Markets and the Environment

We all use markets every day. Markets allow us to trade—buying and selling goods allows us to create economic value. We appreciate the choices and opportunities that markets provide to us, because we like choice and the freedom to choose. But what is a *market* to an economist? To non-economists, a market is a tangible place in which to spend money; such as a neighbourhood mall or a village market in France, or a global website on which you buy and sell apples or armchairs. But to economists, the idea of a market is more conceptual—they see the market as a way to create value through the voluntary exchange of goods and services regulated by competition.

Economists champion the marketplace as the most useful way to organize economic activity. Markets arise spontaneously because people can create value in trade. Markets create wealth through voluntary exchange of scarce resources, in which prices guide how people decide to trade. Wealth is created when resources move from low-value to high-value uses. Markets *create* value—the benefits exceed the costs—rather than just *redistributing* wealth between people.

Markets are powerful for another reason than just trade. Markets send signals; they are a channel of communication. Many scientists dedicated to protecting the environment believe that markets are the most effective tool humans have 'discovered' to organize and coordinate the diffuse set of information spread throughout society; for example, information on what people want, how much of the good is in supply, given drought or rainy conditions. Markets use prices to communicate scarcity—as defined by both the laws of nature and the laws of humanity. Prices send signals to coordinate decentralized economic decisions. Markets succeed when prices define the trade-offs we face such that resources are allocated to their highest-valued use in society.

But markets fail too. Markets fail when prices send bad information about the true nature of scarcity, or when markets fail to exist at all because they are too costly to construct. For example, we suffer from over-pollution or overdevelopment when a market price is too low to communicate our preferences for environmental protection. Prices might misstate the economic value of a reduction in health risk from an environmental threat, or prices might not even exist to signal the value. Left alone, a market might produce too few or too many goods or services. A wedge is driven between what people want as individuals and what society wants as a collective.

The protection of endangered species on private land is a classic example of market failure. By one estimate, about half of the listed endangered species in the United States have 80 per cent of their habitat on private land. The challenge is that the benefits of the protection of endangered species extend to everyone—the entire world—but the costs of protection fall on private landowners. Since the market price of private land does not capture the social benefits of species protection, landowners have more incentive to protect their own private investment (e.g. their capacity to produce cattle) than to protect endangered species. The market fails when private decisions generate a less-protected habitat than society desires.

But even when markets fail, they can be the cornerstone of the solution. Rather than turning to more government regulation or stakeholder-participation processes, society can fix existing markets or create new markets to manage our environment and natural resources; for example, when we create markets in rights to emit pollution. Since a market is a tool, its precision depends on how society defines the rules to regulate its behaviour; that is, property rights, liability, and information. People who dislike the prices that a market produces have to rethink the connection between price signals and market rules. We can work together to change these rules. We should view markets as having the potential to work for us, not against us.

This chapter explores the nature of markets, market failure, and market redemption. We discuss the power of markets, and why economists continue to promote markets despite their flaws. We examine how markets can fail the environment due to externalities, public goods, common property, thresholds, and hidden information. We end by exploring how we can use elements of markets to correct market failure, or policy failure due to government subsidies.

2.1 The Power of Markets

A market serves society by creating value through free exchange. Markets use prices to communicate the wants and limits of a diffuse and diverse society so as to bring about coordinated economic decisions efficiently. The power of a market system rests in the decentralized process of decision-making and exchange. No omnipotent central planner is needed to allocate resources. Rather, market prices ration resources to those who value them the most, and in doing so under certain conditions, people are swept along by Adam Smith's 'invisible hand' to achieve what is best for society as a whole. Self-interest is the driving power, and competition the regulator of that power—together, they work to improve the lives of common people.

A key idea behind the power of markets and free exchange is *comparative advantage*. One person has a comparative advantage over another person in one good relative to another good if that person's relative *efficiency* in the production of the first good is greater than that of the other person. Alternatively, a person has a comparative advantage if his or her opportunity cost is less than that of the other person. The *opportunity cost* is the economic cost as measured by what we have to give up to do something else.

Absolute advantage does not translate into comparative advantage. Everyone, skilled or unskilled, has a comparative advantage at something, because opportunity costs are lower for some people for different activities. Markets and trade benefit everyone in society because they allow people to specialize in activities in which they have a comparative advantage, and then trade for what they want to consume (for an extension of this idea to the

benefit of trade between nations, see Chapter 8). A market succeeds when it allows for the *efficient* allocation of resources. Efficiency gains exist in an economy if it is possible to trade goods and services such that at least one person is better off and no one else is worse off. This is called *Pareto efficiency*—the inability to reallocate resources without making at least one person worse off.

For example, should you shovel your own snow? No, not necessarily. If you follow the idea of opportunity cost and comparative advantage, it might be to your and to society's advantage to use the market and hire someone to shovel your snow. Everyone has a comparative advantage at something, based on his or her relative opportunity cost. Suppose you can shovel snow better than the next person, but it might be that your opportunity costs are too great. Say you could remove the snow in two hours; but in those two hours you could have written a new essay on Napoleon's wild youth and earned $5,000 selling it to a blog on historical French leadership. In contrast, your teenage neighbour could do the job in four hours at $10 per hour, so it would cost you $40 to remove the snow. The teenager's opportunity cost is that he or she would have to give up gaming on the PlayStation for four hours—which we assume he or she values at less than $40. Both you and the teenager gain from the trade: you write the essay and get paid, the teenager shovels your snow and gets paid, and society is better off since you both gained—it is a Pareto-efficient trade. Box 2.1 illustrates the idea of gains from trade, by means of an example.

What is the key to a successful market? Most economists agree that well-defined property rights are the key. A well-defined property rights system represents a set of entitlements that define the owners' privileges and obligations for use of a resource or asset. A well-defined property rights system is based on four characteristics:

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- *Comprehensive*—all resources are either privately or collectively owned, and all entitlements are defined, well known, and enforced.
- *Exclusive*—all benefits and costs from use of a resource accrue to the owner(s), and only to the owner(s), either directly or by sale to others. This applies to both private and common-property resources.
- *Transferable*—property rights should be transferable from one owner to another through a voluntary exchange. The owner has an incentive to conserve the resource beyond the time during which he or she expects to make use of it.
- *Secure*—property rights to resources should be secure from involuntary seizure or encroachment by other people, firms, and governments. Security provides the owner with an incentive to improve and preserve a resource while it is in his or her control, rather than exploit the assets.

These four conditions represent an ideal scenario in which gains from trade are created and captured by people who trade. The idea of a complete set of markets does not reflect reality, however; rather, the notion of *complete markets* represents a theoretical benchmark against which economists can judge the effectiveness of different plans to organize economic activity. This orthodoxy of maximization and equilibrium to capture the interactions of intelligent self-interested people is a necessary fiction rather than literal truth.

Markets also force people to make a distinction between rhetoric and action in the context of environmental assets. We all have opinions. Markets help separate those opinions we

BOX 2.1 Market Equilibrium and the Gains from Trade

Consider the following market. Suppose that a market exists for a classic Ansel Adams photo of the Grand Tetons National Park, with eight buyers and eight sellers. Each buyer has his or her maximum willingness to pay (WTP) for one photo; each seller has his or her minimum willingness to accept compensation (WTA) for one photo:

Buyer ID	WTP	Seller ID	WTA
B1	$300	S1	250
B2	$200	S2	350
B3	$50	S3	150
B4	$500	S4	450
B5	$300	S5	250
B6	$250	S6	100
B7	$400	S7	200
B8	$100	S8	100

Using the WTP and WTA data, we can graph the market demand and supply curves, and then calculate the equilibrium price and quantity, and the total gains from trade. First, we can rank-order the buyers from highest to lowest WTP, and draw them as a set of downward steps. This is the market demand curve. Now we rank-order the sellers from lowest to highest WTA, and graph them as a set of upward steps. This is the market supply curve. When market demand intersects market supply, we find the market equilibrium—the market clearing price and quantity sold. In this example, then, the equilibrium market price equals $250 and the equilibrium quantity is 4 or 5.

How do economists measure the gains from trade? We have defined the total gain from trade as the sum of two measures of welfare—the *consumer surplus* and the *producer surplus*. The consumer surplus (CS) represents the gains to each buyer, and is represented as the difference between each buyer's WTP and the market price:

$$CS = (\$500 - 250) + (\$400 - 250) + (\$300 - 250) + (\$300 - 250) + (\$250 - 250) = \$500.$$

For example, buyer 7 was willing to pay $400, but since the market set the price at $250, that is all he had to pay; his consumer surplus equals $150 (= $400–250). The consumer surplus represents his gain from exchange. If we add up each buyer's consumer surplus we have measured the total benefits to all the consumers in this market.

Similarly, the producer surplus (PS) represents what the sellers gain from this market. Here the producer surplus is the difference between the market price and each seller's WTA:

$$PS = (\$250 - 100) + (\$250 - 100) + (\$250 - 150) + (\$250 - 200) + (\$250 - 250) = \$450.$$

For example, seller 6 was willing to accept $100 to sell, but since the market set the price at $250, her producer surplus equals $150 (= $250 – 100). Again, if we add up each seller's producer surplus, we have measured the total benefits to all the producers.

Finally, the total gains from trade in this market equal the sum of the consumer and the producer surplus, which in our example is $950 = ($500 + 450). This is represented by the shaded area between the demand and supply curves. Both the low-cost sellers and the high-value buyers gain in this market. The market is *efficient* because it has helped move low-valued resources to high-valued uses (for more details, Krugman and Wells, 2008).

are willing to back up with real economic commitments from those we are not. The discipline provided by the market forces people to relate their choices to the choices of others and to the consequences of these choices.

People tend to overstate their real willingness to pay or to co-operate—say, to protect threatened tree frogs or critical wetlands—when asked a hypothetical survey question. Good intentions are just that; but markets do not sustain cheap talk. Markets force us to decide how to use our scarce resources for development or conservation, or some combination of the two.

2.2 Market Failure

Market failure is a reality that we must confront. *Market failure* exists when resources do not attain their highest social value. For environmental goods and natural resources, markets fail when benefits and costs cannot be allocated with precision across and within nations and generations. Sometimes, the needed conditions of well-defined property rights do not hold up for environmental goods. Markets fail when private self-interested actions could still be improved on relative to collective goals.

Market failure comes about when people cannot define property rights clearly. Markets fail when we cannot transfer rights; when we cannot exclude others from using the good; or when we cannot protect our rights to use the good. Under these conditions, free exchange does not lead to a socially desirable outcome, because private actions provide too many 'bads', such as pollution, or too few goods, such as open space. Since everyone 'owns' the right to clean air and biodiversity, nobody owns the right. This makes it a challenge for a market to operate effectively. The market system is said to be 'incomplete', and we have the problem of 'missing markets'.

For example, most societies do not currently have well-defined rights to produce or consume pig odour (i.e. the smell of manure) from a large-scale pig-farming enterprise. Those up- or downwind cannot buy or sell tickets for fragrant air. The pig farm upwind cannot sell fresh air; those downwind cannot buy fresh air. Since the farm does not bear the downwind costs, it can ignore these costs. With incomplete markets, the pig farmer lacks a motivating economic incentive to control emissions or to switch to less-polluting practices. Similarly, if no legal or institutional basis exists, people who use polluted river water cannot receive compensation from upstream farmers whose sediments, pesticides, or fertilizers impose downstream costs in the form of contaminated drinking water, poor fishing, or reduced recreational opportunities. Farmers can impose 'external costs' on these other users of the river.

A market can fail for several reasons. Economists use a taxonomy to help identify and categorize the different types of market failure. Understanding how and why a market fails is the first step to correcting the problem. We examine four types of market failure for environmental resources—*externalities*, *public goods*, *open-access common property*, and *hidden information*. Some overlap exists between these types of market failure, whilst there are other types of market failure—such as market power or monopoly—that we do not discuss here.

Externalities. Externalities are the classic type of market failure for environmental problems. Pollution is an externality when a person or firm does not bear all the costs or receive all the benefits of his or her actions. An externality can arise when the market price or cost of production excludes its social impact, cost, or benefit. If you look around, you can see

externalities everywhere. Think of how your actions affect other's well-being, for better or worse, and how you do not pay or receive compensation for the extra costs or benefits. The market fails because the market is *missing*—no exchange institution exists in which people pay others for extra benefits or receive compensation for extra costs (see also Box 2.2).

BOX 2.2 An Example of an Externality: Air Pollution in Ecuador

Failing to put the correct 'price' on using the environment can lead to too much environmental degradation. Factory owners who decide to increase output face no cost for any resultant increase in pollution. This suggests that they have no economic incentive to cut down on emissions, and then society has too much pollution. Another example is the air pollution arising from driving to work. When people drive to work, they pay no immediate price for the pollution coming from their cars.

Jurado and Southgate (1999) explore these factory and automobile externalities in a study of air quality in Quito, the capital of Ecuador. Quito lies high up in an Andean mountain valley, which exacerbates its air quality problem. The table below shows that the major sources of pollutants are vehicles and factories. Neither factory nor vehicle owners face any immediate economic price for the pollution for which they are responsible.

	Total suspended particulates (TSP)	Sulphur dioxide (SO_2)	Nitrous oxides (NO_x)
Vehicles	1,069	659	5,298
Factories	7,170	18,707	5,023

These levels of air pollution exceed the maximum recommended levels set by the World Health Organization (WHO). The concentrations of TSP in 1991 averaged 149.9 g/m^3, compared with the WHO standard of 60 g/m^3.

The authors estimated the economic costs of air pollution as measured by the impact on human health. Pneumonia and other respiratory ailments are the leading cause of death in all age groups in the city, and are exacerbated by the high TSP levels. The study used statistical relationships between TSP levels and three standard measures of ill-health: restricted activity days, work days lost, and excess mortality.

The predicted increases in ill-health from pollution were valued in economic terms using several approaches, including the value of working time, and the cost of illness (e.g. hospital resources used up in treating patients; see rows 2 and 3 of the table below). Extra deaths were valued as the discounted value of lifetime earnings, a somewhat dated approach. This yields a value of $16,887 per avoided death, which then gives the values in row 4 of the table.

	Annual costs to citizens of Quito (US$)
Restricted activity day costs (given 3,433,000 restricted days)	$14,418,600
Working days lost costs (given 1,765,000 working days lost)	$12,708,000
Excess mortality costs, as per study (given 94 extra deaths per year)	$1,587,378
Excess mortality costs, revised	$12,220,000

We have used 'value of statistical life' estimates based on how much people are willing to pay for risk reductions (for details, see Chapter 5). The value of the reduced risk is increased by an order of magnitude in row 4. These new estimates are based on the figure of $130,000 per avoided death from Fankhauser et al. (1998) for developing countries. Whatever the values used, the message is clear: externalities due to private air pollution decisions impose social costs on the citizens of Quito.

For instance, driving your car around town creates numerous externalities. The exhaust contributes to air pollution, driving at rush hour adds to congestion, road rage increases the risk to others and yourself, and the beautiful racing flames painted on the side add to cultural pride. No explicit markets exist to exchange the good for the bad. You live with it. But from an efficiency viewpoint, in which society is trying to get the most out of its limited resources, the lack of a market leads to too many exhaust fumes, too much congestion, too much road rage, and so on.

Consider another example of a negative externality, or external cost, in a local environment. The village of Centennial sits at the base of the Snowy Range Mountains. Not many people live in Centennial, and development of new houses is slow. The houses and yurts (originally, a Central Asian dwelling type) that exist sit below the ridgeline, so they do not stick out as people look towards the horizon. Citizens of Centennial and people driving through enjoy the wide-open space that the current development promotes. But suppose that a newcomer called Riley moves into the valley and wants to build a new house on his private property. This property sits on a prominent ridge, a 'hogback', and the proposed three-storey house is to be built on top of the ridge, visible to everyone in the valley.

Suppose that Ole lives below the ridge and has an undisturbed view of Centennial valley and the mountains beyond. If Riley, the newcomer, builds his house on the ridge, Ole's view of the wide open spaces in Centennial valley will disappear. Riley's actions reduce Ole's well-being. But Riley does not have to pay compensation to Ole or anyone else, since no one owns the right to the vista. Riley's private decision to build his house on his own land does not account for the losses suffered by the rest of the community who valued the open space—a wedge is driven between the private and socially optimal allocation of resources.

Figure 2.1 illustrates this example. Riley accounts for his own marginal benefits and costs, and chooses to develop his house at level H'. If he had accounted for the social costs of lost open space suffered by Ole and the rest of the community, Riley would have developed at level H^*—a smaller house built below the ridge. Since $H' > H^*$, the market is said to have failed to allocate resources efficiently—there is too much housing on the ridge in Centennial valley.

This example involves a loss of aesthetics; other externalities affect matters of life and death. Many externalities increase the risks to human life and limb. Toxic wastes that leach into drinking water are an example; urban air pollution due to transportation, which curtails the activities of young children, is another. All actions that alter the health risk to others in which no compensation is paid or received create externalities that are left unattended by the market.

These examples of pollution reflect a direct externality—you breathe or drink polluted air or water and there is a direct impact on your health. But over the past century tracking the direct effects of an externality has become more complicated, as humanity has developed new technologies to separate itself from the whims of nature. In many cases, it is less obvious to determine the cause and potential effects: the effects are less direct and more roundabout. The idea of *ecosystem externalities* captures these indirect impacts. An action affects an environmental system at one obvious point, at which no harm seems to be done. But the action is working its way through the system, and can show up somewhere else as an unexpected and unwelcome surprise. For example, citizens who kill predators in order to protect

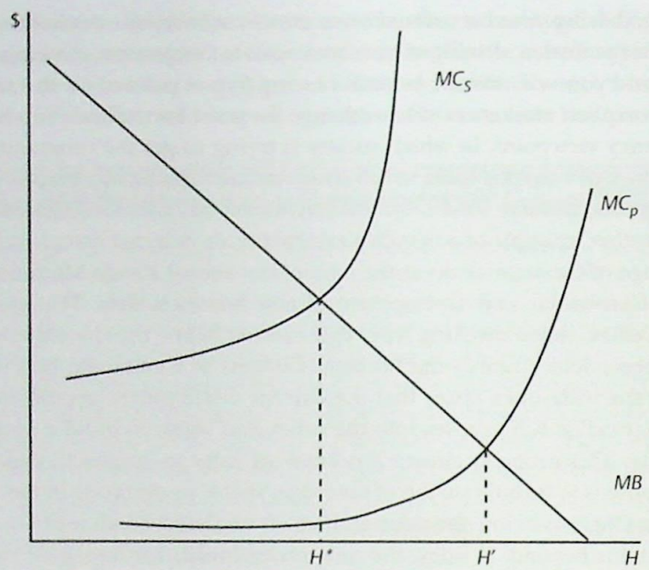

Figure 2.1 Marginal benefits and marginal costs: private and social.

children and domestic animals can generate large rodent infestations that affect crops and sanity. DDT does not kill birds but, rather, it thins the shells of their eggs.

Ecosystem externalities highlight the fact that the economist cannot presume that the cause and effect of production and consumption decisions are obvious; and that even though there is no effect 'under the streetlamp', there might be an unanticipated effect somewhere else (Finnoff and Tschirhart, 2008). Economists have to work with natural scientists in the life sciences to better anticipate the potential for indirect externalities, feedbacks between the economic and ecological systems, and the subsequent unintended and unpleasant surprises.

Public goods. Public goods are a second form of market failure. A public good exists when a person cannot be excluded from its benefits or costs—*non-excludability*; and when one person's consumption of the good does not reduce its availability to anyone else—*non-rival consumption*. Together, non-excludability and non-rival consumption are what separates a public good from a private good, which is excludable and rival in consumption.

Economists make use of the terms *pure* and *impure* public goods. The difference is that a pure public good is both non-excludable and non-rival; whereas an impure public good might be either non-excludable or non-rival, but not both. Climate-change protection, the ozone layer, and biodiversity are examples of pure public goods in which the benefits accrue to all those around the globe. Common-property and club goods such as rivers, local parks, and lakes are impure public goods because the benefits can be excluded from non-members of the group that owns the resource. We focus first on pure public goods, and then turn to common property in the next section.

Non-exclusion depends on the physical characteristics of the good and the property rights regime. Climate-change protection is the most obvious form of public good in the