directly comparable (due to the use of differing methodologies). Their results are best interpreted as providing orders of magnitude.

In the absence of precise cost estimates, regulators must set somewhat arbitrary standards based on studies estimating the impact of pollutants on human health, animal survival, forest die back (from acid rain) and regeneration, and presumed climate changes.

TAXES, SUBSIDIES, AND PAYMENTS FOR ENVIRONMENTAL SERVICES

A third option is that, in principle, the government also could achieve optimal rates of resource use by imposing taxes that reduce the incentive for producers to use common properties or manufacture polluting products. A tax might be imposed on output that represents the external costs of production, so that the private marginal cost schedule shifts up to equal the social marginal cost schedule.[19] This might take the

[19]In Figure 20-3, the tax would shift the PMC schedule up to coincide with the SMC schedule.

form of a tax on each ton of steel or petrochemicals at a rate representing the external cost of pollution or a tax on gasoline to cover the costs of both pollution and traffic congestion. If the tax is on output or level of effort, the incentive is to reduce production of the good with external costs. If the tax can be levied on the externality itself, there is an additional incentive to invest in reducing external costs. For example, a tax on the quantity of pollutants would give petrochemical plants an incentive to abate pollution, because the tax then is reduced. In general, attempts to tax pollutants have had limited success (and even less success in high-income countries than in developing and transitional economies). Monitoring is difficult (and expensive), charge rates generally are set too low, and tax avoidance can be relatively easy. Malaysia began to implement pollution taxes in the 1970s, and China now operates the world's largest pollution tax system, though its effectiveness is disputed.[20] Box 20-2 describes efforts to tax water pollution in Colombia.

BOX 20-2 TAXING WATER POLLUTION IN COLOMBIA

Until the mid-1990s, Colombia's efforts to curb water pollution had relied exclusively on a traditional command-and-control approach in which regional environmental regulatory authorities were responsible for issuing permits for the discharge of wastewater. These permits were intended to limit the quantity of discharges and to require that they meet specific effluent standards. These regional regulatory authorities, known as CARs (which stands for *Corporaciónes Autónomas Regionales*), had issued permits to less than one third of all discharges by 2002 and were lax in their monitoring and enforcement of discharge standards.

Beginning in 1997, Colombia tried a new approach to reducing water pollution based on economic incentives, a per unit tax of pollution emitted. The implementation of this tax was specified in Decree 901, which directed that CARs first produce inventories of all facilities discharging wastewater and then set five-year pollution reduction goals for each water basin in their jurisdiction. The CARs would then set tax rates per unit of effluent based on a minimum fee determined by the Ministry of Environment, and then monitor the facilities' discharges on a regular basis.

Implementation of this water pollution tax encountered several barriers. Implementation was uneven across CARs, with only nine of Colombia's 33 CARs

[20] Jeffrey R. Vincent and Rozali Mohamed Ali, *Managing Natural Wealth: Environment and Development in Malaysia* (Washington, DC: Resources for the Future, 2005).

fulfilling all of the program requirements by 2003. In addition, less than half the polluting facilities were actually charged the tax, and collection rates from those facilities averaged only 27 percent between 1997 and 2002. Municipal sewage authorities were particularly reluctant to pay their taxes, sparking complaints of unfairness by private firms. Implementation of the pollution tax was also hindered by confusion surrounding the continued existence of the previous command-and-control system of permits.

Despite these impediments, a number of Colombia's water basins achieved significant reductions in wastewater discharges. The extent to which this achievement can be attributed to the discharge fee program is difficult to assess. The confusion lies in the fact that before 1997, nearly all of the CARs lacked the regulatory and enforcement capacity necessary to effectively implement *any* pollution reduction program. Once charged with the added responsibilities of creating inventories of polluting facilities and developing monitoring systems (with substantial technical support from the Ministry of Environment), the CARs' ability to enforce the old emissions standards was also enhanced. The discharge fee system was more transparent than the previous approach, requiring regular reporting by the CARs. In addition, the new fee system created economic incentives for better performance by the CARs themselves, which were allowed to keep fee revenues.

Source: Allen Blackman, "Incentives to Control Water Pollution in Developing Countries, How Well Has Colombia's Wastewater Discharge Fee Program Worked and Why?," *Resources* (Spring 2006) [Resources for the Future, Washington, DC].

Taxes that internalize external costs have two important advantages over regulation. First, they allow the producer to choose the method of reducing access to a common resource so that rents are not dissipated in wasteful expenditures forced by regulators. The cost savings with this flexibility can be substantial. Second, taxes can generate substantial revenues for the government. These kinds of revenues can be used to fund environmental programs or in other ways to compensate citizens for the harm caused by pollution and other environmental degradation.

The inverse of this discussion is also true. Some externalities are positive. Positive externalities exist when an activity creates social benefits that are external to the firm. Examples might include the invention of new technologies that spill over into other firms or sectors, or the provision of improved health or training for workers, or the pollination of neighboring orchards by bees from an apiary. Because these benefits are external to the firm, marginal social benefits exceed marginal private benefits, and markets undersupply them. In such cases, subsidies (which are simply negative taxes) may be justified to encourage optimal production of positive externalities. Such programs, however, run the risk of subsidizing activities that might have happened even in the absence of the subsidy.

Payments for environmental services (PES) are an extension of the idea of subsidizing the production of positive externalities. Economist Sven Wunder has defined PES as a voluntary transaction by which a well-defined environmental service is purchased by a buyer of that service from a provider conditional on the provision of the service.[21] Such arrangements effectively create markets that had been missing for external environmental benefits. For instance, forest conservation may provide little direct benefit to farmers, whose private costs and benefits might then favor cutting down forests to expand their fields. Yet, downstream populations must then forego the benefits created by forests, such as biodiversity and carbon storage. PES systems create markets through which potential beneficiaries of environmental services pay potential providers of those services. In this example, PES could be made to farmers to induce them not to destroy forest land for agricultural expansion. The buyers of environmental services might be the actual users of the services (for instance, a producer of hydroelectric power might pay upstream land users to conserve water). In other instances, governments (or even international financial institutions such as the World Bank) might pay providers for environmental services on behalf of users of those services.[22] Examples of user-financed PES programs are payments for watershed services in Pimampiro, Ecuador; payments for biodiversity and watershed services in Los Negros, Bolivia; and payments for carbon sequestration in Ecuador. Examples of government-financed PES programs are China's Sloping Land Conservation Program, Mexico's Payments for Hydrological Environmental Services program, and South Africa's Working for Water program.[23] PES programs exemplify practical efforts to implement the Coase theorem, as do the idea of marketable permits to pollute.

MARKETABLE PERMITS

A fourth intervention is to create a property right where none exists by issuing **marketable permits**, granting the holders the right to harvest a common resource up to a given limit or giving producers a license to pollute the environment up to specified amounts. Although environmentalists sometimes scoff at the notion of a *right* to pollute or exploit resources, this idea recognizes that zero pollution is usually not optimal because of the costs involved in achieving that goal. These permits may be

[21] Cited in Stefanie Engel, Stefano Pagiola, and Sven Wunder, "Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues," *Ecological Economics* 65 (2008), 663–74.

[22] Engel et al., Designing Payments for Environmental Services in Theory and Practice," p. 666.

[23] These programs are reviewed in Sven Wunder, Stefanie Engel, and Stefano Pagiola, "Payments for Environmental Services in Developing and Developed Countries," *Ecological Economics* [Special ed.] 65, no. 4 (May 2008), 663–852.

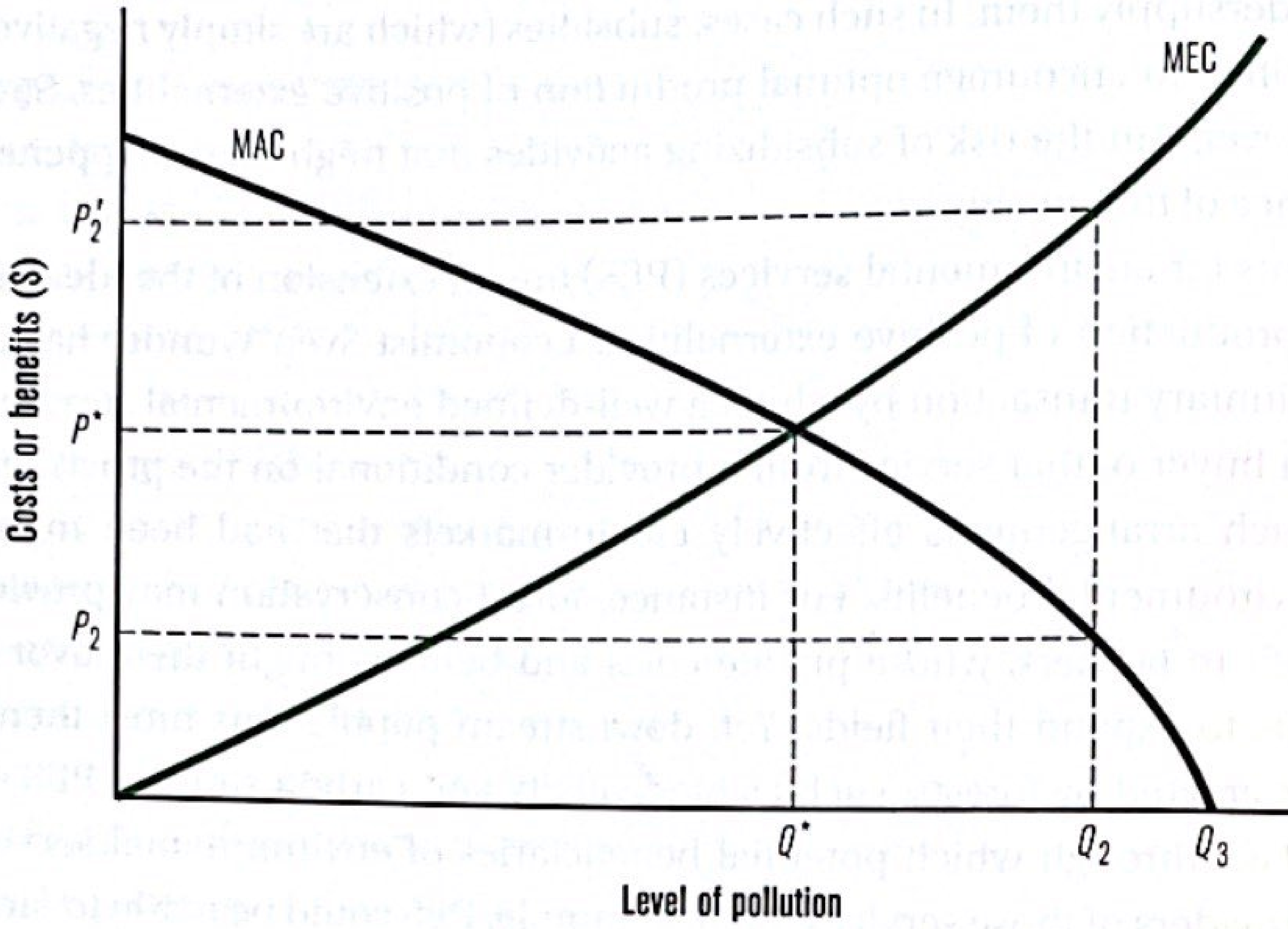

FIGURE 20-5 Marketable Permits to Pollute

The marginal cost of abatement (MAC) schedule shows the demand for pollution rights. If rights are issued to pollute up to Q_2, these are worth P_2 to polluters, but the public places a value of P_2' on reducing pollution. This could be the basis for a bargain to reduce pollution to the optimal level, Q^*.

MEC, marginal external cost.

the most efficient way to reduce pollution and resource overuse, and this approach has been a major innovation of the past decade. The U.S. sulfur dioxide reduction scheme relies on tradable rights, and both Iceland and New Zealand revived fishing stocks by assigning fishing rights at a sustainable level and allowing fishers to trade their quotas freely.

Figure 20-5 shows how a pollution permit works.[24] The MAC and MEC curves are copied from Figure 20-4. Say that the government knows the optimal level of pollution and auctions off emissions permits totaling Q^*. Any firm polluting without a permit, if detected, would be fined or shut down. (Thus permits have the same enforcement requirements as regulations or taxes.) If MAC represents the cost of pollution abatement for all firms in the market, they would bid up the price of permits to P^*. The MAC schedule (moving from right to left) shows that firms can reduce pollution from Q_3 to Q^* at costs less than P^*. Additional reductions in pollution would cost more than P^*. Therefore, the MAC schedule is the demand curve for permits. Either the government can issue a given number and observe the auction price paid for them or it can set a price and issue whatever number of permits is demanded by polluters.

[24]This figure is adapted from David W. Pearce and R. Kerry Turner, *Economics of Natural Resources and the Environment* (Baltimore: Johns Hopkins Press, 1990), 319–20.

In developing and transitional economies, where policy dependence on market forces is a more recent phenomenon, marketable permits have been less common, though are increasing in frequency. Examples are transferable quotas for fisheries in Chile (beginning in 1991) and South Africa (beginning in 1997). Chile also implemented an auctioning system for bus permits in its capital city, Santiago, starting in 1991, and a system of tradable quotas for the emission of total suspended particulates (TSP) from stationary sources in Santiago the following year. A review of Chile's TSP trading program found it to have had limited success due to several problems with its implementation.[25] One problem was that the enabling law itself was vague in regard to the way that permits would be allocated across firms. The program also initially overestimated the emissions target, which was subsequently reduced. By issuing permits totaling too high a level of emissions, effectiveness was limited. Effectiveness was further limited by the long period of time acquired for approval by the government for the sale of pollution permits between firms. These technical and institutional impediments to implementing Chile's marketable permit program indicate the challenges facing countries that choose this approach.

INFORMAL REGULATION

Informal regulation of pollution does not rely on traditional government-generated regulation. In place of formal regulation, such programs often rely on the public disclosure of information about firms' and factories' environmental performance to local stake holders (for instance people living near a factory or a firm's customers). Potential benefits of informal regulation are its low cost and its lack of reliance on formal regulatory institutions. These characteristics make informal regulation of pollution especially attractive in developing countries, which are typically short of both funds and highly evolved regulatory institutions. Public disclosure potentially empowers communities to pressure polluters to improve their environmental performance. The effects of such pressure might operate directly on the firm or indirectly if increased community awareness of the problem and its source leads to greater demand for formal intervention. In some circumstances, public disclosure can even bring pressure from capital markets for firms to alter their behavior. Public disclosure programs take one of two forms: registries of plants' emissions (without rating environmental performance), and programs that use plants' emissions data to rate environmental performance.[26] Chile and Mexico are among at least 20 countries with pollution registries, and performance ratings programs exist in China, Ghana, India, and several other developing countries.

[25] Jessica Coria and Thomas Sterner, "Tradable Permits in Developing Countries: Evidence from Air Pollution in Chile," *Journal of Environment & Development* 19, no. 2 (2010), 145–70.

[26] For an excellent survey, see Allen Blackman, "Alternative Pollution Control Policies in Developing Countries," *Review of Environmental Economics and Policy* 4, no. 2, (Summer 2010), 234–53.

The effectiveness of public disclosure types of informal environmental regulation, in practice, may depend on characteristics that may or may not be present in developing countries. For instance, in the absence of a credible threat of more stringent formal regulation, informal regulation may have less traction. In addition, capital markets may have little leverage in settings dominated by small firms with little reliance on outside investors. Further, information does not always flow freely in every country. Despite these contingencies, reviews of the effectiveness of public disclosure programs have found them to be effective in reducing pollution. These effects tend to be greater in cases in which the initial violations were the most flagrant. Yet, to date, rigorous evidence of successful ratings programs comes only from Indonesia, the Philippines, Vietnam, and China.[27]

POLICY FAILURES

Although some government intervention is necessary to correct for the market failures associated with natural resources, it is equally true that, all over the world, government policies frequently contribute to wasteful use of resources and the degradation of the environment. Too much intervention or intervention of the wrong kind can be just as costly as too little intervention. We have seen that, when production has external costs, one approach is to internalize those costs by raising production costs through taxing output or granting marketable property rights. But, instead, governments commonly subsidize or otherwise reduce the costs the production of commodities that degrade natural resources and often compromise property rights in ways that encourage rapacious exploitation. Examples are not hard to find.

Forestry policy has been especially destructive in many tropical countries. For many years Brazil subsidized ranching and other activities that encroached on the Amazon rain forest. Through at least the first five years of the twenty-first century, the area deforested each year in the Brazilian Amazon was equivalent in size to the state of New Jersey. Approximately two thirds of the deforested land in Brazil in recent decades has been used for cattle ranches, and most of the remaining third has been cleared for subsistence farming. More recently, commercial agriculture has also been an important source of deforestation in Brazil. Tax policies favorable to pasture land encouraged deforestation. Brazil has reformed some of these environmentally harmful tax incentives and stepped up efforts to regulate deforestation. At the end of 2010, the government of Brazil announced that the rate of deforestation in the Amazon for the previous year was 67 percent lower than the average rate of deforestation for the period 1996–2005. Time will tell if this improved trend proves durable. Box 20-3 describes the policy failures underlying the rapid rate of deforestation in Indonesia.

[27]Blackman, "Alternative Pollution Control Policies in Developing Countries," pp. 241–42.

BOX 20-3 POLICY FAILURES AND DEFORESTATION IN INDONESIA

Over the course of the twentieth century, Indonesia's forested area was cut by nearly 50 percent, mostly the result of commercial logging. In May 2010, the government of Indonesia introduced a moratorium on new logging contracts. Yet, for decades before 2010, Indonesia's rapid rate of deforestation was in some measure the result of government policy, more specifically, the failure of government policy. Four main categories of policy failure are to blame: policies supporting the buildup of excess capacity in the wood processing industry, conversion of forested areas into agricultural land, inefficient collection and use of rents collected from the forestry sector, and the absence of effective property rights in many forested areas.

Beginning in the 1970s, government policy in Indonesia supported the expansion of the timber processing industry by restricting the export of raw timber. This depressed domestic timber prices, thus subsidizing timber processors. The resulting overcapacity stimulated the demand for raw timber, much of it logged illegally. Government-subsidized loans to the timber processing industry heightened these incentives.

Substantial tracts of forest were also clearcut to create space for large oil palm plantations. This process accelerated during the 1990s and is cited as having contributed to the massive forest fires of 1997–98. In addition, the government was promoting migration from densely populated Java to the outer islands and cleared additional forest land to accommodate the migrants' farming activities.

The government was also inefficient in its collection of rents from the forestry sector. By law, the government was supposed to levy fees based on both forest area harvested and the number of units harvested. These fees were to be used for replanting the harvested areas. In practice, rent collection was limited, estimated to be between 24 and 36 percent of total economic rents in 1997–98, resulting in substantial windfall profits for the logging industry.

All of these problems have been made worse by the absence of secure property rights. By law, the state controls all forest areas. This means that the actual users of those lands have minimal incentive to invest in the long-term maintenance of that resource. Accelerated deforestation is one symptom of this problem.

Source: Raymond Atje and Kurnya Roesad, "Who Should Own Indonesia's Forests? Exploring the Links between Economic Incentives, Property Rights and Sustainable Forest Management," Economics Working Paper Series 76, Center for Strategic and International Studies, Jakarta, 2004.