CHAPTER 23

Efficient Allocation

Allocation receives the lion's share of attention in conventional economic thinking, but it plays a tertiary role in the ecological economic approach to policy. This is not to deny its importance. Efficient or at least cost-effective allocation is, in fact, a vital component of good policy, and we have seen how the various policies discussed so far effectively allocate resources. In this chapter, we turn to some of the "big picture" issues in allocation.

1. We address the myth that if mechanisms can be developed for internalizing all external costs and valuing all nonmarket goods and services, the market alone will lead to efficient allocation.
2. We examine the asymmetric information flows that shape our preferences, and how these influence resource allocation. Allocating resources efficiently toward goods that do little to increase our well-being is not efficient.
3. We return to policies aimed at macro-allocation, the allocation of resources between private and public goods.
4. We examine some problems confronting the allocation of resources under local control and national sovereignty that supply global public goods.
5. We propose an expanded definition of efficiency more compatible with the goals of ecological economics.

Pricing and Valuing Nonmarket Goods and Services

Recall from Chapter 8 that markets lead to efficient allocation of market goods by using the price mechanism as a fulcrum on which to balance supply and demand. Many economists argue that if we could determine monetary values for nonmarket goods, we could then use the market mechanism to efficiently allocate them. As a result, one of the most active research areas in environmental economics is the calculation of "prices" for nonmarket goods. Once prices are established, we need a mechanism to "internalize" these values into the market system. While it is critically important to establish the value of nonmarket goods and services, it is controversial whether establishing monetary values, which are identical to exchange values, is appropriate or meaningful. Internalizing those values is, in any event, not a simple task.

We already discussed in Chapter 20 the problem of circularity in using prices to determine the optimal scale when those prices were already based on the initial scale. A similar problem arises when we try to put market values on nonmarket ecosystem services, an exercise that is sometimes thought necessary to determine the costs and benefits of changes in scale. However, even if we could overcome that problem, we would still confront a number of serious difficulties.

Recalculating Marginal Values

You will recall the resolution of the "diamonds-water paradox" from Box 14.1. Water is far more valuable than diamonds, yet it is available at a very low price. Price is exchange value, or the marginal use value of the good or service in question. Use value is the total value, or the value of all units together. The use value of water is infinite, yet where this resource is very abundant, the value of an additional unit approaches zero. However, when water is extremely scarce, an additional unit may mean the difference between life and death, so its marginal value also becomes immeasurably large. The same is true for any essential good or service, such as the life-support functions of ecosystems: When an essential resource is scarce, the marginal value is extremely high, and it increases rapidly with growing scarcity.

Around 150 years ago, many ecosystem goods and services were so abundant an extra unit had no appreciable value. As a result, the economic system ignored the value of such goods. Over time, however, these goods and services have become increasingly scarce and their marginal values have soared, which is why economists now attempt to calculate their values. As we approach ecological thresholds, which we may already be doing, the marginal value and hence "price" of these goods and services will increase extremely rapidly.

To internalize these ecosystem values, we would need to continuously recalculate them, centralize the information, then feed it back into the market mechanism via taxes or subsidies. Yet calculating the value of such resources is very expensive, and centralizing the knowledge and feeding it back into the pricing mechanism would require an enormous and expen-

Box 23-1 Pricing Nature and Life

In response to a legal demand to assess the value of claims in lawsuits, economists have designed a number of *ad hoc* methods of estimation. Probably this began with "statistical value of a life" calculations to assess damages in cases involving legal liability for accidental death. The usual procedure is to calculate the present value of expected future lifetime earnings of the deceased. Most people would not give up their life voluntarily for such an amount, primarily because they would no longer be around to receive the payment, but even if the payment went to their heirs, there would be few volunteers. Clearly this sum is in no sense "the value of a life." But as a practical procedure for settling legal cases involving accidental death, it is not unreasonable—as long as we always remember that we are valuing human capital as an object, not human beings as subjects. But the question remains: Should compensation be for lost human capital or the lost life of a person?

Question: If you contributed to a fund for the survivors of the victims of September 11, would you prefer that compensation be made according to the differing human capital values of the victims, or an equal amount for each victim?

Given this precedent of valuing human capital, it was a short step to price the loss of ecosystem services and natural capital caused by accidental oil spills such as the Exxon Valdez, industrial accidents, and so on. As a practical way of making after-the-fact compensation for accidents, this is not unreasonable. Problems arise when we move from after-the-fact to before-the-fact, from adjustments to an involuntary occurrence to an imagined voluntary tradeoff. This is what **contingent valuation** estimates do. They present people with imaginary alternatives and ask them, before the fact, and indeed totally hypothetically, how much they would be willing to pay, say, to save 100 grizzly bears, or how much they would accept for the loss of 100 grizzly bears. Interestingly, the two questions usually yield very different answers, although in theory they should be the same for a market transaction. Alternatively, the grizzlies could be valued as a public good. Citizens could be asked how much they would be willing to be taxed along with everyone else to save 100 grizzlies. This makes more sense, but it is still very artificial.

There are other methods besides contingent valuation for estimating hypothetical prices for nontraded goods. Environmental economics texts discuss them in detail. Why we have given little attention to this subject is, we trust, evident from our discussions of the separateness of allocation and scale, and the circularity of deciding scale questions by allocative prices.

sive bureaucracy. The paradox is that we love markets precisely because they constantly and almost costlessly recalculate prices on the basis of decentralized information with minimal government intervention. However, this approach to allocation would be expensive, centralized, and require large-scale government intervention.

Uncertainty, Ignorance, and Unfamiliarity

In addition, methodologies for valuing nonmarket goods are fraught with problems. Most rely on artificially constructed markets or ways of inferring nonmarket values through existing markets. Two problems in particular merit discussion: our lack of knowledge of ecosystem function and our lack of familiarity with valuing nonmarket goods.

As an example, the contingent valuation method constructs a hypothetical market basically by asking people what they would be willing to pay for a given nonmarketed good or service. The problem, as we have repeatedly discussed, is that even the experts are ignorant of all the goods and services healthy ecosystems provide, how they provide them, the impacts of human activities on their provision, where critical ecological thresholds lie, and the outcomes when these thresholds are passed.

If we emit a given stream of pollutants into a lake, what will the impact be? What ecosystem services will be lost? Will the waste flow accumulate, causing worse damage over time—perhaps irreversible loss? Will the loss of the system being polluted affect other systems? What is the time scale involved? Even if it were possible for the experts to resolve all these uncertainties (which it is not) and disseminate that information to the population at large, people have no experience with markets in such goods and services, and would still have a very difficult time assigning meaningful exchange values.

Time, Distribution, and Valuation

Yet another problem is the time factor. Most ecosystem goods and services are renewable, and hence will provide benefits into the indefinite future. A typical decision is whether to sacrifice a renewable flow from a natural fund-service for a nonrenewable (manmade) fund-service or for a one-time liquidation of stock. This demands that we compare present values with future values. As we discussed in Chapter 15, economists generally do this by discounting future values. The discount rate will typically be one of the most important variables in determining value, and there is no agreed upon objective rule for determining an appropriate rate.

We must also recognize that the question of what should be left to the future is inherently an ethical decision concerning intergenerational *distribution*. Conventional economists argue that the question is not one of

Box 23-2 Methodologies for Monetary Valuations of Ecosystems

Several methods are available for putting dollar values on the nonmarketed goods and services provided by ecosystems. Many of these are appropriate for valuing only a small subset of services. Most textbooks in environmental economics provide an adequate introduction to these methodologies. We recommend as a good starting point the Web site "Ecosystem Valuation" at http://www.ecosystemvaluation.org, where the following methods are listed:

- *Market Price Method:* Estimates economic values for ecosystem products or services that are bought and sold in commercial markets.
- *Productivity Method:* Estimates economic values for ecosystem products or services that contribute to the production of commercially marketed goods.
- *Hedonic Pricing Method:* Estimates economic values for ecosystem or environmental services that directly affect market prices of some other good.
- *Travel Cost Method:* Estimates economic values associated with ecosystems or sites that are used for recreation. Assumes that the value of a site is reflected in how much people are willing to pay to travel to visit the site.
- *Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods:* Estimate economic values based on the costs of avoided damages resulting from lost ecosystem services, the costs of replacing ecosystem services, or the costs of providing substitute services.
- *Contingent Valuation Method:* Estimates economic values for virtually any ecosystem or environmental service. The most widely used method for estimating nonuse or "passive use" values. Asks people to directly state their willingness to pay for specific environmental services, based on a hypothetical scenario.
- *Contingent Choice Method:* Estimates economic values for virtually any ecosystem or environmental service. Based on asking people to make tradeoffs among sets of ecosystem or environmental services or characteristics. Does not directly ask for willingness to pay; this is inferred from tradeoffs that include cost as an attribute.
- *Benefit Transfer Method:* Estimates economic values by transferring existing benefit estimates from studies already completed for another location or issue.

distribution, but rather efficient allocation. If a resource will be sufficiently more valuable in the future than in the present, it should be saved for the future. Therefore, maximizing the net present value (NPV) of resource use will lead to the optimal allocation. However, NPV is the value of present and future resources to this generation. If you recall our discussion of property rights from Chapter 20, this corresponds to a property rule assigning property rights to the current generation, which is free to interfere with the future's access to resources. Under this approach, all that matters is the value of resources to the present generation.

As an alternative, we could assign some resource property rights to future generations. For example, assigning rights via a liability rule would leave this generation free to use resources as long as it compensated the future with an equivalent amount of other resources. Under an inalienability rule, the future would be entitled to a certain share of resources, and the present would be obliged to leave them. These three rules are simply different initial distributions of resources, and each would lead to a different set of prices for both market and nonmarket resources. Which rule to use is an ethical decision, not a matter of allocative efficiency.

Market vs. Nonmarket Values

Assuming that all these other issues are addressed, would monetary valuation then lead to efficient allocation? Price provides a feedback mechanism used by the market to maximize profit, which economists assume creates the appropriate conditions for maximizing human well-being. Is a single feedback mechanism sufficient for allocating all the resources that contribute to human well-being? Could natural ecosystems in all their incomprehensible complexity function with only one feedback mechanism? Some ecologists might argue that ecological systems do indeed function this way, where maximizing energy consumption is the ultimate feedback system.

Although energy consumption is a useful simplification in some ecological models, it is not the only driving force in nature. And even if it were, as a principle of competitive exclusion, it does not translate well to the human economy, in which maximizing a cost is surely uneconomic. Moreover, human ethical beliefs make the interaction between the human economy and the ecosystem more complex than the functioning of the ecosystem alone. We therefore cannot support the reductionist approach of assuming that the profit motive alone is sufficient to maximize human well-being, much less to guide us in any quest toward an ultimate end.

As a concrete example of the problems with monetary valuation of everything, it would be quite simple to develop a methodology for calculating a dollar value for democracy. Certainly people in general have a better understanding of democracy than of ecosystem services, and we could readily devise a survey that would tell us how much a voter would be willing to pay for the right to vote (or alternatively the minimum amount for which a voter would sell their vote). We could do the same for human rights, and many people consider the right to live in a healthy environment such a right. But most people would probably agree that politics and human rights are in a different moral sphere than economics, and power in the sphere of economics should not translate to power in these other spheres.[1] (While this, of course, does happen, people do not generally consider it desirable.) Political rights, human rights, and other ethical values are not individual values, but social values. Attempting to estimate social values by aggregating individual tastes suffers from the fallacy of composition and is a categorical mistake.

THINK ABOUT IT!

Would you sell your right to vote? If there were such a market for votes, would you expect the price to be high or very low?

It is true that we are constantly forced to make decisions between mutually exclusive alternatives, such as more forests or more strip malls, which require a comparison between market and nonmarket values. However, many nonmarket goods are fundamentally different from market goods in ways that make "scientific" comparison not only impossible but also undesirable. Putting dollar values on everything does not make the necessary decisions more objective; it simply obscures the ethical decisions required to make those "objective" valuations.

Most textbooks in environmental economics devote considerable space to discussing methodologies for valuing nonmarket goods and services. Valuing ecosystems can play an important role in capturing the attention of the public and policy makers, and can offer insights into appropriate economic policies. But attempting to calculate an exchange value for all nonmarket goods, then use that value to decide what we will preserve and what we will destroy, is an example of economic imperialism, as discussed in Chapter 3.

Ecological economics takes the broader perspective that such methodologies are inadequate to capture the range of human values and physical needs we have for nonmarket goods. Instead of spending time trying to calculate the "correct" price for nonmarket goods, ecological economics stresses that we should act on our knowledge that zero is the incorrect price, and spend our time trying to improve upon and implement policies that recognize they have significant, often infinite value, even if we cannot precisely quantify it.

[1] M. Walzer, *Spheres of Justice*. New York: Basic Books, 1990.

MACRO-ALLOCATION

As we discussed in Chapter 16, macro-allocation is the problem of how to allocate resources between the provision of market and nonmarket goods. The government plays an important role in providing nonmarket goods and can also influence demand for market goods through the use of taxes and subsidies. Presumably, in democratic countries, citizens will elect politicians who will make the right choice regarding macro-allocation. One serious problem with this assumption is the discouraging lack of information people have regarding nonmarket goods and services. For people to make appropriate choices, they require appropriate amounts of information. In this section, we will first look at policies addressing unequal information flows concerning the attributes of market and nonmarket goods, then examine possibilities for the government to provide incentives to the private sector for providing public goods.

Asymmetric Information Flows[2]

Asymmetric information is where either the buyer or seller has information that the other does not have, and that information affects the value of the good or service exchanged. Economists have long known that asymmetric information is a market failure, generating serious inefficiencies. For example, if I am selling a car, I know how well it works, but the potential buyer does not. The buyer will adjust the price she is willing to pay based on the risk of purchasing a lemon, and this risk-adjusted price will be less than the value of a good used car. The rational seller will not be willing to sell a good car at the risk-adjusted price, and the market will provide only lemons (at least according to theory). Joseph Stiglitz won the Nobel Prize in economics for such basic insights.

We face a related problem with the asymmetry of information flows that form our preferences. While many economists argue that preferences are innate, businesses are betting an estimated $652 billion per year that preferences are heavily influenced by advertising.[3] Advertising costs money, and it can only pay for itself by advertising market goods. Most words we hear today are direct sales pitches for market goods and the programs sponsored by them.[4] In stark contrast to advertising for market goods, very little money is spent convincing people to prefer nonmarket

[2]Much of this discussion is adapted from J. Farley, R. Costanza, P. Templet et al. Synthesis Paper: Quality of Life and the Distribution of Wealth and Resources. In R. Costanza and S. E. Jørgensen (eds.), *Understanding and Solving Environmental Problems in the 21st Century: Toward a New, Integrated Hard Problem Science*. Amsterdam: Elsevier, 2002.

[3]International Advertising Association, 2000. To place this figure in context, only seven countries in the world had a GNP higher than $600 billion in 1997.

[4]A. T. Durning, *How Much Is Enough? The Consumer Society and the Fate of the Earth*, New York: Norton, 1992.

goods. To the extent that advertising alters preferences, it systematically does so in favor of market goods over nonmarket goods.

People have a finite amount of resources to allocate. If advertising convinces us as a society to allocate more resources toward market goods, correspondingly fewer are available to allocate toward nonmarket goods. And as we know, all resources allocated toward consumer goods are extracted from nature and return to nature as waste. Seen from this light, advertising convinces us to degrade or destroy public goods for private gain. It appears that current levels of consumption in the developed countries are incompatible with a sustainable future; yet reducing consumption levels will be exceedingly difficult in the presence of so much advertising.

Nor is this the only market failure associated with advertising. Arguably, human welfare is determined by our ability to satisfy our needs and wants. Advertising creates wants by making us believe we need some product or another, yet it gives us no greater ability to satisfy those wants. In this sense, advertising directly diminishes our welfare. We can make this point no better than B. Earl Puckett, former head of Allied Stores Corporation, who once declared that "it is our job to make women unhappy with what they have."[5] In this line of thinking, advertising is basically a "public bad."

The problem is one of providing symmetric information flows for nonmarket goods. This is a very contentious issue. We briefly present several possibilities here for discussion, but welcome new and better ideas for addressing the market failures associated with advertising.

The first involves the recognition that advertising over the airwaves in many countries is subsidized. The airwaves are valuable public property, but are often given free of charge or at low cost to communications corporations. Since transmissions beamed over airwaves have properties of public goods in that they are nonexcludable (at least when the transmissions are not scrambled) and nonrival, there is a solid rationale for giving away airwaves to those who will beam such transmissions, in spite of the fact that the airwaves themselves are rival, excludable, and scarce. However, if the government charged corporations for the use of airwaves for advertising, it would target only that portion of the airwaves devoted to private profit. Advertising is currently considered a business cost and is tax-exempt. For the reasons listed above, however, it would be more appropriate to tax advertising as a public bad. At a minimum we should not allow advertising to be written off as a cost of production. The rationale is that production is supposed to meet existing demand, not create new demands for whatever happens to be produced.

While taxes would presumably reduce the quantity of ads for market

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[5]Ibid., pp. 119–120.

goods, it would not help to generate concern for nonmarket satisfiers of human needs. There are several alternatives for helping to achieve this goal. One approach would be a law mandating “full disclosure” advertising. Just as medicines are labeled with all their potential adverse side effects, advertisements could list all the potential adverse side effects of the products they advertise. This would include, of course, all the negative impacts on the environment and their implications. Another alternative would be to provide free airtime for public service announcements that specifically seek to create demand for environmental services and other nonconsumptive satisfiers of human needs. The media is a phenomenally powerful tool for persuasion, and thus an effective approach to policy would be to make the information flows it provides more symmetric.

A problem with both of these restrictions on advertising is that people will complain that they infringe on the basic right of free speech. However, the right to free speech does have restrictions, it does not include the right to lie or misrepresent. Nor does it include the right to amplification by a powerful megaphone. For example, no one is allowed to shout “fire!” in a crowded theater if there is no fire, because it threatens the well-being of others. Shouting “fire!” may not be fundamentally different from encouraging people to consume when such consumption threatens the well-being of future generations. Many nations already curb advertising on alcohol and tobacco, and the Australian Consumers Association is currently attacking the right to advertise unhealthy foods on children’s TV shows.[6] The same rationale also applies to curbing advertising that indirectly encourages destruction of the environment.

Subsidies for Nonmarket Goods

Even if people are well educated concerning the benefits of nonmarket goods and subsequently elect governments willing to provide them, there remains the problem of how best to do so. Often the best strategy will be for the government to simply supply them outright, or directly pay private sector contractors to do so. In many circumstances though, the nonmarket goods are positive externalities from the production of market or private goods. For example, when farmers terrace their land, use contour plowing, and retain buffer zones along streams, they may dramatically improve downstream water quality, thereby maintaining the productive capacity of their land for future generations. The problem is that the private sector will supply less of the positive externality than is socially desirable. When the positive externality is in the form of a public good, the best approach may be for the government to subsidize the portion of the private activity that generates the public good.

[6] Ibid.

Several types of subsidies are possible. A direct subsidy can simply compensate the private sector for its provision of the positive externality,[7] at which point the externality is partially "internalized" and presumably supplied in more adequate amounts. Alternatively, tax relief can be used to subsidize positive externalities. Possibilities range from a decrease in land taxes for farmers who reduce erosion to tax breaks for business investments in training personnel (people these days regularly change jobs, and firms may offer less training than is socially optimal if the worker will move her newly acquired productivity to another firm). As another option, a subsidy can be in the form of subsidized credit. If people underinvest in activities with positive externalities, lower interest payments would stimulate greater investment.

Using Seigniorage

Where would governments find the money for subsidized interest rates? Again we suggest the option of restoring the sole right to seigniorage to the government, as discussed in Chapter 14. When banks create money, they do so through interest-bearing loans. On average, such loans must generate financial returns that can repay the loan plus interest, which means money is loaned for the production (and consumption) of market goods. Unless the economy is growing, it becomes impossible to pay back all loans with positive real interest rates. Governments, in contrast, could use their power to create money to make interest-free loans or even outright grants to activities that best promote the common good, including the provision of nonmarket goods. Not only would this help in the macroallocation of resource toward nonmarket goods, it could lead to a financial system whose viability is not based on unending growth.

Spatial Aspects of Nonmarket Goods

In previous chapters we discussed the spatial characteristics of nonmarket goods. Most ecosystems provide services at the local level, the regional level, and the global level. For example, a forest can affect climate stability at each of these levels. Yet the principle of subsidiarity requires that the domain of the policy-making unit be congruent with the domain of the causes and effects of the problem with which the policy deals. The causes of ecosystem degradation are often at the local level; effects are felt at local, regional, and global levels; and policy-making institutions are primarily local and national. This poses serious problems for effective policy.

[7] In most cases, it is difficult to know the exact value of the nonmarket good and hence the optimal level of compensation. We do know that zero is the wrong value, and a reasonable compensation will improve allocation.

To make the problem more concrete, we will use the specific example of clearing tropical forests for farmland on the Atherton Tablelands of Australia. On private lands, the decision is local. The net private marginal benefits to farmers of clearing forests for agriculture decreases with area cleared. The first units cleared meet basic needs and are on the very best lands. Additional units cleared meet less important needs and utilize less adequate lands (e.g., steeper slopes, less fertile soils, and greater distances). Eventually, farmers unaware of the ecosystem services provided by forests cleared to the point that water quality was affected, and shade cover was inadequate, leading to reduced yields—that is, a negative marginal net private benefit (MNPB) to deforestation.

This scenario is depicted in Figure 23.1 by the curve MNPB. With the right to do as they pleased on their land, the rational, well-informed farmers should have cleared the forests until marginal benefits were zero, at point A. Instead, due to ignorance, they cleared to point B. It was not just the farmers that were ignorant—at the time this was occurring, few people, if any, knew of the negative impacts caused by deforestation.

Towns downstream of deforested farmlands suffer from irregular water flow and poor quality. The nature tourism industry in the region generates far more income than farming, and it also suffers from deforestation. These local marginal external costs of deforestation (MEC local) are also depicted on the graph. If the local governments had been aware of these negative externalities, they might have implemented policies designed to limit deforestation to point C, perhaps by imposing a local deforestation tax equal to OC′, or issuing tradeable deforestation permits in the quantity OC.

National MEC of deforestation includes local MEC. In addition, deforestation on the tablelands causes erosion, siltation, and nutrient runoff, all of which flows out to sea to be deposited on the coral reefs. This affects fisheries and tourism outside the shire boundaries. The state or national government should have implemented policies to limit deforestation to point D, perhaps through a national deforestation tax equal to C′D′, or by purchasing DC of the OC local level quotas and discarding them.

Global MEC similarly includes national MEC, in addition to deforestation's contribution to global climate change and biodiversity loss. Point E would therefore be the globally optimal level of deforestation, but there is of course no global authority that overrides national sovereignty on issues such as deforestation, so taxation would not be a policy option. Nor is there a global coalition that could purchase deforestation permits (in the event they happened to be internationally tradeable). While individual governments, multilateral institutions and international NGOs currently play some role in preserving ecosystems and reducing the rate of ecosystem degradation in some countries, it is almost certainly insufficient to

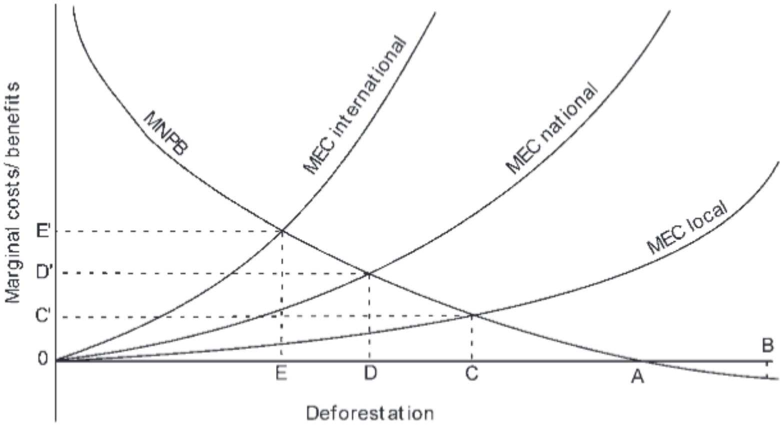

Figure 23.1 • Marginal costs and benefits of deforestation at different spatial levels. Curve MNPB shows the marginal net private benefits of deforestation to farmers on the Atherton Tablelands. This curve accounts for the cost of lost ecosystem services that directly benefit the farmer. Through ignorance, farmers initially cleared amount OB of forest, while had they been better informed, they would have cleared amount OA. Marginal external costs of deforestation are shown for local, national, and international society, along with the corresponding optimal levels of deforestation: C, D, and E, respectively.

achieve globally optimal levels of ecosystem preservation. The insufficiency of these efforts may result from a combination of ignorance and the free-rider effect.

The spatial distribution of ecosystem goods and services thus presents a serious problem. Control over ecosystems is usually at the level of the individual, who retains all the benefits of deforestation (e.g., timber sales and subsequent use of farm land) and shares the costs of lost ecosystem services with society. Where effective institutions and information exists, local and national governments can impose regulations that optimize ecosystem preservation from their points of view. Alternatively, civil society in the form of volunteer community organizations and NGOs can step in when governments fail to act. However, they can only rely on good will, altruism, or other behaviors inconsistent with the assumptions of rational self-interest, but thankfully important parts of the human psyche nonetheless. When governments do act, they are unlikely to pursue globally desirable levels of ecosystem preservation, as there are few incentives to do so, and national sovereignty allows them to ignore global benefits. Making optimal outcomes even more elusive, policy makers at all levels are probably unaware of the full range of benefits intact ecosystems actually supply.

While continued conversion of tropical forests may be uneconomic at the global level, in many of the world's remaining tropical forests (and other healthy ecosystems), it may still make economic sense at the local level to continue the deforestation process. If we look at the Amazon rainforest, much of South East Asia, and Central Africa, there are still vast tracts of largely untouched forest along with high levels of poverty and landlessness. There is little question that for the individual, the best available alternative under current circumstances is often to clear forest and grow crops. The farmers who do this are not irrational. They may be ignorant of the ecosystem services their activities destroy (though probably considerably less ignorant than city dwellers), but even if they were aware, their personal gains from deforestation almost certainly far outweigh their share of the loss from ecosystem services destroyed.

Much of the forest within these countries occurs in states or administrative districts that are almost entirely forested, and have very low population densities. It may thus also make sense at the local and regional level to continue deforesting. There is an important caveat, however. Even if continued deforestation may be appropriate at the local level, in many areas it is carried out in a destructive and inefficient manner. For example, where market access is poor, valuable timber and trees providing important nontimber resources (such as Brazil nuts) may be felled and burnt. Unsustainable production techniques that mine the soil are common, even when small investments could yield far more sustainable and lucrative alternatives. Thus, while deforestation may be appropriate from the local point of view, the way in which it is carried out may at the same time be highly inappropriate.

Even at the national level in countries like Suriname, Guyana, and French Guyana that are up to 90% forested, continued deforestation, if carried out without wanton waste, could help improve well-being for the majority of society (though the indigenous cultures that depend on the forest would almost certainly not be part of that majority). It can also strengthen claims to contested boundaries. In other countries where it may be in the national interest to slow or halt deforestation, it may still not be worth the investment of the resources that would be required to do so. Vast areas of intact forest make monitoring and enforcement of regulations intended to curb deforestation expensive and difficult. In fact, in many of these countries, large areas of forests are essentially open access resources. For example, an estimated 80% of timber harvests in Brazil are illegal.[8]

Brazil provides an interesting case study of a country in which the national government over the past two decades has moved from policies explicitly and vigorously promoting deforestation toward considerable

[8]C. Bright and A. Mattoon, The Restoration of a Hotspot Begins, *World Watch Magazine*, November/December, 2001.

legislation designed to reduce deforestation. Much of the national legislation designed to preserve forests is poorly enforced, and other national policies will almost certainly dramatically increase deforestation in some areas, but there is nonetheless a real trend toward greater efforts for preservation at the national level. This trend presumably reflects a growing knowledge of ecosystem services provided by the forest, growing marginal utility of remaining forests, and international pressure. Some of the more heavily deforested states have implemented innovative policies for reducing deforestation, while heavily forested states still promote it. In the Atlantic Forest, of which only some 8% remains, some individual landowners are working to protect their remaining forests, or are even actively restoring the forest. What are conspicuously absent are adequate resources from the global community to preserve the forest.

International Policies

Problems of global scale must ultimately be solved via global policies. What policies are available to the global community to limit deforestation and other forms of ecosystem destruction to a globally acceptable level? We previously discussed the polluter pays principle, but when it comes to deforestation and the destruction of coral reefs, wetlands, and other ecosystems (or greenhouse gas emissions), sovereign nations will not pay for the impacts their activities have on the rest of the world. Although all nations in the world benefit from healthy ecosystems in other countries, they do little or nothing to help pay for their preservation. Ecosystem services are global public goods, and most countries are free riders on the provision of those public goods.

One solution is the application of a "beneficiary pays principle," where those who benefit pay for the benefits they receive. The fact is that less developed countries, which may now contain the bulk of the world's most productive ecosystems, often lack the institutions and resources to limit ecosystem conversion to nationally desirable levels. An effective policy for preserving ecosystems at a globally desirable level must provide both incentives and resources for doing so.

International Subsidies for Ecosystem Preservation. One possibility for implementing a market-based "beneficiary pays principle" would be an international Pigouvian subsidy for providing ecosystem services. Take the Brazilian Amazon as a case study. Ideally, to reach point E on Figure 23.1, the global community would need to pay only quantity D′-E′ to get from the nationally optimal to the globally optimal level. The first problem is the transaction cost of getting the wealthy nations to agree to paying Brazil to reduce deforestation and deciding how much each must pay.

A potentially larger problem is deciding to whom the subsidy should be paid.

The Amazon is vast, and while deforestation is rapid, it still affects on average less than 1% of the region per year. It would not be efficient to pay all landowners not to deforest, as not all of them plan to deforest in the first place. One possibility would simply be to pay only farmers who are currently deforesting not to do so, but this presents numerous difficulties. Transaction costs of reaching agreements with individual farmers would be enormous, and the monitoring and enforcement costs necessary to ensure landowner compliance would also be substantial. If the farmer agrees not to deforest one area, he may simply deforest another area instead.

Asymmetric information presents another serious problem, as only the landowners themselves know how much they plan to deforest. If payments were made only to farmers in the process of deforesting, other farmers might begin to deforest simply to become entitled to payments. Subsidies directed to the landowners actually involved in deforestation could thus perversely increase the rate of deforestation.

A plausible alternative for a subsidy would be for the international community to pay Brazil for reducing the rate of deforestation below some predetermined baseline. The baseline might be average deforestation over the past several years, or expected deforestation estimated through a more sophisticated model, including variables such as rainfall and economic growth. For example, the most recent available 3-year average of deforestation rates in the Amazon is in the range of 2 million ha per year (average of 1995–1997[9]). The international community could pay a given amount for every hectare deforestation falls short of 2 million. If too much deforestation still occurs, the subsidy can be raised, while if the subsidy is too costly, it can be decreased. Deforesting the full 2 million ha would forego all subsidies, but there still would be no incentive to deforest beyond this point, because there is no incentive to do so in the absence of the subsidy.

Another alternative would be to adopt a strategy currently in use in Brazil known as the ICMS *ecológico*. The ICMS is a tax on merchandise and services, and in certain states, some of this money is refunded to municipalities according to the extent that they meet ecological goals, such as watershed protection and forest conservation. Essentially a payment for the provision of ecological services, it has proven quite effective.

There is no reason a similar approach could not be used at a global level. Initially perhaps, it could be directed toward biodiversity hot-spots,

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[9]Instituto Nacional de Pesquisas Espaciais (INPE), Desflorestamento 1995–1997 Amazonia, 1998. Online: http://www.inpe.br/amz-00.htm.

25 areas round the world identified by scientists that contain an unusually large number of species and are seriously threatened, with 70% or more of the area destroyed. Given the importance of biodiversity in maintaining ecosystem resilience and function, it is likely that hot-spots offer an unusually large amount of ecosystem services. Similar to the ICMS *ecológico*, a global pool of money could be distributed to the countries that harbor these hot-spots according to how well they meet well-defined conservation criteria. It would then be up to the individual countries to determine how best to meet these criteria, thereby allowing micro-freedom to achieve macro-control.

There are several features that contribute toward the feasibility of such international subsidy schemes. First, transaction costs are minimized. Inexpensive satellite photos are capable of providing increasingly accurate estimates of annual deforestation, so monitoring costs would be small.[10] While interpretation of photos may not be an exact science, computer analysis can at least make it a consistent one, in which case quantitative precision is unnecessary. This approach is currently being used to monitor compliance with land use laws in Mato Grosso, Brazil. A subsidy can thus reflect the amount of forest preserved, though an exact dollars-per-hectare figure for the subsidy may not be accurate.

Second, it would not be necessary at the international level to pinpoint who is deforesting. Enforcement and accountability are not major problems, since funds would only be dispersed after conservation occurs; if deforestation is not slowed, no money is spent. Third, national sovereignty would remain intact, as no country would be under any obligation to change behavior. Finally, a major problem in many less developed countries is that they lack the institutions and resources to enforce environmental policy, especially in such vast areas as the Amazon. A subsidy could provide both the incentive and resources for local and national governments to slow deforestation using some of the previously discussed policies.

A very similar approach would be to pair a national Pigouvian tax with an international subsidy. In this case, the national government would be required to tax deforestation. Such a tax might be costly to implement and administer, both fiscally and politically. While these costs might be less than the revenue gained, they still reduce the incentive to implement such a policy. If, however, a global institution matched such a tax, or some percentage of such a tax (perhaps greater than 100%), it would effectively combine the "polluter pays" and the "beneficiary pays" principles in one policy package.

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[10]A. Almeida and C. Uhl, Brazil's Rural Land Tax: A Mechanism to Promote Sustainable Land Use in Amazonia, *Land Use and Policy* 12:105–114 (1995).

The problem with subsidies for firms to reduce pollution is that it might lead to more firms. If countries decide to grow forests simply to earn a subsidy not to cut them down, that would hardly be a problem.

Although these suggestions make economic sense, they have not been tried at an international level. This is why we call for adaptive management with all policies. When a policy works, use it. When it doesn't, either fix it or replace it with another. What we cannot afford to do is stand by and do nothing when it is obvious that the status quo is not working.

Redefining Efficiency

In standard economic practice, allocative efficiency is achieved when we put scarce resources to the use that generates most monetary value (which is taken to be a measure of utility). With a central focus on monetary value, allocative efficiency generally ignores nonmarket goods and services. Typically economists defer to Pareto efficiency, which is an allocation such that nobody can be made better off without making someone else worse off. Pareto efficiency does not permit comparisons between individuals, and it accepts the status quo distribution of wealth, however, unequal that may be. It ignores the diminishing marginal utility of wealth and the potential for gains from redistribution.

Many economists and policy makers favor potential Pareto efficiency (Hicks-Kaldor welfare criterion, see Chapter 17) as an "objective" decision-making tool that favors any allocations that could potentially create a Pareto improvement after redistribution but that does not require that redistribution. Since wealth clearly generates more wealth in the modern economy, potential Pareto improvements are more likely to benefit the already wealthy than the poor.

Technical efficiency, in contrast, is defined as the maximum amount of physical output one can get from a given amount of resource input. While a desirable goal, it alone does little, if anything, to create a more sustainable society. Greater technical efficiency can reduce the demand for a resource. Alternatively, lowering the quantity of resource required to make something can lower the cost of the final product. Quite possibly, the result of increased technical efficiency, thanks to lower price, is greater use of resources, not less.

We have already seen that the goal of economics is not to maximize production, but rather to provide service. We define service as a psychic flux of satisfaction, which is derived from manmade capital as well as from ecosystem services provided directly by natural capital. Manmade capital can only be created through the transformation of natural capital, hence the production of services from manmade capital demands a sacrifice of services from natural capital. We will call this the **comprehensive effi-**

ciency identity. Therefore, an appropriate measure of efficiency is the ratio of services gained from manmade capital stock (MMK) to the services sacrificed from the natural capital stock (NK) as a result. There are several ways to improve this efficiency ratio, as shown in the following identity:

$$\frac{\substack{\textit{MMK}\\\textit{services}\\\textit{gained}}}{\substack{\textit{NK}\\\textit{services}\\\textit{sacrificed}}} = \underset{(1)}{\frac{\substack{\textit{MMK}\\\textit{services}\\\textit{gained}}}{\substack{\textit{MMK}\\\textit{stock}}}} \times \underset{(2)}{\frac{\substack{\textit{MMK}\\\textit{stock}}}{\textit{thruput}}} \times \underset{(3)}{\frac{\textit{throughput}}{\substack{\textit{NK}\\\textit{stock}}}} \times \underset{(4)}{\frac{\substack{\textit{NK}\\\textit{stock}}}{\substack{\textit{NK}\\\textit{services}\\\textit{sacrificed}}}}$$

Ratio 1 is service efficiency; it is composed of technical design efficiency, allocation efficiency, and distribution efficiency. For example, a well-designed house provides more of the service of shelter than a poorly designed one using the same amount of material; alternatively, glue-laminated beams and laminated I-beam floor joists use less wood to provide the service of structural strength than traditional one-piece solid wood building materials. Allocation efficiency requires that black walnut be used to build fine furniture instead of floor joists. As to distributive efficiency, wood used to provide essential shelter to 50 homeless families provides more service than the same wood used to build a rarely used summer mansion for a billionaire.

Ratio 2 is maintenance efficiency or durability. All MMK stock requires throughput to maintain or replace it, but the less throughput required, the greater the efficiency. A well-built house lasts longer and requires less maintenance than one sloppily slapped together.

Ratio 3 is growth efficiency of natural capital and harvest efficiency. Well-managed forests and plantations of fast-growing species provide more sustainably harvested timber each year than poorly managed forests or plantations consisting of slowly growing species. For example, studies in the Amazon show that carefully selecting trees to be cut, removing vines on those trees, and carefully planning skid tracks can reduce the time between harvests from 90 to 30 years.

Ratio 4 is increased by creating more natural capital stock, or by sacrificing fewer ecosystem services per unit of stock we exploit. Reforestation increases the stock of forest. While a timber plantation may be efficient in terms of growth and timber production, it may provide few other ecosystem services. In contrast, improved management of selective logging of existing forests, as described above, is likely to increase both efficiency ratios 3 and 4.

This definition addresses scale by capturing the tradeoff between services gained (numerator) and services lost (denominator), as shown on the left-hand side of the identity. Uneconomic growth invariably reduces efficiency. On the right-hand side of the identity we see the components of overall efficiency—namely, design, distribution, durability, growth, and harvesting.

THINK ABOUT IT!

Analyze the efficiency of burning coal from a strip mine using the comprehensive efficiency identity. Consider each of the four ratios in your answer. (Hint: MMK stock is inventory of mined coal, NK is coal in the ground.)

BIG IDEAS to remember

- Pricing nonmarket goods and services
- Contingent valuation and pricing nature
- Market vs. nonmarket values
- Macro-allocation asymmetric information
- Asymmetric information
- Subsidies for nonmarket goods
- Seigniorage
- International subsidies for ecosystem preservation
- Comprehensive efficiency identity