20 The Quest for Sustainable Development

The challenge of finding sustainable development paths ought to provide the impetus—indeed the imperative—for a renewed search for multilateral solutions and a restructured international economic system of co-operation. These challenges cut across the divides of national sovereignty, of limited strategies for economic gain, and of separated disciplines of science.

—Gro Harlem Brundtland, Prime Minister of Norway, *Our Common Future* (1987)

Introduction

Delegations from 178 countries met in Rio de Janeiro during the first two weeks of June 1992 to begin the process of charting a sustainable development course for the future global economy. Billed by its organizers as the largest summit ever held, the United Nations Conference on Environment and Development (known popularly as the Earth Summit) sought to lay the groundwork for solving global environmental problems. The central focus for this meeting was sustainable development.

What is sustainable development? According to the Brundtland Report, which is widely credited with raising the concept to its current level of importance, "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). But that is far from the only possible definition.[1] Part of the widespread appeal of the concept, according to critics, is due to its vagueness. Being all things to all people can build a large following, but it also has a substantial disadvantage; close inspection may reveal the concept to be vacuous. As the emperor discovered about his new clothes, things are not always what they seem.

In this chapter we take a hard look at the concept of sustainable development and whether or not it is useful as a guide to the future. What are the basic principles of sustainable development? What does sustainable development imply about

[1]One search for definitions produced 61, although many were very similar. See Pezzey (1992).

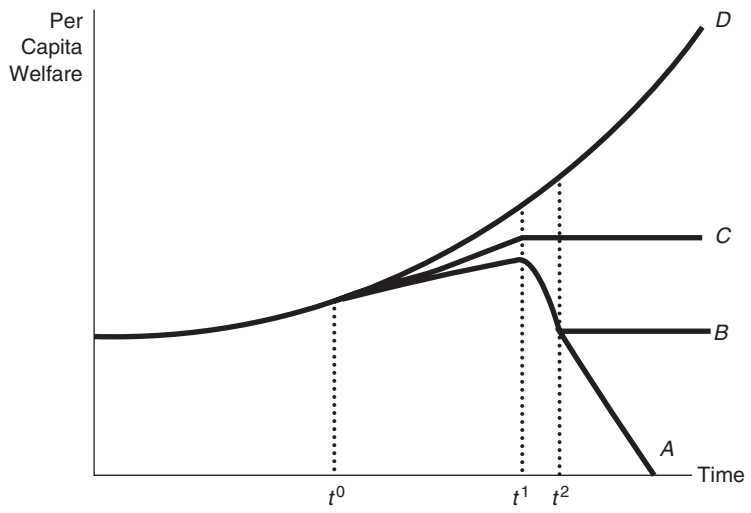
changes in the way our system operates? How could the transition to sustainable development be managed? Will the global economic system automatically produce sustainable development or will policy changes be needed? What policy changes?

Sustainability of Development

Suppose we were to map out possible future trends in the long-term welfare of the average citizen. Using a timescale measured in centuries on the horizontal axis (see Figure 20.1), four basic culture trends emerge, labeled *A*, *B*, *C*, and *D*, with t^0 representing the present. *D* portrays continued exponential growth in which the future becomes a simple repetition of the past. Although this scenario is generally considered to be infeasible, it is worth thinking about its implications if it were feasible. In this scenario not only would current welfare levels be sustainable, but also growth in welfare would be sustainable. Our concern for intergenerational justice would lead us to favor current generations, since they would be the poorest. Worrying about future generations would be unnecessary if unlimited growth were possible.

The second scenario (*C*) envisions slowly diminished growth culminating in a steady state where growth diminishes to zero. The welfare of each future generation is at least as well-off as all previous generations. Current welfare levels are sustainable, although current levels of welfare growth would not be. Since the level of welfare of each generation is sustainable, artificial constraints on the process would be unnecessary. To constrain growth would injure all subsequent generations.

FIGURE 20.1 Possible Alternative Futures



The third scenario (*B*) is similar in that it envisions initial growth followed by a steady state, but with an important difference—those generations between t^1 and t^2 are worse off than the generation preceding them. Neither growth nor welfare levels are sustainable at current levels, and the sustainability criterion would call for policy to transform the economy so that earlier generations do not benefit themselves at the expense of future generations.

The final scenario (*A*) denies the existence of sustainable per capita welfare levels, suggesting that the only possible sustainable level is zero. All consumption by the current generation serves simply to hasten the end of civilization.

These scenarios suggest three important dimensions of the sustainability issue: (1) the existence of a positive sustainable level of welfare; (2) the magnitude of the ultimate sustainable level of welfare vis-à-vis current welfare levels; and (3) the sensitivity of the future level of welfare to actions by previous generations. The first dimension is important because if positive sustainable levels of welfare are possible, scenario *A*, which in some ways is the most philosophically difficult, is ruled out. The second is important because if the ultimately sustainable welfare level is higher than the current level, radical surgery to cut current living standards is not necessary. The final dimension raises the issue of whether the ultimate sustainable level of welfare can be increased or reduced by the actions of current generations. If so, the sustainability criterion would suggest taking these impacts into account, lest future generations be unnecessarily impoverished by involuntary wealth transfers to previous generations.

The first dimension is relatively easy to dispense with. The existence of positive sustainable welfare levels is guaranteed by the existence of renewable resources, particularly solar energy, as well as by nature's ability to assimilate a certain amount of waste.[2] Therefore, we can rule out scenario *A*.

Scenarios *B* and *C* require actions to assure the maintenance of a sustainable level of welfare. They differ in terms of how radical the actions must be. Although no one knows exactly what level of economic activity can ultimately be sustained, the ecological footprint measurements discussed later in this chapter suggest that current welfare levels are not sustainable. If that controversial assessment is valid, more stringent measures are called for. If scenario *C* is more likely, then the actions could be more measured, but still necessary.

Current generations can affect the sustainable welfare levels of future generations both positively and negatively. We could use our resources to accumulate a capital stock, providing future generations with shelter, productivity, and transportation, but machines and buildings do not last forever. Even capital that physically stands the test of time may become economically obsolete by being ill suited to the needs of subsequent generations.

Our most lasting contribution to future generations would probably come from what economists call human capital—investments in people. Though the people

[2]One study estimates that humans are currently using approximately 19–25 percent of the renewable energy available from photosynthesis. On land the estimate is more likely 40 percent (Vitousek et al., 1986).

who receive education and training are mortal, the ideas they bring forth are not: knowledge endures.[3]

Current actions could also reduce future welfare levels, however. Fossil fuel combustion could modify the climate to the detriment of future agriculture. Current chlorofluorocarbon emissions might, by depleting the atmosphere's ozone, raise the incidence of skin cancer. The storage of radioactive wastes could increase the likelihood of genetic damage in the future. The reduction of genetic diversity in the stock of plants and animals could well reduce future medical discoveries.

Suppose that higher levels of sustainable welfare are feasible. Would our market system automatically choose a growth path that produces sustainable welfare levels, or could it choose one that enriches current generations at the expense of future generations?

Market Allocations

Market imperfections, including intertemporal externalities, open-access resources, and market power create incentives that can interfere in important ways with the quest for sustainable development.

Allowing open access to resources can, and commonly does, promote unsustainable allocations. When resources are allocated by open-access, even the existence of renewable resources cannot assure sustainability. Diminished stocks are left for the future. In the extreme, it is even possible that some harvested species would become extinct.

Intertemporal externalities also undermine the ability of the market to produce sustainable outcomes. Emissions of greenhouse gases impose a cost on future generations that is external to current generations. Current actions to reduce the gases will impose costs on this generation, but the bulk of the benefits would not be felt until significantly later. Economic theory clearly forecasts that too many greenhouse gas emissions would be forthcoming for the sustainability criterion to be satisfied.

While market imperfections normally do exacerbate the problem of unsustainability, the more general conclusion that they always promote unsustainability, however, is not correct. For example, the high oil prices driven by an oil cartel serve to retard demand and conserve more for future generations than otherwise would be the case.

Markets can sometimes provide a safety valve to ensure sustainability when the supply of a renewable resource is threatened. Fish farming is one example where declining supplies of a renewable resource trigger the availability of an alternative renewable substitute. Even when the government intervenes detrimentally in a way that benefits current generations at the expense of future generations,

[3]While it is true that ideas can last forever, the value of those ideas may decline with time as they are supplanted by new ideas. The person who conceived of horseshoes made an enormous contribution to society at the time, but the value of that insight to society has diminished along with our reliance on horses for transportation.

as it did with natural gas, the market can limit the damage by making substitutes available. While government regulation made the transition significantly less smooth than it might have been, it did not prevent the transition altogether.

The flexibility and responsiveness of markets to scarcity can be an important component of the transition to sustainability, but the notion that markets would, if left to their own devices, automatically provide for the future is naïve, despite their apparent success in providing for generations in the past.

Efficiency and Sustainability

Suppose future governments were able to eliminate all market imperfections, restoring efficiency to the global economic system. In this idealized world, intertemporal and contemporaneous externalities would be reduced to efficient levels. Access to common resources would be restricted to efficient levels and harvesting excess capacity would be eliminated. Competition would be restored to previously cartelized natural resource markets. Would this package of policies be sufficient to achieve sustainability, or is something more required?

One way to examine this question is to examine a number of different models that capture the essence of intertemporal resource allocation. For each model the question becomes, "Will efficient markets automatically produce sustainable development?" The conclusion to be drawn from these models is very clear; restoring efficiency is *not* always sufficient to produce sustainability.

Take the allocation of depletable resources over time. Imagine a simple economy where the only activity is the extraction and consumption of a single depletable resource. Even when the population is constant and demand curves are temporally stable, the efficient quantity profiles show declining consumption over time. In this hypothetical world, later generations would be unambiguously worse off unless current generations transferred some of the net benefits into the future. Even an efficient market allocation would not be sustainable in the absence of transfers.

The existence of an abundant renewable backstop resource would not solve the problem. Even in this more congenial set of circumstances, the quantity profile of the depletable resource would still involve declining consumption until the backstop was reached. In the absence of compensating transfers, even efficient markets would use depletable resources to support a higher current standard of living than could ultimately be permanently supported.

In a historically important article, Dasgupta and Heal (1979) find a similar result for a slightly more realistic model. They assume an economy in which a single consumption good is produced by combining capital with a depletable resource. The finite supply of the depletable resource can either be used to produce capital or it can be used in combination with capital to produce the consumption good. The more capital produced, the higher is the marginal product of the remaining depletable resource in making the consumption good.

They prove that a sustainable constant consumption level exists in this model. The rising capital stock (implying a rising marginal product for the depletable resource) would compensate for the declining availability of the depletable resource. They also prove, however, that the use of any positive discount rate would

necessarily result in declining consumption levels, a violation of the sustainability criterion. Discounting, of course, is an inherent component of dynamically efficient allocations.

In this model, sustainable development is possible, but it is not the choice made by markets, even efficient markets. Why not? What would it take to ensure sustainable allocations? Hartwick (1977) shows that the achievement of a constant per capita consumption path (which would satisfy our definition of sustainability) results when all scarcity rent is invested in capital. None of it should be consumed by current generations.

Would this be the normal outcome? No, it would not. With a positive discount rate, some of the scarcity rent is consumed, violating the Hartwick rule. The point is profound. Restoring efficiency will typically represent a move toward sustainability, but it will not, by itself, *always* be sufficient. Additional policies must be implemented to guarantee sustainable outcomes.

Not all economic models reach this discouraging conclusion. Specifically, a class of models with endogenous technical progress allows the possibility that efficient markets will produce sustainable outcomes. Endogenous technical progress means that the economic incentives inherent in the growth process produce a rate of technological progress that benefits future generations (remember that technological process shifts out the production possibilities). If the resulting rate is large enough to offset the declines to future generations caused by any current generations, efficient markets can produce sustainable outcomes.

Can we count on the fact that the endogenous rate to technological progress will be sufficiently high to generate a sustainable outcome? It is not guaranteed.

In Chapter 5 we pointed out that maintaining a nondeclining value of the capital stock (both physical and natural) provided an observable means of checking on the sustainability of current activity. If the value of the capital stock is declining, the activity is unsustainable. Can we automatically conclude that a nondeclining value of the capital stock implies the sustainability of current consumption levels? According to work by Asheim (1994) and elaborated on by Pezzey (1994), we cannot. Rising net wealth can coincide with unsustainability when the capital stock is being valued at the wrong (i.e., unsustainable) prices. When nonrenewable resources are being used up too rapidly, prices are driven down. Using these (artificially depressed) prices can create the false impression that the value of the depletion is less than the value of the additional investment and, therefore, that the value of the capital stock is rising. In fact, at the correct prices, it may be falling.

Another study by Howarth and Norgaard (1990) reaches a similar conclusion from a different perspective. They derive competitive resource allocations across generations, assuming that each generation is assigned a specific share of the available depletable resources. This share is then varied and a new allocation calculated for each to reveal the effect of this intertemporal assignment of property rights to resources among generations. For our purposes, two of their conclusions are relevant: (1) the resulting allocations are sensitive to the initial allocation of the resource rights across generations; and (2) assigning all of the rights to the first generation would not produce a sustainable outcome. This study provides yet

another perspective underlying the conclusion that efficient allocations of depletable resources do not necessarily produce sustainable outcomes.

How about with renewable resources? At least renewable resource flows could, in principle, endure forever. Are efficient market allocations of renewable resources compatible with sustainable development? John Pezzey (1992) has examined the sustainability of an allocation of a single renewable resource (such as corn) over time. Sustained growth of welfare can occur in this model, but only if two conditions hold: (1) the resource growth rate exceeds the sum of the discount rate and the population growth rate; (2) and the initial food supply is sufficient for the existing population. The first condition is sometimes difficult to meet, particularly with rapid population growth and slow-growing biological resources. Sustainable development of renewable resources is much harder in the presence of rapid population growth rates because the pressure to exceed sustainable harvest rates becomes harder to resist.

The second condition raises a more general and a more difficult concern. It implies the distinct possibility that if the starting conditions are sufficiently far from a sustainable path, sustainable outcomes may not be achievable without outside intervention. The simplest way to see this point is to note that a country that is so poor that it is reduced to eating all the seed corn sacrifices its future in order to survive in the present. The double message that can be derived from these results is that (1) it is important to ensure, by acting quickly, that conditions do not deteriorate to the extent that survival strategies preclude investment; and (2) foreign aid is likely to be an essential part of sustainability policies for the poorest nations.

We must be careful to distinguish between what has been said and what has not been said. Restoring efficiency may well result in an improvement in sustainability, but efficiency may not be either necessary or sufficient for sustainability. Three different cases can emerge. In the first case, the private inefficient outcome is sustainable and the efficient outcome is also sustainable. In this case, restoring efficiency will raise well-being, but it is not necessary for sustainability. This case might prevail when resources are extraordinarily abundant relative to their use. In the second case, the private inefficient equilibrium is unsustainable, but the efficient outcome is sustainable. In this case, restoring efficiency not only increases current well-being, but it is also sufficient to ensure sustainability. In the final case, neither the private inefficient outcome nor the efficient outcome is sustainable. In this case, restoring efficiency will not be enough to produce a sustainable outcome. Some sacrifice by current generations would be necessary to ensure adequate protection for the well-being of future generations.

While efficient markets cannot always achieve sustainable development paths, this does not mean that unsustainability would be the norm. Indeed, the historical record suggests that the incompatibility of the efficiency criterion and the sustainability criterion has been the exception, not the rule. Capital accumulation and technological progress have expanded the ways in which resources could be used and have increased subsequent welfare levels in spite of a declining resource base. Nonetheless, the two criteria are certainly not inevitably compatible. As resource bases diminish and global externalities increase, the conflict between these criteria can be expected to become more important.

Trade and the Environment

One of the traditional paths to development involves opening up the economy to trade. Freer international markets provide lower prices for consumer goods (due to the availability of and competition from imported products) and the opportunity for domestic producers to serve foreign markets. The law of comparative advantage suggests that trade can benefit both parties. One might suspect (correctly) that as one moves from theory to practice, the story would become a bit more complicated.

The Role of Property Rights. From our previous studies in this book, it should be clear that trade can certainly inflict detrimental (and inefficient) effects on the environment when some nations (presumably those in the less developed South) have poorly defined property rights or have not internalized their externalities (such as pollution). Chichilnisky (1994) showed that in this kind of situation, the tragedy of the commons can become greatly intensified by freer trade. Poorly defined property rights in the exporting nations encourage the importing nations (by artificially lowering prices) to greatly expand their consumption of the underpriced resources. In this scenario, trade intensifies environmental problems by increasing the pressure on open-access resources and hastening their degradation.

Pollution Havens and the Race to the Bottom. The failure to control externalities such as pollution provides another possible route, known as the "pollution havens" hypothesis, for trade to induce environmental degradation. According to this hypothesis, producers affected by stricter environmental regulations in one country will either move their dirtiest production facilities to countries with less stringent environmental regulations (presumed to be lower-income countries) or face a loss of market share. Consumers in the country with the strict regulation have an incentive to prefer the cheaper goods produced in the pollution havens.

Pollution levels can change in the pollution havens for three different reasons: (1) the composition effect; (2) the technique effect; or (3) the scale effect. According to the *composition effect*, emissions change as the mix of dirty and clean industries changes; as the ratio of dirty to clean industries increases, emissions increase, even if total output remains the same. (Note that this is the expected outcome from the pollution havens hypothesis.) The *technique effect* involves the ratio of emissions per unit output in each industry. Emissions could increase in pollution havens via this effect if each firm in the pollution haven became dirtier as a result of openness to trade. And finally the *scale effect* looks at the role of output level on emissions; even if the composition and technique effects were zero, emissions could increase in pollution havens simply because output levels increased.

In addition to suggesting a channel for degradation, the pollution havens hypothesis, if correct, could provide a justification for developing countries to accept lower environmental standards. In this view, lower environmental standards protect against job loss. In other words, it suggests a "race to the bottom" feedback mechanism where competitive incentives among nations force developing countries to keep environmental standards weak in order to attract jobs, and jobs move to those locations in search of the lower costs resulting from lower standards.

What is the evidence on the empirical validity of the pollution havens hypothesis and its race to the bottom implication? Earlier surveys of the empirical work, such as Dean (1992), found absolutely no support for the effect of environmental regulation on either trade or capital flows. Jaffe et al. (1995) reach the same conclusion in their survey of the effect of environmental regulations on U.S. competitiveness. Several recent studies reviewed by Copeland and Taylor (2004), however, have begun to find that environmental regulation can influence trade flows and plant location, all other things being equal, though the effects are small.

Some of this work focuses on the effect of environmental regulations on the movement of production among states within the United States, rather than to developing countries. Studies by Kahn (1997), Greenstone (2002), and Becker and Henderson (2000), for example, find that growth in such indicators as manufacturing activity and employment as well as new plant start-ups for polluting industries was higher in attainment areas than in the more stringently regulated nonattainment areas.

Has there been a discernable exodus of dirty industries to developing countries? Apparently not. Studies that attempt to isolate composition, technique, and scale effects generally find that the composition effect (the most important effect for confirming the pollution havens hypothesis) is small relative to scale effects. Furthermore, technique effects normally result in less, not more, pollution (Hettige, Mani, and Wheeler, 2000). Though trade can increase pollution through the scale effect, these findings are quite different from what we would expect from a race to the bottom.

Actually, these results should not be surprising. Because pollution control costs comprise a relatively small part of the costs of production, it would be surprising if lowering environmental standards could become a major determinant of either firm location decisions or the direction of trade unless the costs of meeting those standards became a significant component of production cost.

The Porter "Induced Innovation" Hypothesis. The story does not end there. Michael Porter (1991), a Harvard Business School professor, has argued that more environmental protection can, under the right circumstances, promote jobs, not destroy them. Now known as the "Porter induced innovation hypothesis," this view suggests that firms in nations with the most stringent regulations experience a competitive advantage rather than a competitive disadvantage. Under this nontraditional view, strict environmental regulations force firms to innovate, and innovative firms tend to be more competitive. This advantage is particularly pronounced for firms producing pollution control equipment (which can then be exported to firms in countries subsequently raising their environmental standards), but it might also be present for firms that find that meeting environmental regulations actually lowers their production costs. Some instances of regulation-induced lower production costs have been recorded in the literature (Barbera and McConnell, 1990), but few studies have found the Porter hypothesis to be universally true.

While it seems clear that innovation induced by environmental regulation could simultaneously increase productivity (lower costs) and lower emissions, it is less clear why this would necessarily always or even normally be the case. And if it were

universally true, it is not clear why all firms would fail to adopt these techniques even in the absence of regulations.

The Porter hypothesis is valuable because it reminds us that a particularly ingrained piece of conventional wisdom ("environmental regulation reduces firm competitiveness") is frequently wrong. It would be a mistake, however, to use it as confirmation of the much stronger proposition that environmental regulation is universally good for competitiveness.

The Environmental Kuznets Curve (EKC). Although proponents of free trade have come to recognize the potential problems for the environment posed by free trade, particularly in the face of externalities or poor property right regimes in the exporting countries, they tend to suggest that these problems will be self-correcting. Specifically, they argue that as freer trade increases incomes, the higher incomes will promote more environmental protection.

The specific functional relationship underlying this view comes from some earlier work by Simon Kuznets, a Harvard professor who died in 1985, and so has become known as the Environmental Kuznets Curve. According to this relationship, environmental degradation increases with higher per capita incomes up to some income level (the turning point). After the turning point, however, higher incomes result in reductions in environmental degradation. Some apparent confirmation of this view came from early studies that plotted variables such as SO_2 concentrations against per capita incomes using countries as the units of observation (data points).

The notion that increasing income from trade involves a self-correcting mechanism would have quite a different meaning if part of that correction involved exporting the pollution-intensive industries to other countries. This would change the meaning of the Kuznets curve considerably since it would involve a transfer of pollution, not a reduction of pollution. This conjecture is especially important in a finite world because it implies that developing countries would never experience the Kuznets turning point. Since they would have nowhere to go, the pollution-intensive industries could not be transferred again.

How is the EKC relationship affected by trade? Cole (2004) examines this question and finds that explicit consideration of trade effects in estimating the EKC relationship does not eliminate the turning point for most pollutants, but it does affect the timing. In particular, controlling for the transfer of pollution-intensive industries makes the actual turning point occur later than without considering these effects.

How about the general proposition that pollution problems are self-correcting with development? In general, that proposition has little empirical support (Neumayer, 2001). The early studies used different nations as data points, but the interpretation suggested that an individual country would eventually increase environmental protection as its income increased. Subsequent studies that looked at how environmental protection varied over time as income increased within an individual country frequently did not find the expected relationship (Deacon and Norman, 2006; Vincent, 1997). Other studies found that it seemed to apply to some pollutants (such as SO_2) but not to others (such as CO_2) (List and Gallet, 1999; World Bank, 1992). And finally, as Example 20.1 illustrates, some case

EXAMPLE 20.1

Has NAFTA Improved the Environment in Mexico?

The North American Free Trade Agreement (NAFTA) took effect in 1994. By lowering tariff barriers and promoting the freer flow of goods and capital, NAFTA integrated the United States, Canada, and Mexico into a single, giant market. The agreement has apparently been successful in promoting trade and investment. Has it also been successful in promoting environmental protection in Mexico?

According to a study by Kevin Gallagher (2004), it has not, although not necessarily due to the forces identified by the pollution havens hypothesis. Some effects clearly resulted in less pollution and others more, although on balance, air quality has deteriorated.

The pollution havens hypothesis might lead us to expect a relocation of heavily polluting firms from the United States to Mexico, but that apparently did not happen. None of the numerous statistical tests performed by the author supported that hypothesis.

In terms of positive effects on air quality from trade, Gallagher found significant shifts in Mexican industry away from pollution-intensive sectors; the posttrade Mexican industrial mix was less polluting than the pretrade industrial mix (the opposite of what would be expected from the pollution havens hypothesis). He even found that some Mexican industries (specifically steel and cement) were cleaner than their counterparts in the United States, a fact he attributes to their success in securing new investment for more modern plants with cleaner technologies.

The largest trade-related source of air quality degradation was the scale effect. Although the posttrade industrial mix generally shifted away from the most polluting sectors (meaning fewer average emissions per unit output), the promotion of exports increased output levels considerably. Increased output meant more emissions (in this case, almost a doubling).

One expectation emanating from the Environmental Kuznets Curve is that the increased incomes from trade would result in more environmental regulation, which, in turn, would curb emissions. That expectation was not met either. Gallagher found that both real government spending on environmental policy and the number of Mexican plant-level environmental compliance inspections fell by 45 percent after NAFTA, despite the fact that income levels reached the turning point expected by the pretrade studies.

Source: Kevin P. Gallagher. *Free Trade and the Environment: Mexico, NAFTA and Beyond* (Palo Alto, CA: Stanford University Press, 2004).

studies in countries that have experienced considerably freer trade regimes have generally experienced intensified, not reduced, environmental degradation.

What are we to make of this evidence? Apparently, environmental regulations are not a major determinant of either firm location decisions or the direction of trade. This implies that reasonable environmental regulations should not be held hostage to threats that polluters will leave the area and take their jobs with them; with few exceptions, firms that are going to move will move anyway, while firms that are not going to move will tend to stay whatever the regulatory environment.

When deterioration is caused by inadequate local property right regimes or inadequate internalization of externalities, it may not be necessary or desirable to prevent trade, but rather to correct these sources of market failure. These inefficiencies associated with trade could be solved with adequate property regimes and appropriate pollution control mechanisms. On the other hand, if establishing appropriate property regimes or pollution control mechanisms is not politically feasible, other means of protecting the resources must be found, including possibly restricting detrimental trade. However, caution must be used in imposing these trade restrictions, since they are a second-best policy instrument in this case and can even be counterproductive.[4]

While the foregoing argument suggests that the starkest claims against the environmental effects of free trade do not bear up under close scrutiny, it would be equally wrong to suggest that opening borders to freer trade inevitably results in a gain in efficiency and/or sustainability. The truth, it seems, depends on the circumstances, so pure ideology does not get us very far. The context matters.

Since new trade institutions are now emerging, new issues with enormous implications for the environment are emerging with them. Among these issues are the environmental consequences of (1) protections for companies investing in foreign countries that are adversely affected by environmental regulations and (2) international trade rules under the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization.

Investor Protections: NAFTA's Chapter 11. The North American Free Trade Agreement includes an array of new corporate investment rights and protections that are unprecedented in scope and power. Under Chapter 11 of that agreement, NAFTA allows corporations to sue the national government of a NAFTA country in secret arbitration tribunals if they feel that a regulation or government decision adversely affects their investment in a way that violates these new NAFTA rights. If the corporation wins, the taxpayers of the "losing" NAFTA nation must foot the bill.

The environmental concern raised by this provision is that it could be used to require governments to compensate companies that are financially damaged by legitimate environmental regulations, a consequence that has historically not been common. Requiring companies to be compensated could in turn put a significant damper on efforts to enact environmental legislation.

How strong this effect will be remains to be seen, but several cases involving environmental legislation have already arisen. For example, consider the effect of this rule on the movement away from the gasoline additive MTBE discussed in Chapter 17. In 1999, the State of California decided to phase out MTBE. Suspected by the World Health Organization of being carcinogenic, MTBE had been found to have contaminated at least 10,000 groundwater wells in the state. The MTBE ban went into effect January 1, 2004.

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[4]Barbier and Schulz (1997) note a case in which a trade restriction designed to protect against deforestation from excessive export logging sufficiently lowered the value of the forest that the land was deforested to facilitate its conversion to agriculture.

A Canadian company, Methanex Corporation, which has a subsidiary in the United States, filed a NAFTA Chapter 11 claim against the United States. The company produces methanol, a component of MTBE, and alleges that California's ban of MTBE constitutes an expropriation of their investment, by interfering with their ability to do business. The company sought $970 million in compensation. During 2005, the Methanex claims were found to be without merit and the corporation was ordered to reimburse the United States for all legal costs it incurred in defending itself against their claim.

Many observers, including many proponents of freer trade, believe this rule has gone too far, although the concerns are based more on potential harms than actual settled cases. It is, however, hard to imagine how secret proceedings could be justified. They are an anachronism in a society that places emphasis on freedom of information. In addition, observers have called for a change in the burden of proof. A finding that a uniformly applied action had a differentially large impact on a company should not be sufficient to justify compensation. Plaintiffs in Chapter 11 actions should have to show that the government agency was discriminating against the foreign firm.

Trade Rules under GATT and the WTO

The General Agreement on Tariffs and Trade (GATT), the international agreement that laid the groundwork for the World Trade Organization (WTO), was first signed in 1947. That agreement provided an international forum for encouraging free trade between member states by regulating and reducing tariffs on traded goods and by providing a common mechanism for resolving trade disputes. Having now replaced the GATT forum, the WTO is the sole global international organization dealing with the rules of trade between nations.

As an organization devoted to freer trade, the WTO adjudicates disputes among trading nations through the lens of its effect on trade. Domestic restrictions on trade of any kind (including environmental restrictions) are suspect unless they pass muster. To decide whether they pass muster or not, the WTO has evolved a set of rules to define the border between acceptable actions and unacceptable actions.

These rules examine, for example, such things as "differential treatment." A disputed environmental action that discriminates against goods from another country (rather than holding imports and domestically produced goods to the same standard) is deemed differential treatment and is unacceptable. Disputed actions that are not the lowest-cost (and least injurious to trade) action that could have been taken to address the particular environmental problem are also unacceptable.

One of the most controversial rules involves a distinction between "product" concerns and "process" concerns (see Debate 20.1). At the risk of oversimplification, regulations that address product concerns (such as mandating the highest acceptable residual pesticide levels in foods) are acceptable, but regulations addressing the process by which the product was made or harvested (such as banning steel from a particular country because it is made in coal-burning plants) are not acceptable. In the latter case, the steel from coal-burning plants is considered to be indistinguishable from steel made by other processes, so the product is considered to be homogeneous and treating it as different is unacceptable.

DEBATE 20.1

Should an Importing Country Be Able to Use Trade Restrictions to Influence Harmful Fishing Practices in an Exporting Nation?

Yellowfin tuna in the Eastern Tropical Pacific often travel in the company of dolphins. Recognizing that this connection could be exploited to more readily locate tuna, tuna fishermen used it to increase their catch with deadly effects for dolphins. Having located dolphins, tuna vessels would use giant purse seines to encircle and trap the tuna, capturing (and frequently killing) dolphins at the same time.

In response to public outrage at this technique, the United States enacted the Marine Mammal Protection Act (MMPA). This act prohibited the importation of fish caught with commercial fishing technology that results in the incidental kill or serious injury of ocean mammals in excess of U.S. standards.

In 1991, a GATT panel ruled on an action brought by Mexico asserting that U.S. law violated GATT rules because it treated physically identical goods (tuna) differently. According to this ruling, countries could regulate products that were harmful (as long as they treated domestic and imported products the same), but not the processes by which the products were harvested or produced in foreign countries. Using domestic regulations to selectively ban products as a means of securing change in the production or harvesting decisions of other countries was ruled a violation of the international trade rules.

The United States responded by mandating an ecolabeling program. Under this law, tuna caught in ways that killed dolphins could be imported, but exporters were not allowed to use the "dolphin-safe" label. Tuna caught with purse seines nets could only use the "dolphin-safe" label if special on-board observers witnessed no dolphin deaths. The dispute has ultimately been resolved by a bilateral agreement rather than a WTO ruling.

Sources: The official GATT history of the case can be found at http://www.wto.org/english/tratop_e/envir_e/envir_backgrnd_e/c8s1_e.htm#united_states_tuna_mexico and an environmental take on it can be found on the Public citizen Web site at http://www.citizen.org/trade/wto/ENVIRONMENT/articles.cfm?ID=9298/.

The inability of any country to address process concerns in its imports clearly limits its ability to internalize externalities. In light of this interpretation, one way to internalize externalities in other countries would be to use means other than trade (international agreements to limit carbon emissions, for example). Another, as Debate 20.1 points out, is to use ecolabeling as a means of putting at least some market pressure on the disputed practices. How far that labeling can go without triggering a negative WTO ruling remains to be seen.

The Natural Resource Curse

One, especially intriguing possible barrier to development might plague resource-abundant nations. Common sense suggests that those countries blessed with abundant

EXAMPLE 20.2

The "Natural Resource Curse" Hypothesis

Perhaps, surprisingly, there is robust evidence that countries endowed with an abundance of natural resources are likely to develop less rapidly. And it is not merely because resource-rich countries are subject to volatile commodity prices.

Why might a large resource endowment exert a drag on growth? Several possibilities have been suggested. Most share the characteristic that resource-rich sectors are thought to "crowd out" investment in other sectors that might be more likely to support development:

- One popular explanation, known as the "Dutch Disease," is usually triggered by a significant increase in revenues from raw material exports. The resulting boom draws both labor and capital out of traditional manufacturing and causes it to decline.
- Another explanation focuses on how the increase in domestic prices that typically accompanies the resource boom impedes the international competitiveness of manufactured exports and therefore export-led development.
- A third explanation suggests that the large rents to be gained from the resource sectors in resource-abundant countries would cause entrepreneurial talent and innovation to be siphoned away from other sectors. Thus, resource-rich countries could be expected to have lower rates of innovation, which, in turn, results in lower rates of development.

While countries with large resource endowments may not have the significant opportunities for development that might have been expected, it is encouraging to note that lots of countries without large resource endowments have not been precluded from achieving significant levels of development.

Sources: Jeffrey D. Sachs and Andrew M. Warner. "The Curse of Natural Resources," *European Economic Review* Vol. 45, No. 4–6 (2001): 827–838; Richard M. Auty. *Sustaining Development in Mineral Economies*: *The Resource Curse Thesis* (London: Routledge, Inc.); Tobias Kromenberg. "The Curse of Natural Resources in the Transition Economies," *Economics of Transition* Vol. 12, No. 3 (2004): 399–426.

resource endowments would be more likely to prosper. In fact, the evidence suggests the opposite—resource-abundant countries are less likely to experience rapid development (see Example 20.2).

The Growth–Development Relationship

Has economic growth historically served as a vehicle for development? Has growth really made the average person better off? Would the lowest-income members of the United States and the world fare better with economic growth or without it?

These turn out to be difficult questions to answer in a way that satisfies everyone, but we must start somewhere. One appropriate point of departure is clarifying what we mean by development. Some of the disenchantment with development can

be traced to the way that development is measured. It is not so much that all growth is bad, but that increases in conventional indicators of development are not always good. Some of the enthusiasm for zero economic growth stems from the fact that economic development, as currently measured, can be shown to have several undesirable characteristics.

Conventional Measures

A true measure of development would increase whenever we, as a nation or as a world, were better off and decrease whenever we were worse off. Such a measure is called a *welfare measure* and no conventional existing measure is designed to be a welfare measure.

What we currently have are *output measures*, which attempt to indicate how many goods and services have been produced, not how well off we are. Measuring output sounds fairly simple, but it is not. The measure of economic development with which most are familiar is based upon the GDP (gross domestic product). This number represents the sum of the outputs of goods and services produced by the economy in any year. Prices are used to weight the importance of these goods and services in GDP. Conceptually, this is accomplished by adding up the value added by each sector of the production process until the product is sold.

Why weight by prices? Some means of comparing the value of extremely dissimilar commodities is needed. Prices provide a readily available system of weights that takes into account the value of those commodities to consumers. From early chapters we know that prices should reflect both the marginal benefit to the consumer and the marginal cost to the producer.

GDP is not a measure of welfare and was never meant to be one. Therefore increases in this indicator (growth) may not represent increases in development or well-being. One limitation of this indicator as a measure of welfare is that it includes the value of new machines that are replacing worn-out ones, rather than increasing the size of the capital stock. To compensate for the fact that some investment merely replaces old machines and does not add to the size of capital stock, a new concept known as net domestic product (NDP) was introduced. NDP is defined as the gross domestic product minus depreciation.

NDP and GDP share the deficiency that they are both influenced by inflation. If the flow of all goods and services were to remain the same while prices doubled, both NDP and GDP would also double. Since neither welfare nor output would have increased, an accurate indicator should reflect that fact.

To resolve this problem, national income accountants present data on *constant-dollar* GDP and *constant-dollar* NDP. These numbers are derived by "cleansing" the actual GDP and NDP data to take out the effects of price rises. Conceptually, this is accomplished by defining a market basket of goods that stays the same over time. Each year, this same basket is repriced. If the cost of the goods in the basket went up 10 percent, then because the quantities are held constant, we know that prices went up by 10 percent. This information is used to remove the effects of prices on the indicators; remaining increases should be due to an increased production of goods and services.

This correction does not solve all problems. For one thing, not all components of GDP contribute equally to welfare. Probably the closest, though still deficient, we could use in the existing system of accounts would be consumption, the amount of goods and services consumed by households. It leaves out government expenditures, investments, exports, and imports.

The final correction that could easily be made to the existing accounts would involve dividing real consumption by the population to get *real consumption per capita*. This correction allows us to differentiate between rises in output needed to maintain the standard of living for an increasing population and rises indicating more goods and services consumed by the average member of that population.

Real consumption per capita is about as close as we can get to a welfare-oriented output measure using readily available data. Yet it is a far cry from being an ideal welfare indicator.

In particular, changes in real consumption per capita fail to distinguish between economic growth resulting from a true increase in income, and economic growth resulting from a depreciation in what economists have come to call "natural capital," the stock of environmentally provided assets, such as the soil, the atmosphere, the forests, wildlife, and water.

The traditional definition of income was articulated by Sir John Hicks (1947):

> *The purpose of income calculations in practical affairs is to give people an indication of the amount they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning. [p. 172]*

While human-created capital (such as buildings and bridges) is treated in a manner consistent with this definition, natural capital is not. As human-created capital wears out, the accounts set aside an amount called depreciation to compensate for the decline in value as the equipment wears out. No increase in economic activity is recorded as an increase in income until depreciation has been subtracted from gross returns. That portion of the gains that merely serves to replace worn-out capital is not appropriately considered income.

No such adjustment is made for natural capital in the standard national income accounting system. Depreciation of the stock of natural capital is incorrectly counted as income. Development strategies that "cash in" on the endowment of natural resources are in these accounts indistinguishable from development strategies that do not depreciate the natural capital stock; the returns from both are treated as income.

Consider an analogy. Many high-quality private educational institutions in the United States have large financial endowments. When considering their budgets for the year, these institutions take the revenue from tuition and other fees and add in some proportion of the interest and capital gains earned from the endowment. Except in extraordinary circumstances, standard financial practice, however, does not allow the institution to attack the principal. Drawing down the endowment and treating this increase in financial resources as income is not allowed.

Yet that is precisely what the traditional national accounts allow us to do in terms of natural resources. We can deplete our soils, cut down our forests, and douse ocean coves with oil, and the resulting economic activity is treated as income, not as a decline in the endowment of natural capital.

Because the Hicksian definition is violated for natural capital, policy makers can be misled. By relying upon misleading information, policy makers are more likely to undertake unsustainable development strategies.

Adjusting the national income accounts to apply the Hicksian definition uniformly to human-made and natural capital could, in resource-dependent countries, make quite a difference. For example, Robert Repetto (1989) and colleagues of the World Resources Institute studied the growth rates of gross national product in Indonesia using both conventional unadjusted figures and figures adjusted to account for the depreciation of natural capital. Their study found that while the unadjusted gross national product increased at an average annual rate of 7.1 percent from 1971 to 1984, the adjusted estimates rose by only 4.0 percent per year.

Motivated by a recognition of these serious flaws in the current system of accounts, a number of other industrial countries have now proposed (or in a few cases have already set up) systems of adjusted accounts, including Norway, France, Canada, Japan, the Netherlands, and Germany. Significant differences of opinion on such issues as whether the changes should be incorporated into a complementary system of accounts or into a complete revision of the standard accounts remain to be resolved.

In the United States, the Bureau of Economic Analysis (1994) published some initial estimates of the value of the U.S. stock of minerals—oil, gas, coal, and nonfuel minerals—and how the value of that stock (in constant dollars) had changed over time. The objective was to determine whether current use patterns are consistent with the constant-value version of the sustainability criterion. Declining values are interpreted as a violation of the criterion while constant or increasing values would be compatible with it. In general, they found that the value of additions just about offset the value of the depletion; for the period 1958–1991, their estimates suggest that the criterion was not violated. It is not possible to examine what has happened over time more recently since these estimates fell victim to budget cutting and were discontinued.

Alternative Measures

Are we fulfilling the sustainability criterion or not? Although that turns out to be a difficult question to answer, a number of indicators have now been designed to allow us to make some headway. These indicators differ in both their construction and the insights that can be derived from them.

Adjusted Net Savings. We begin with an indicator derived by the World Bank that attempts to provide an empirical method for judging whether or not we are fulfilling the weak sustainability criterion. Recall from Chapter 5 that a decline in total capital indicates unsustainability according to the weak sustainability criterion. This implies that net savings, which is the addition to the value of total

capital, must be positive. Negative net savings implies that the total capital stock has gone down, a violation of the criterion.

Adjusted net savings (formerly called "genuine savings") is a sustainability indicator that explicitly considers natural capital. Constructed by the Environmental Economics group of the World Bank, adjusted net savings estimates are derived by making four types of adjustments to standard national accounting measures of gross national savings. First, estimates of capital consumption of produced assets are deducted to obtain net national savings. Second, current expenditures on education are added to net domestic savings as an appropriate value of investments in human capital (in standard national accounting, these expenditures are treated as consumption). Third, estimates of the depletion of a variety of natural resources are subtracted to reflect the decline in asset values associated with their extraction and harvest. Estimates of resource depletion are based on the calculation of resource rents. Rents are derived by taking the difference between world prices and the average unit extraction or harvest costs (including a "normal" return on capital). Finally, pollution damages are deducted. Because many pollution damages are local in their effects, and therefore difficult to estimate without location-specific data, the World Bank estimates include only global climate change damages from carbon dioxide emissions.

What do these estimates show? Generally, adjusted savings indicate that the countries violating the weak sustainability criterion are some of the former Soviet Republics and countries in Sub-Saharan Africa and the Middle East. Higher-income countries are generally estimated to be weakly sustainable because their savings and expenditures on education are large enough to offset declines in the value of natural capital (http://data.worldbank.org/data-catalog/environmental-accounting).

Wealth Estimates. The World Bank has also begun collecting wealth estimates for a large group of countries. The wealth estimates include produced capital, natural capital, and intangible capital. This latter category includes human capital, institutions, and governance. For all countries, intangible capital makes up the largest component of wealth, but for the poorest developing countries, natural capital is also a significant component and is larger than produced capital.[5] Traditional measures of wealth may underestimate the significance of this fact, if sale of natural resources shows up as income.

Genuine Progress Indicator. The Genuine Progress Indicator (GPI), developed and maintained by an organization called Redefining Progress in San Francisco, differs from adjusted savings in two main ways: (1) it focuses on an adjusted measure of consumption, rather than savings; and (2) it includes many more categories of adjustments.[6]

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[5]Details on this measure can be found at http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTEEI/0,,contentMDK:20487828~menuPK:1187788~pagePK:148956~piPK:216618~theSitePK:408050,00.html.

[6]Details about this indicator, including the data and its calculation, can be found on the Redefining Progress Web site at http://www.redefiningprogress.org/.

The GPI adjusts national personal consumption expenditures in several ways. The most unique (and the most controversial) adjusts personal consumption expenditures for income distribution; more equal income distributions adjust the GPI upward, while less equal income distributions reduce it.[7] Using personal-consumption expenditures adjusted for income inequality as its base, the GPI then adds or subtracts categories of spending based on whether they enhance or detract from national well-being. Examples of additions include the value of time spent on household work, parenting, and volunteer work; and the value of both services of consumer durables (such as cars and refrigerators) and services provided by highways and streets. Examples of subtractions include defensive expenditures, defined as money spent to maintain the household's level of comfort, security, or satisfaction such as personal water filters, locks or security systems, hospital bills from auto accidents, or the cost of repainting houses damaged by air pollution; social costs, such as the cost of divorce, crime, or loss of leisure time; and the depreciation of environmental assets and natural resources (due to the loss of farmland, wetlands, and old-growth forests); the reduction of stocks of energy and other natural resources; and damaging effects of wastes and pollution. In 2004, for example, $1.8 trillion was subtracted for cumulative carbon dioxide emissions.

To provide some context for knowing how much difference these adjustments make in 2004 per capita GDP in the United States was $36,595 while the per capita GPI was estimated to be $15,036 ($2000). While the GDP rose at approximately 3.8 percent per year between 1950 and 2004, the GPI rose at only 1.8 percent per year during this same time period.[8] According to this indicator, not only do traditional accounting measures such as the Gross Domestic Product considerably overstate the health of the economy, but in several years since the 1970s, per capita well-being has actually declined. In those years, declines in income inequality and leisure time, coupled with increases in the costs of crime, pollution, and other social ills, have more than offset the increases due to larger levels of economic activity and increases in socially productive activities such as volunteerism.

Ecological Footprint. Another example of an indicator, the Ecological Footprint, differs considerably from the other two in that it is based upon a physical measure rather than an economic measure. The Ecological Footprint indicator attempts to measure the amount of renewable and nonrenewable ecologically productive land area that is required to support the resource demands and to absorb the wastes of a given population or specific activities.[9] The footprint is expressed in "global acres." Each unit corresponds to one acre of biologically productive space with "world

[7]This step relies on the measure of inequality known as the Gini coefficient, which is defined in the Glossary to this text.

[8]John Talberth, Clifford Cobb, and Noah Slattery. "The Genuine Progress Indicator 2006. A Tool for Sustainable Development," 2006, http://www.rprogress.org/publications/2007/GPI%202006.pdf http://www.rprogress.org/publications/2007/GPI%202006.pdf, redefining progress (accessed March 2009).

[9]The details about this indicator can also be found on the Redefining Progress Web site at http://www.redefiningprogress.org/footprint/. Anyone can have his/her own ecological footprint calculated by answering a few questions at http://www.myfootprint.org/.

average productivity." Every year has its own set of equivalence factors since land-use productivities change over time. By comparing this "footprint" to the amount of ecologically available land, deficits or surpluses can be uncovered.

This indicator, calculates national consumption by adding imports to, and subtracting exports from, domestic production. This balance is computed for 72 categories, such as cereals, timber, fishmeal, coal, and cotton. The footprint (in terms of acres) for each category of resource uses is calculated by dividing the total amount consumed in each category by its ecological productivity (or yield per unit area). In the case of carbon dioxide (CO_2) emissions, the footprint is calculated by dividing the emissions by the average assimilative capacity of forests to find the number of acres necessary to absorb the pollutants.

According to this indicator, the industrialized nations have the most unsustainable consumption levels (meaning that their consumption requires more ecologically productive land than is domestically available). This analysis also suggests that current global consumption levels cannot be sustained indefinitely by the current amount of ecologically productive land—we are in a deficit situation.

The Human Development Index. One reason for dissatisfaction with all of these measures of well-being is their focus on an average citizen. To the extent that the most serious problems of deprivation are not experienced by the average member of society, this focus may leave a highly misleading impression about well-being. To rectify this problem, in 1990 the United Nations Development Program (UNDP) constructed an alternative measure, the Human Development Index (HDI). This index has three major components: longevity, knowledge, and income.

Though highly controversial, because both the measures to be included in this index and the weights assigned to each component are rather arbitrary, the UNDP (2004) has drawn some interesting conclusions from the results of comparing HDIs among countries:

- The link between per capita national income and this measure of human development is not automatic; it depends on how the income is spent. Some relatively high-income countries (such as South Africa and the Persian Gulf states) do not fare as well as expected in human development terms, while some low-income countries (such as Sri Lanka and Cuba) were able to achieve a higher level of human development than would be expected given their income levels.
- Nonetheless, income is a major determinant of the capacity to improve human development. It is not a coincidence that the top five countries in terms of the human development index (Norway, Sweden, Australia, Canada, and the Netherlands) are all very high-income countries.

Gross National Happiness. Bhutan is a small Asian country situated at the eastern end of the Himalayas. It shares borders with India and the People's Republic of

China. In November 2008, the country adopted the Gross National Happiness index as an alternative to more conventional measures to guide its development strategy (http://www.grossnationalhappiness.com/gnhIndex/intruductionGNH.aspx0). This single number, Gross National Happiness index, which is based upon an extensive survey of the citizens of Bhutan, is based upon nine core *dimensions* that are regarded as components of happiness and well-being in Bhutan. The nine dimensions are:

1. *Psychological Well-being*
2. *Time Use*
3. *Community Vitality*
4. *Culture*
5. *Health*
6. *Education*
7. *Environmental Diversity*
8. *Living Standard*
9. *Governance*

Gross national happiness is deemed to have risen over time if sufficient achievements in these nine dimensions have been obtained. Since it is very new, how well this index serves its intended purpose remains to be seen.

A Summary of Alternative Measures. All of the alternative measures described above acknowledge and attempt to address flaws in the traditional measures of wealth. Each offers a potential contribution. However, some of the characteristics of the alternative measures rely on prices to weight their importance, but in many nonmarket circumstances those prices are difficult, but not impossible, to measure (see Chapter 4).

The estimation difficulties become most problematic in developing countries where nonmarket valuation methods have been utilized the least. Whittington (2002) offers some reasons why the contingent valuation studies that have been implemented in developing countries are unreliable. Suggesting that surveys are poorly administered and poorly crafted for the target audience, he goes on to recommend more research since the questions being addressed tend to be extremely important for policy and the cost of policy mistakes can be tragic in poor countries.

The above measures all suggest that intrinsic values are important. The ability to measure these values with some confidence is vital, but difficult. Different measures yield different results (Example 20.3).

EXAMPLE 20.3

Happiness Economics: Does Money Buy Happiness?

In recent years economists and psychologists have become interested in what had become known as the economics of happiness. What is that makes people happy and what role does income play?

A psychologist and an economist (Kahneman and Deaton, 2010) analyzed the responses of more than 450,000 U.S. residents surveyed in 2008 and 2009 to several questions about their subjective well-being. Their results suggest a rather complex answer to this question, suggesting that it depends on how well-being is measured.

The authors defined two rather different subjective measures of well-being.

- One measure, labeled "Emotional Well-Being," refers to the emotional quality of an individual's everyday experience—the frequency and intensity of experiences of joy, fascination, anxiety, sadness, anger, and affection that make one's life pleasant or unpleasant. In this study emotional well-being is captured by two variables. The first, which deals with aspects of positive well-being, sums three binary (1 or 0) variables measuring self-reported happiness, enjoyment, and frequent smiling and laughter. The second, capturing a "blue effect," takes the average of two binary variables, measuring stress and worry. All questions asked the respondent to respond relative to his/her experience the previous day.
- The second measure, which the authors label "Life Evaluation," is based upon Cantril's Self-Anchoring Scale, which has the respondent rate his or her current life on a ladder scale in which 0 is "the worst possible life for you" and 10 is "the best possible life for you." Unlike the previous measure that focuses on a snapshot of feelings at a specific point in time, this question is a more overarching measure of well-being.

Before getting to the statistical results of how income affects these measures of well-being, consider some comparative observations revealed by these data. The authors found that most people were quite happy and satisfied with their lives. These results indicate that the U.S. population ranks high on the Life Evaluation Index (ninth after the Scandinavian countries, Canada, The Netherlands, Switzerland, and New Zealand), and also does well in terms of happiness (5th), smiling (33rd), and enjoyment (10th), but much less well on worry (89th from least worried), sadness (69th from least sad), and anger (75th). Americans report very high levels of stress (5th among 151 countries).

In terms of income, the present study finds that "a lack of money brings both emotional misery and low life evaluation. . . . Beyond <$75,000 in the contemporary United States, however, higher income is neither the road to experienced happiness nor the road to the relief of unhappiness or stress, although higher income continues to improve individuals' life evaluations" (p. 16491).

Sources: Luigino Bruni and Pier Luigi Porta. *Economics and Happiness: Framing the Analysis* (Oxford/New York: Oxford University Press, 2005). Daniel Kahneman and Angus Deaton. "High Income Improves Evaluation of Life But Not Emotional Well-being," *Proceedings of the National Academy of Sciences* Vol. 107, No. 38 (2010): 16489–16493.

Summary

Sustainable development refers to a process for providing for the needs of the present generation (particularly those in poverty) without compromising the ability of future generations to meet their own needs.

Market imperfections frequently make sustainable development less likely. Intergenerational externalities such as climate modification impose excessive costs on future generations. Free access to biological common property resources can lead to excessive exploitation and even extinction of the species.

Even efficient markets do not necessarily produce sustainable development. Restoring efficiency is desirable and helpful but can be insufficient as a means for producing sustainable welfare levels. While in principle dynamically efficient allocations can produce extraction profiles for depletable resources that are compatible with the interests of future generations, in practice this is not necessarily the case. When trade is used as part of the development strategy, it must be used carefully. The effects of trade on the environment are neither universally benign nor universally detrimental. Context matters.

We have examined a series of indicators that attempt to shed light on the degree to which current national practices are sustainable. Though all of these indicators are both incomplete and flawed, they all convey some important insights.

Because it is based on the weak sustainability criterion, which is limited in scope, the adjusted net savings indicator is not particularly helpful in validating the practices in countries that are identified by this indicator as being sustainable. Yet it can be helpful identifying countries that are not sustainable (as well as the sources of their unsustainability), since any failure to pass this weak test sends a powerful signal of serious problems. The fact that many of the countries that fail this test are low-income countries reminds us that poverty can be both a cause and an effect of unsustainability.

The Genuine Progress Indicator provides a helpful reminder that increases in traditional accounting measures, which are uniformly trumpeted in the press as evidence of "progress," may not represent an increase in well-being at all. Traditional accounting techniques measure economic activity, not well-being.

The Ecological Footprint provides helpful reminders that scale does matter and that the earth on which we all depend is ultimately limited in its ability to fulfill our unlimited wants. Though the Ecological Footprint finding that we have already exceeded the earth's carrying capacity is controversial, it does usefully lay to rest the naïve view that our ability to consume is limitless and emphasize that we had better start thinking about how to stay within those limits. The Ecological Footprint is also helpful in pointing out that affluence is fully as big a challenge to sustainability as poverty.

The Human Development Index reminds us that the relationship between income growth and the well-being of the poorest citizens of the world is far from a sure thing, in contrast to what some would have us believe. While income growth can provide a means for empowerment for the poor, it can only do so when accompanied by appropriate policy measures, such as ensuring universal health care and education and limiting the perverse effects of corruption. The Index also

identifies a number of low-income countries that have made great strides in ensuring that the fruits of development do reach the poor.

The outlook for the developing nations is mixed at best. Solving many of their future environmental problems will require raising standards of living and dealing with population growth. However, following the path of development pioneered by the industrialized nations is probably not possible without triggering severe global environmental problems; the solution would become the problem. New forms of development will be necessary.

New sustainable forms of development are possible, but they will not automatically be adopted. Economic incentive policies can facilitate the transition from unsustainable to sustainable activities. The search for solutions must recognize that market forces are extremely powerful. Attempts that ignore those forces are probably doomed to failure. Nonetheless, it is possible to harness those forces and channel them in directions that enhance the possibilities of sustainable outcomes. To take these steps will require thinking and acting in somewhat unconventional ways. Whether the world community is equal to the task remains to be seen.

Discussion Questions

1. Consider a possible mechanism for controlling population. According to an idea first put forth by Kenneth Boulding (1964) each individual would be given the right to produce one (and only one!) child. Because this scheme over a generation allows each member of the current population to replace himself or herself, births would necessarily equal deaths and population stability would be achieved.

   This scheme would award each person a certificate, entitling the holder to have one child. Couples could pool their certificates to have two. Every time a child was born, a certificate would be surrendered. Failure to produce a certificate would cause the child to be put up for adoption. Certificates would be fully transferable.

   Is this a good idea? What are its advantages and disadvantages? Would it be appropriate to implement this policy now in the United States? For those who believe that it would, what are the crucial reasons? For those who believe it is not appropriate, are there any circumstances in any countries where it might be appropriate? Why or why not?
2. "Every molecule of a nonrenewable resource used today precludes its use by future generations. Therefore, the only morally defensible policy for any generation is to use only renewable resources." Discuss.
3. "Future generations can cast neither votes in current elections nor dollars in current market decisions. Therefore, it should not come as a surprise to anyone that the interests in future generations are ignored in a market economy." Discuss.
4. "Trade simply represents economic imperialism where one country exploits another. The environment is the inevitable victim." Discuss.

Self-Test Exercise

1. "With a global economy, the only way to achieve cost-effective control of greenhouse gases is to assure that every country imposes the same universal set of emissions standards." Discuss.

Further Reading

Copeland, Brain R., and M. Scott Taylor. "Trade, Growth, and the Environment," *Journal of Economic Literature* Vol. 42 (March 2004): 7–71. An excellent survey of the lessons to be derived from the theory and empirical work focusing on the relationship between trade and the environment.

Deacon, Robert T., and Catherine S. Norman. "Does the Environmental Kuznets Curve Describe How Individual Countries Behave?" *Land Economics* Vol. 82, No. 2 (2006): 291–315. Examining time series data within countries, the authors find weak evidence of the existence of a Kuznets curve for SO_2 in wealthier countries, but no evidence for a Kuznets curve for other pollutants and for poorer countries.

De Soysa, Indra, and Eric Neumayer. "False Prophet, or Genuine Savior? Assessing the Effects of Economic Openness on Sustainable Development, 1980–1999," *International Organization* Vol. 59, No. 3 (2005): 731–772. Estimates the effects of a dependence on trade, and foreign direct investment on sustainability as measured by the genuine saving rate. They find openness enhances sustainability.

Fischer, Carolyn. "Does Trade Help or Hinder the Conservation of Natural Resources?" *Review of Environmental Economics and Policy* Vol. 4, No. 1 (2010): 103–121. This article reviews and takes stock of the lessons from the recent economics literature on the links between trade and the conservation of natural resources.

Layard, R. *Happiness: Lessons from a New Science* (New York: Penguin Press, 2005). Using integrated insights from psychology, economics, neuroscience, and sociology, a distinguished British economist explores the sources of human happiness.

Pearce, David, Anil Markandya, and Edward B. Barbier. *Blueprint for a Green Economy* (London: Earthscan, 2000). Seeks to answer the question, "If we accept sustainable development as a working idea, what does it mean for the way we manage a modern economy?"

Pezzey, John C. V., and Michael A. Toman. "Progress and Problems in the Economics of Sustainability," in Tom Tietenberg and Henk Folmer, eds. *The International Yearbook of Environmental and Resource Economics: A Survey of Current Issues* (Cheltenham, UK: Edward Elgar, 2002). A comprehensive review of what we have learned from economic analysis about the nature and consequences of sustainability by two major contributors to the literature.

Additional References and Historically Significant References are available on this book's Companion Website: http://www.pearsonhighered.com/tietenberg/

22 Visions of the Future Revisited

Mankind was destined to live on the edge of perpetual disaster. We are mankind because we survive. We do it in a half-assed way, but we do it.

—Paul Adamson, a fictional character in James A. Michener's *Chesapeake*

We have now come full circle. Having begun our study with two lofty visions of the future, we proceeded to dissect the details of the various components of these visions—the management of depletable and renewable resources, pollution, population, and the development process itself. During these inquiries we gained a number of useful insights about individual environmental and natural resource problems. Now it is time to step back and coalesce those insights into a systematic assessment of the two visions.

Addressing the Issues

In Chapter 1 we posed a number of questions to serve as our focus for the overarching issue of growth in a finite environment. Those questions addressed three major issues: (1) How is the problem correctly conceptualized? (2) Can our economic and political institutions respond in a timely and democratic fashion to the challenges presented? (3) Can the needs of the present generation be met without compromising the ability of future generations to meet their own needs? Can short-term and long-term goals be harmonized? The next three segments of this section summarize and interpret the evidence.

Conceptualizing the Problem

At the beginning of this book we suggested that if the problem is characterized as an exponential growth in demand coupled with a finite supply of resources, the resources must eventually be exhausted. If those resources are essential, society will collapse when the resources are exhausted.

We have seen that this is an excessively harsh and somewhat misleading characterization. The growth in the demand for resources is not insensitive to their

scarcity. Though the rise in energy prices in the 1970s was triggered more by cartel actions than by scarcity, it is possible to use higher energy prices during that period as an example of how the economic system reacts.

Following the increase in prices in the 1970s, demand growth fell dramatically, with petroleum experiencing the largest reductions. In the United States, for example, total energy consumption in 1981 (73.8 quadrillion BTUs) was lower than it was in 1973 (74.6 quadrillion BTUs), despite increases in income and population. Petroleum consumption went from 34.8 quadrillion BTUs in 1973 to 32.0 quadrillion BTUs in 1981. Though some of this reduction was caused by sluggishness of the economy, price certainly played a major role.

Price is not the only factor that retards demand growth. Declines in population growth also play a significant role. Since the developed nations appropriate a disproportionate share of the world's resources, the dramatic declines in population growth in those countries has had a disproportionate effect on slowing the demand for resources. On the other hand, the rapidly rising consumption levels in high-growth countries like China and India are having the opposite effect.

Characterizing the resource base as finite—the second aspect of the model—is also excessively harsh: (1) this characterization ignores the existence of a substantial renewable resource base and (2) it focuses attention on the wrong issue.

In a very real sense, a significant portion of the resource base is not finite. Plentiful supplies of renewable resources including, significantly, energy are available. The normal reaction to increasing scarcity of individual depletable resources, such as oil, is to switch to renewable resources. That is clearly happening. The most dramatic examples can be found in the transition to wind, solar, and hydrogen fuel cells.

In addition, labeling the resource base as finite is also misleading because it suggests that our concern should be "running out." In fact, for most resources we shall never run out. Millions of years of finite resources are left at current consumption rates. The rising cost of extracting and using those resources including environmental costs is the chief threat to future standards of living, not the potential for their exhaustion. The limits on our uses of these resources are not determined by their scarcity in the crust of the earth, but rather by the environmental consequences of their use. The implications of climate change, including rising sea level, heat extremes, droughts and storm surges, are potentially so severe as to force a major reevaluation of our carbon-based energy choices. Similarly the loss of biodiversity, which would be intensified by climate change, could irreversibly alter our ecosystems and reduce their resilience to future shocks.

Resource scarcity can be countered without violating sustainability by finding new sources of conventional materials, as well as discovering new uses for unconventional materials, including what was previously considered waste. We can also stretch the useful life of these reserves by reducing the amount of materials needed to produce the products. Striking examples include the diminishing size of a typical computer system needed to process a given amount of information and the substantially diminished amount of energy needed to heat a well-designed home.

Conventional energy sources such as oil, are likely to become scarce in the not-too-distant future, but a host of alternative renewable substitutes exist.

The issue is whether the transition can proceed with sufficient speed and sufficient effectiveness so as to maintain economic well-being while preventing serious climate change damages.

Paradoxically, some of the most obvious cases of binding limits involve renewable resources, rather than depletable resources. Demand pressure, whether driven by population growth or rising incomes, is a key contributor to this phenomenon. Expanding demand forces the cultivation of marginal lands and the deforestation of large, biologically rich tracts. The erosion of overworked soils diminishes their fertility and, ultimately, their productivity. Demand pressure can also contribute to the overexploitation of biological resources such as fisheries, even to the point of extinction. Trade can intensify these processes, especially when property regimes do not adequately protect the resources. For many resources the problem is not their finiteness, but the way in which they have been managed. It is important to recognize that "renewable" and "sustainable" are not synonyms.

Correct conceptualization of the resource scarcity problem suggests that both extremely pessimistic and extremely optimistic views are wrong. Impenetrable proximate physical limits on resource availability are typically less of a problem than the adverse atmospheric and biological consequences of their use. Transitions to renewable resources, recycled resources, carbon-free fuels, and less costly depletable resources have already begun.

Institutional Responses

One of the keys to understanding how society will cope with increasing resource scarcity and environmental damage lies in understanding how social institutions will react. Are market systems, with their emphasis on decentralized decision making, and democratic political systems, with their commitment to public participation and majority rule, equal to the challenge?

Our examination of the record seems to suggest that while our economic and political systems are far from infallible and have some rather glaring deficiencies, no fatal flaws are apparent.

On the positive side, markets have responded swiftly and automatically to deal with those resources experiencing higher prices. Demand has been reduced and substitution encouraged. Markets for recycling are growing and consumer habits are changing. Green buildings are proliferating. Renewable energy sources are being developed. No one has had to oversee these responses to make sure they occur. As long as property rights are well defined, the market system provides incentives for consumers and producers to respond to scarcity in a variety of useful ways (see Example 22.1).

As compelling as the evidence is for this point of view, it does not support the conclusion that, left to itself, the market would automatically choose a dynamically efficient or a sustainable path for the future. Market imperfections frequently make sustainable development less likely. One serious limitation of the market arises from how it treats common-pool resources, such as the fish we eat, the air we breathe, and the water we drink. Left to its own devices a market will overexploit free-access resources, substantially lowering the net benefits received by future

EXAMPLE 22.1

Private Incentives for Sustainable Development: Can Adopting Sustainable Practices Be Profitable?

Motivated by what it perceived to be great inefficiencies associated with its industry, the Interface Corporation, a carpet manufacturer, has totally transformed the nature of its business.

First, the company recognized that unworn carpet, usually under furniture, did not need to be replaced. Thus, the traditional wall-to-wall carpet was superseded by a carpet tile system. Whereas in traditional practice, wear in any part of the carpet meant that the entire carpet had to be replaced, with carpet tiles only those specific tiles showing wear are replaced. As an added benefit, the reduction in carpet replacement simultaneously reduces the amount of potentially harmful glue fumes being released into the indoor air.

Next, Interface totally changed its relationship with its customers. Rather than selling carpet, Interface leases it. In effect, it has become a seller of carpet services rather than a seller of carpets. Carpet tiles can be easily replaced or cleaned overnight by Interface employees, eliminating the loss of productivity that could occur from halting company activities during the day. The cost to consumers is substantially lower not only because less carpet is replaced, but also because leasing allows tax advantages. Leased carpet is treated by the tax code as an expense, not an asset.

The environment has also benefited. In traditional industry practice, most used carpet was transported to a landfill. Much of the rest was remanufactured into much-lower-valued uses. Seeing that as a waste of resources, Interface created an entirely new product, Solarium, that, when recycled at the end of its useful life, could be remanufactured back into new Solarium. Not only is this production process 99.7 percent less wasteful in terms of its drain on energy and raw materials, the product is also reportedly highly stain-resistant, four times as durable as regular carpet material, and easily cleaned with water.

These moves toward more sustainable manufacturing did not result from government mandates. Rather, an innovative company found that it could benefit itself and the environment at the same time.

Source: Paul Hawken, Amory Lovins, and L. Hunter Lovins. *Natural Capitalism*: *Creating the Next Industrial Revolution* (Boston, MA: Little, Brown and Company, 1999).

generations. In the absence of sufficient compensating increases in net benefits elsewhere in the economy, such exploitation could result in a violation of the sustainability criterion.

Externalities are also a barrier in the transition to sustainability. When many of the costs of using unsustainable resources are born by someone other than those making the resource choices, private and social costs will not align and the market process will be biased. Only when the externalities are internalized can sustainable resources compete on a level playing field.

Even efficient markets do not necessarily produce sustainable development. Restoring efficiency is frequently a desirable, but often insufficient means for

producing sustainable welfare levels. While in principle dynamically efficient allocations can produce extraction profiles for depletable resources that are compatible with the interests of future generations, as we have seen in practice this is not necessarily the case. The market does have some capacity for self-correction. The decline of overexploited fish populations, for example, has led to the rise of private property fish farming. The artificial scarcity created by imperfectly defined property rights gives rise to incentives for the development of a private property substitute.

This capacity of the market for self-healing, while comforting, is not always adequate. In some cases, cheaper more effective solutions (such as preventing the deterioration of the original natural resource base) are available. Preventive medicine is frequently superior to corrective surgery. In other cases, such as when our air is polluted, no good private substitutes are available. To provide an adequate response, it is sometimes necessary to complement market decisions with political ones.

The case for government intervention is especially compelling in controlling pollution. Uncontrolled markets not only produce too much pollution, but also they tend to underprice commodities (such as coal) that contribute to pollution either when produced or consumed. Firms that unilaterally attempt to control their pollution run the risk of pricing themselves out of the market. Government intervention is needed to ensure that firms that neglect environmental damage in their operating decisions do not thereby gain a competitive edge.

Significant progress has been made in reducing the amount of pollution, particularly conventional air pollution. Regulatory innovations, such as the sulfur allowance program and the Swedish NO_x charge, represent major steps toward the development of a flexible but powerful framework for controlling air pollutants. By making it less costly to achieve environmental goals, these reforms can limit the potential for a backlash against the policy. They have brought perceived costs more in line with perceived benefits.

It would be a great mistake, however, to assume that government intervention has been uniformly benign. The acid-rain problem, for example, was almost certainly made worse by a policy structure that focused on local rather than regional pollution problems, and using MTBE as a gasoline additive to reduce air pollution created new water pollution problems.

One aspect of the policy process that does not seem to have been handled well is the speed with which improvement has been sought. Public opinion polls have unambiguously shown that the general public supports environmental protection even when it raises costs and lowers employment. Historically, as shown by the regulation of automobile pollution, policy-makers reacted to this resolve by writing very tough legislation designed to force rapid technological development.

Common sense suggests that tough legislation with early deadlines can achieve environmental goals more rapidly than weaker legislation with less tight deadlines. In this case common sense is frequently wrong. Writing tough legislation with early deadlines can have the opposite effect. Unreasonably tough regulations are virtually impossible to enforce. Recognizing this, polluters repeatedly sought (and received) delays in compliance. It was frequently better, from the polluter's point of view, to spend resources to change the regulations than to comply with them.

This would not have been the case with less stringent regulations, since the firms would have had no legally supportable grounds for delay.

Another flagrant example of counterproductive government intervention is to be found in treatment of both energy and water. By imposing price ceilings on natural gas and oil, the government removed much of the normal resiliency of the economic system. With price controls, the incentives for expanding the supply are reduced and the time profile of consumption is tilted toward the present. A similar story can be told about water. By holding water prices below the marginal cost of supply, water authorities have subsidized excess use.

Resources that in a normal market would have been conserved for future generations are, with price controls, consumed by the current generation. When price controls are placed on normal market transactions, the smooth transition to renewable resources that characterizes the normal market allocation is eliminated; shortages can arise.

Price controls also play a key role in the world hunger problem. By controlling the price of food, many developing countries have undervalued domestic agriculture. The long-run effect of these controls has been to increase these countries' reliance on food imports at a time when foreign exchange to pay for those imports is becoming increasingly scarce. Whereas developed countries have gone substantially down the road to price decontrol, less-developed countries have not yet been able to extricate themselves to a similar degree.

In summary, the record compiled by our economic and political institutions has been mixed. It seems clear that simple prescriptions such as "leave it to the market" or "more government intervention" simply do not bear up under a close scrutiny of the record. The relationship between the economic and political sectors has to be one of selective engagement, complemented in some areas by selective disengagement. Each problem has to be treated on a case-by-case basis. As we have seen in our examination of a variety of environmental and natural resource problems, the efficiency and sustainability criteria allow such distinctions to be drawn, and they can serve as a basis for policy reform.

Sustainable Development

Historically, increases in inputs and technological progress have been important sources of economic growth in the industrialized nations. In the future, some factors of production, such as labor, will not increase as rapidly as they have in the past. The effect of this decline on growth depends on the interplay among the law of diminishing marginal productivity, substitution possibilities, and technological progress. The law of diminishing marginal productivity suggests slower growth rates, while technological progress and the availability of substitutes counteract this drag. One view foresees limits to technological progress imposed by the second law of thermodynamics, implying that the growth process must culminate in a steady or stationary state where growth ultimately, but inevitably, diminishes to zero.

The economy is currently being transformed. It is not business as usual. The increasing focus of corporations on corporate sustainability is playing a role. As citizens become better informed, they are beginning to use their power as

consumers, employees, shareholders, and voters to let companies know that they support business behavior that is compatible with sustainable outcomes.

Recognizing that conventional measures of economic growth shed little light on the question, some crude attempts have been made to estimate whether or not growth in the industrialized countries has historically made the citizens of those countries better off. Results of these studies suggest that because growth has ultimately generated more leisure, longer life expectancy, and more goods and services, it has been beneficial. Yet other measures, such as the ecological footprint, convey a more cautionary story. They remind us that our inability to measure precisely the carrying capacity for humans in no way diminishes the existence and importance of those limits.

Our examination of the evidence suggests that the notion that all of the world's people are automatically benefited by economic growth is naïve. Economic growth has demonstrably benefited some citizens in the developed countries, but that is certainly not inevitable for all people in all settings. Expanding pollution and diminishing access to crucial resources such as water or land can offset or even more than offset the gains for at least some of the population.

New sustainable forms of development are possible and desirable, but they will not automatically be adopted in either the high-income or the low-income nations. Are cooperative solutions possible? Can any common ground be established?

The experience in the United States suggests that cooperative solutions may be possible even among traditional adversaries. Environmental regulators and lobbying groups with a special interest in environmental protection in the United States have traditionally looked upon the market system as a powerful and potentially dangerous adversary. It was widely recognized that the market unleashed powerful forces and was widely lamented that those forces clearly acted to degrade the environment. Meanwhile, development proponents have traditionally seen environmental concerns as blocking projects that had the potential to raise living standards significantly. Conflict and confrontation became the modus operandi for dealing with this clash of objectives.

The climate for dealing effectively with both concerns has improved dramatically within the last few years. Not only have development proponents learned that in many cases short-term wealth enhancement projects that degrade the environment are ultimately counterproductive, but also environmental groups have come to realize that poverty itself is a major threat to environmental protection. The possibilities for "green jobs" are one example of this trend. No longer are economic development and environmental protection seen as an "either-or" proposition. Rather, the focus has shifted toward the identification of policies or policy instruments that can promote the alleviation of poverty, while protecting the environment.

The economic incentives approach to environmental and natural resource regulation has become a significant component of environmental and natural resource policy. Instead of mandating prescribed actions, such as requiring the installation of a particular piece of pollution control equipment, this approach achieves environmental objectives by changing the economic incentives of those doing the polluting. Incentives can be changed by fees or charges, transferable entitlements, disclosure strategies, or even liability law. By changing the incentives

an individual agent faces, that agent can use his or her typically superior information to select the best means of meeting his or her assigned responsibility. When it is in the interest of individuals to change to new forms of development, the transformation can be amazingly rapid.

Public policy and sustainable development must proceed in a mutually supportive relationship. In some cases that relationship takes the form of public–private partnerships that involve explicit agreements between government and the private sector regarding the provision of public services or infrastructure (see Example 22.2). In other cases, it involves government regulatory action to ensure that the market is sending the right signals to all participants so that the sustainable outcome is compatible with other business objectives. Economic-incentive approaches are a means of establishing that kind of compatibility. The experience with the various versions of this approach used in the United States, Europe, and Asia suggests that allowing business great flexibility within a regulatory framework that harmonizes private and social costs in general is both feasible and effective.

How about global environmental problems? Economic-incentives approaches could be helpful here as well. Cap-and-trade facilitates cost sharing among participants while ensuring cost-effective responses to the need for additional control.

EXAMPLE 22.2

Public–Private Partnerships: The Kalundborg Experience

Located on an island 75 miles off the coast of Copenhagen, the city of Kalundborg has achieved a remarkable symbiosis among the various industries that provide the employment base for the city. The four main industries, along with small businesses and the municipal government, began developing cooperative relationships in the 1970s designed to lower disposal costs, attain less expensive input materials, and receive income from their waste products.

A coal-fired power plant (Asnaes) transports its residual steam to a refinery (Statoil). In exchange, Statoil gives Asnaes refinery gas that Asnaes burns to generate electricity. Asnaes sells excess steam to a local fish farm, to a heating system for the city, and to a pharmaceuticals and enzyme producer (Novo Nordisk). Continuing the cycle, the fish farm and Novo Nordisk send their sludge to farms to be used as fertilizer. Produced fly ash is sold to a cement plant and gypsum produced by its desulfurization process is sold to a wallboard manufacturer. Statoil, the refinery, sells the sulfur removed from its natural gas to a sulfuric acid manufacturer, Kemira.

This entire process resulted not from centralized planning, but simply because it was in the individual best interests of the public and private entities involved. Although the motives were purely financial, this synergetic situation has clear environmental benefits. It is therefore likely to be economically, as well as environmentally, sustainable.

Source: Pierre Desroches. "Eco-Industrial Parks: The Case for Private Planning," *Report # RS 00-1*, Political Economy Research Center, Bozeman, MT 59718.

By separating the question of what control is undertaken from the question of who ultimately pays for it, the government significantly widens the control possibilities and lowers compliance costs. Conferring property rights for biological populations on local communities provides an incentive for those communities to protect the populations. Strategies for reducing debt can diminish the pressure on natural resources that might otherwise be "cashed in" to pay off the debt.

The courts are beginning to use economic incentives as well; judicial remedies for environmental problems are beginning to take their place alongside regulatory remedies. Take, for example, the problem of cleaning up already-closed toxic waste sites. Allowing the government to sue all potentially responsible parties accomplishes a double purpose: (1) successful suits ensures that the financial responsibility for contaminated sites is borne by those who directly caused the problem, and (2) it encourages those who are currently using those sites to exercise great care, lest they be forced to bear a large financial burden in the event of an incident. The alternative remedy of putting the burden on taxpayers would have resulted in less revenue raised, fewer sites restored, and less adequate incentives for users to exercise care.

Europe has tended to depend more on effluent or emissions charges. This approach places a per-unit fee on each unit of pollution discharged. Faced with the responsibility for paying for the damage caused by their pollution, firms recognize it as a controllable cost of doing business. This recognition triggers a search for possible ways to reduce the damage, including changing inputs, changing the production process, transforming the residuals to less-harmful substances, and recycling by-products. The experience in the Netherlands, a country where the fees are higher than in most other countries, suggests that the effects can be dramatic.

Fees also raise revenue. Successful development, particularly sustainable development, requires a symbiotic partnership between the public and private sectors. To function as an equal partner, the public sector must be adequately funded. If it fails to raise adequate revenue, the public sector becomes a drag on the transformation process, but if it raises revenue in ways that distort incentives that, too, can act as a drag. Effluent or emissions charges offer the realistic opportunity to raise revenue for the public sector, while reducing the drag from more distortionary taxes. Whereas other types of taxation discourage growth by penalizing legitimate development incentives (such as taxing wages), emissions or effluent charges provide incentives for sustainable development. Some work from the United States suggests that the drag on development avoided by substituting effluent or emission charges for more traditional revenue-raising devices, such as capital gains, income, and sales taxes, could be significant.

Incentives for forward-looking public action are as important as those for private action. The current national income accounting system provides an example of a perverse economic signal. Though national income accounts were never intended to function as a device for measuring the welfare of a nation, in practice that is how they are used. National income per capita is a common metric for evaluating how well-off a nation's people are. Yet the current construction of those accounts conveys the wrong message.

Rather than recognizing oil spills for what they are, namely a source of decline in the value of the endowment of natural resources in the area, cleanup expenditures increase measured national income; spills actually boost GDP! But the reason, of course, is that no account is taken of the consequent depreciation of the natural environment. Under the current system, the accounts make no distinction between growth that is occurring because a country is damaging its natural resource endowment with a consequent irreversible decline in its value, and sustainable development, where the value of the endowment remains intact. Only when suitable corrections are made to these accounts will governments be judged by the appropriate standards.

The power of economic incentives is certainly not inevitably channeled toward the achievement of sustainable growth. They can be misapplied as well as appropriately applied. Tax subsidies to promote cattle ranching on the fragile soil in the Brazilian rain forest stimulated an unsustainable activity and imposed irreparable damage to an ecologically significant area. They must be used with care.

A Concluding Comment

Our society is evolving. The emerging complementary relationship among the economic system, the court system, and the legislative and executive branches of government is promising. We are, however, not yet out of the woods. Significantly, we the public must learn that part of the responsibility is ours. The government cannot solve all problems without our significant participation.

Not all behavior can be regulated. It costs too much to catch every offender. Our law enforcement system works because most people obey the law, whether anyone is watching or not. A high degree of voluntary compliance is essential for the system to work smoothly.

The best resolution of the toxic substance problem, for example, is undoubtedly for all makers of potentially toxic substances to be genuinely concerned about the safety of their products and to bite the bullet whenever their research raises questions. The ultimate responsibility for developing an acceptable level of risk must rest on the integrity of those who make, use, transport, and dispose of the substances. The government can assist by penalizing and controlling those few who fail to exhibit this integrity, but it can never completely substitute for integrity. We cannot and should not depend purely upon altruism to solve these problems, but we should not underestimate its importance either.

We also need to recognize that markets serve our preferences as consumers. Making sure our purchases and investments reflect environmental values will help markets move in the right direction. Fuel-efficient automobiles will enter the market much faster if many consumers demand them. It is easy to see large corporations as villains, but it is tougher to notice the villains in our mirrors.

The notion that we are at the end of an era may well be true. But we are also at the beginning of a new one. What the future holds is not the decline of civilization, but its transformation. As the opening quote to this chapter suggests, the road may be strewn with obstacles and our social institutions may deal with those obstacles with less grace and less finesse than we might have hoped, but we are unquestionably making progress.

Discussion Questions

1. Are you optimistic or pessimistic about the future? Why?
2. In thinking about the appropriate balance between the market and the government in achieving sustainability, do you think the government needs to take a stronger role or would you favor reducing government influence over the market? Why?

1 Visions of the Future

From the arch of the bridge to which his guide has carried him, Dante now sees the Diviners . . . coming slowly along the bottom of the fourth Chasm. By help of their incantations and evil agents, they had endeavored to pry into the future which belongs to the almighty alone, and now their faces are painfully twisted the contrary way; and being unable to look before them, they are forced to walk backwards.

—Dante Alighieri, *Divine Comedy: The Inferno*, translated by Carlyle (1867)

Introduction

The Self-Extinction Premise

About the time the American colonies won independence, Edward Gibbon completed his monumental *The History of the Decline and Fall of the Roman Empire*. In a particularly poignant passage that opens the last chapter of his opus, he re-creates a scene in which the learned Poggius, a friend, and two servants ascend the Capitoline Hill after the fall of Rome. They are awed by the contrast between what Rome once was and what Rome has become:

> *In the time of the poet it was crowned with the golden roofs of a temple; the temple is overthrown, the gold has been pillaged, the wheel of fortune has accomplished her revolution, and the sacred ground is again disfigured with thorns and brambles. . . . The forum of the Roman people, where they assembled to enact their laws and elect their magistrates is now enclosed for the cultivation of potherbs, or thrown open for the reception of swine and buffaloes. The public and private edifices that were founded for eternity lie prostrate, naked, and broken, like the limbs of a mighty giant; and the ruin is the more visible, from the stupendous relics that have survived the injuries of time and fortune. [Vol. 6, pp. 650–651]*

What could cause the demise of such a grand and powerful society? Gibbon weaves a complex thesis to answer this question, suggesting ultimately that the seeds for Rome's destruction were sown by the Empire itself. Although Rome

finally succumbed to such external forces as fires and invasions, its vulnerability was based upon internal weakness.

The premise that societies can germinate the seeds of their own destruction has long fascinated scholars. In 1798, Thomas Malthus published his classic *An Essay on the Principle of Population* in which he foresaw a time when the urge to reproduce would cause population growth to exceed the land's potential to supply sufficient food, resulting in starvation and death. In his view, the adjustment mechanism would involve rising death rates caused by environmental constraints, rather than a recognition of impending scarcity followed either by innovation or self-restraint.

Generally, our society seems remarkably robust, having survived wars and shortages, while dramatically increasing living standards and life expectancy. Yet, actual historical examples suggest that Malthus's self-extinction vision may have merit. Example 1.1 examines two specific cases: the Mayan civilization and Easter Island.

EXAMPLE 1.1

Historical Examples of Societal Self-Extinction

The Mayan civilization, a vibrant and highly cultured society that occupied parts of Central America, did not survive. One of the major settlements, Copán, has been studied in sufficient detail to learn reasons for its collapse (Webster et al., 2000).

The Webster et al. study reports that after A.D. 400 the population growth began to bump into environmental constraints, specifically the agricultural carrying capacity of the land. The growing population depended heavily on a single, locally grown crop—maize—for food. By early in the sixth century, however, the carrying capacity of the most productive local lands was exceeded, and farmers began to depend upon more fragile parts of the ecosystem. The economic result was diminishing returns to agricultural labor and the production of food failed to keep pace with the increasing population.

By the mid-eighth century, when the population was reaching its historic apex, widespread deforestation and soil erosion had set in, thereby intensifying the declining productivity problems associated with moving onto marginal lands. By the eighth and ninth centuries, the evidence reveals not only high levels of infant and adolescent mortality but also widespread malnutrition. The royal dynasty, an important source of leadership in this society, collapsed rather abruptly sometime about A.D. 820–822.

The second case study, Easter Island, shares some remarkable similarities with the Mayan case and the Malthusian vision. Easter Island lies some 2,000 miles off the coast of Chile. Current visitors note that it is distinguished by two features: (1) its enormous statues carved from volcanic rock and (2) a surprisingly sparse vegetation, given the island's favorable climate and conditions, which typically support fertile soil. Both the existence of the imposing statues and the fact that they were erected at a considerable distance from the quarry suggests the presence of an advanced civilization, but to current observers it is nowhere in evidence. What happened to that society?

According to scholars, the short answer is that a rising population, coupled with a heavy reliance on wood for housing, canoe building, and statue transportation, decimated the forest (Brander and Taylor, 1998). The loss of the forest contributed to soil erosion, declining soil productivity, and, ultimately, diminished food

production. How did the community react to the impending scarcity? Apparently, the social response was war, and ultimately, cannibalism.

We would like to believe not only that in the face of impending scarcity societies would react by changing behavior to adapt to the diminishing resource supplies, but also that this benign response would follow automatically from a recognition of the problem. We even have a cliché to capture this sentiment: "necessity is the mother of invention." These stories do point out, however, that nothing is automatic about a problem-solving response. Sometimes societal reactions not only fail to solve the problem, but they can actually make it worse.

Sources: David Webster, Anncorinne Freter, and Nancy Golin. COPAN: THE RISE AND FALL OF AN ANCIENT MAYA KINGDOM. (Fort Worth: Harcourt Brace Publishers, 2000); and Brander, J. A. and M. S. Taylor (1998). "The Simple Economics of Easter Island: A Ricardo-Malthus Model of Renewable Resource Use," THE AMERICAN ECONOMIC REVIEW, 88(1), pp. 119–138.

Future Environmental Challenges

Future societies, like those just discussed, will be confronted by both resource scarcity and accumulating pollutants. Many specific examples of these broad categories of problems are discussed in detail in the following chapters. This section provides a flavor of what is to come by illustrating the challenges posed by one pollution problem (climate change) and one resource scarcity problem (water accessibility).

Climate Change

Energy from the sun drives the earth's weather and climate. Incoming rays heat the earth's surface, radiating energy back into space. Atmospheric "greenhouse" gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy.

Without this natural "greenhouse effect," temperatures on the earth would be much lower than they are now, and life as we know it would be impossible. It is possible, however, to have too much of a good thing. Problems arise when the concentration of greenhouse gases increases beyond normal levels, thus retaining excessive heat somewhat like a car with its windows closed in the summer.

Since the Industrial Revolution, greenhouse gas emissions have increased considerably. These increases have enhanced the heat-trapping capability of the earth's atmosphere. According to the Intergovernmental Panel on Climate Change (2007), "Warming of the climate system is unequivocal . . . ". That study concludes that most of the warming over the last 50 years is attributable to human activities.

As the earth warms, extreme heat conditions are expected to affect both human health and ecosystems. Some damage to humans is caused directly by increased heat, as shown by the heat waves that resulted in thousands of deaths in Europe in

the summer of 2003. Human health can also be affected by pollutants, such as smog, that are exacerbated by warmer temperatures. Rising sea levels (as warmer water expands and previously frozen sources such as glaciers melt), coupled with an increase in storm intensity, are expected to flood coastal communities. Ecosystems will be subjected to unaccustomed temperatures; some will adapt by migrating to new areas, but others may not be able to adapt in time. While these processes have already begun, they will intensify slowly throughout the century.

Climate change also has an important moral dimension. Due to their more limited adaptation capabilities many Developing countries that have produced relatively small amounts of greenhouse gases are expected to be the hardest hit as the climate changes.

Dealing with climate change will require a coordinated international response. That is a significant challenge to a world system where the nation-state reigns supreme and international organizations are relatively weak.

Water Accessibility

Another class of threats is posed by the interaction of a rising demand for resources in the face of a finite supply. Water provides a particularly interesting example because it is vital to life.

According to the United Nations, about 40 percent of the world's population lives in areas with moderate-to-high water stress. ("Moderate stress" is defined in the U.N. Assessment of Freshwater Resources as "human consumption of more than 20 percent of all accessible renewable freshwater resources," whereas "severe stress" denotes consumption greater than 40 percent.) By 2025, it is estimated that about two-thirds of the world's population—about 5.5 billion people—will live in areas facing either moderate or severe water stress.

This stress is not uniformly distributed around the globe. For example, in the United States, Mexico, China, and India, groundwater is being consumed faster than it is being replenished and aquifer levels are steadily falling. Some rivers, such as the Colorado in the western United States and the Yellow in China, often run dry before they reach the sea. Formerly enormous lakes, such as the Aral Sea and Lake Chad, are now a fraction of their once-historic sizes. Glaciers that feed many Asian rivers are shrinking.

According to U.N. data, Africa and Asia suffer the most from the lack of access to sufficient clean water. Up to 50 percent of Africa's urban residents and 75 percent of Asians lack adequate access to a safe water supply.

The availability of potable water is further limited by human activities that contaminate the finite supplies. According to the United Nations, 90 percent of sewage and 70 percent of industrial wastes in developing countries are discharged without treatment.

Some arid areas have compensated for their lack of water by importing it via aqueducts from more richly endowed regions or by building large reservoirs. Regional and international political conflicts can result when the water transfer or the relocation of people living in the area to be flooded by the reservoir is resisted. Additionally, aqueducts and dams may be geologically vulnerable. For example, in