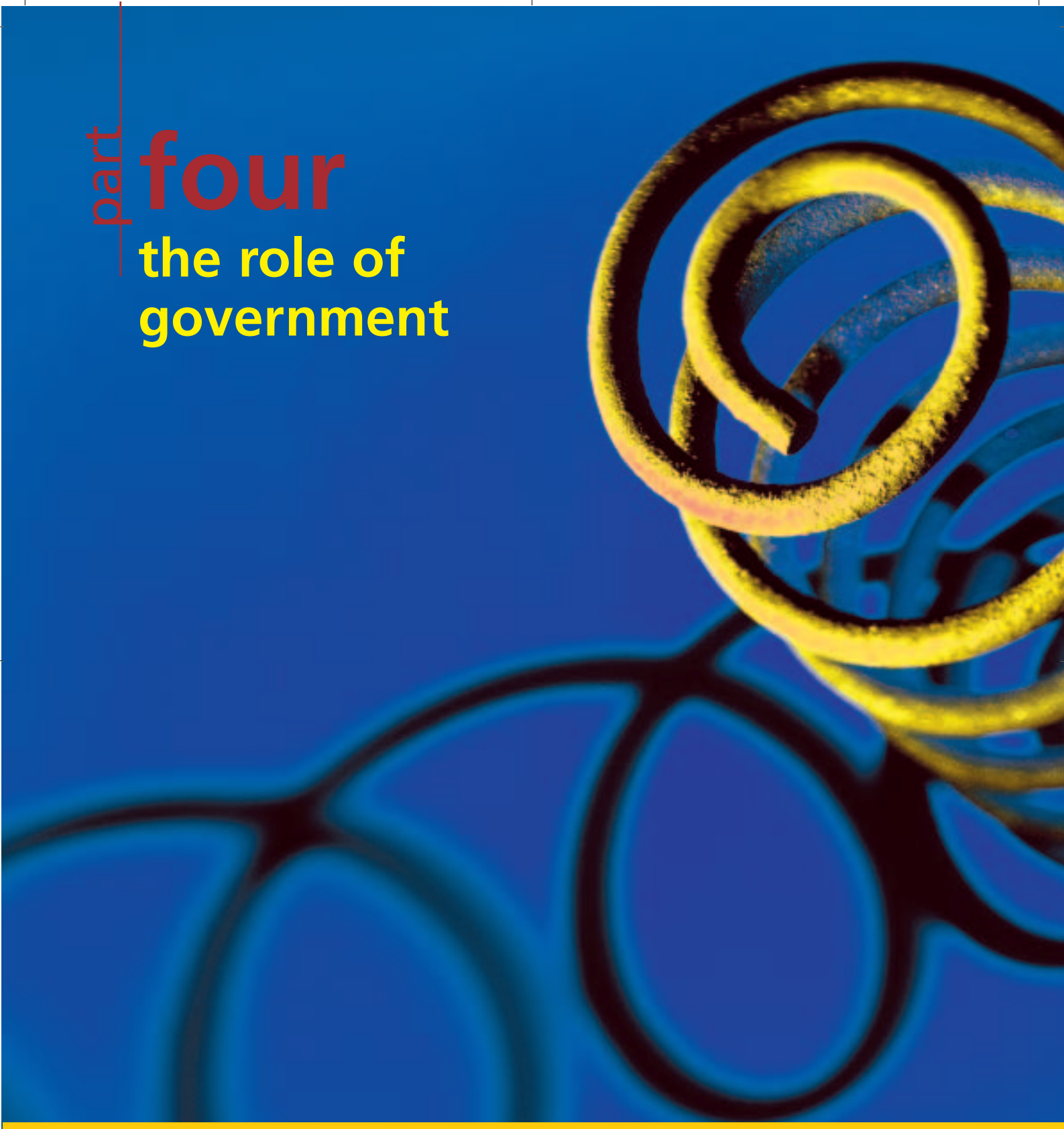
part four

the role of government



chapters

chapter

17

market failure and resource allocation

learning objectives

- Discuss the nature and provide examples of spillovers (externalities).
- Examine the implications of spillovers for the efficient allocation of resources.
- Briefly discuss the problem of the commons and its implications.
- Describe the characteristics of public goods—*indivisibility* and the *inability to apply the exclusion principle*—and the potential role of government in ensuring the adequate provision of these goods.
- Show how we can evaluate government activity through cost–benefit analysis.
- Determine the economic considerations that underlie environmental problems and examine some suggested solutions to the pollution problem.

Introduction

We found in Chapters 4, 8 and 10 that the operation of a competitive market system will result in a socially efficient allocation of economic resources. The 'right', or optimum, amount of resources will be allocated to each good and service. So, the competitive market equilibrium output is also identified as the optimum output.

The conclusion that the unfettered operation of competitive markets automatically results in allocative efficiency relies, however, on a number of hidden assumptions. The first set of assumptions is that all the benefits and costs associated with the production and consumption of each product are fully reflected in the market demand and supply curves. Stated differently, it is assumed that there are no spillovers or externalities associated with the production or consumption of any good or service. Further, there is an assumption that all inputs are priced appropriately. This will often not be the case with socially owned or common property resources.

The second set of assumptions is that all goods and services come in units small enough to be bought by individual buyers—an assumption of divisibility—and that only those who are willing and able to pay the equilibrium price will be able to consume the product. Those who are unable or unwilling to pay are excluded from the benefits provided by that product. There are certain kinds of goods and services—called public goods—which do not possess these characteristics, and which the market may not provide in appropriate quantities if left to its own devices.

Each of the above situations constitutes an example of market failure, the focus of our attention in this chapter.

We will start our exploration of the sources of market failure with a formal analysis of externalities and public goods.

Market failure and its sources

Economists recognise two major cases of **market failure**—when the competitive price system either:

- produces the 'wrong' amounts of goods and services
  or
- fails to allocate any resources at all to the production of certain goods and services whose output is economically justified.

The first case involves 'spillovers' (or 'externalities') and the second 'public' (or 'social') goods.

Spillovers (or externalities)

The virtue of a purely competitive market system over other forms of market structure and organisation is that it supposedly results in an efficient allocation of resources. The 'right', or

optimum, amount of resources is allocated to each good and service due to the pressures of competition and the desire of producers and consumers to maximise their own profits and welfare respectively. So, for the competitive market shown in Figure 17.1(a), the *equilibrium* output Q_e is also identified as the *socially optimum* output Q_o.

The conclusion that competitive markets automatically result in allocative efficiency rested, however, on the hidden assumption that *all* the benefits and costs associated with the production and consumption of each product are fully reflected in the market demand and supply curves. Stated differently, it is assumed that there are no *spillovers* (or *externalities*) associated with the production or consumption of any good or service provided by the market.

Spillovers (or externalities): costs or benefits associated with the production or consumption of a good or service that flow on to parties external to the market transaction.

A **spillover** occurs when some of the benefits or costs associated with the production or consumption of a good 'spill over' to third parties, that is, to parties other than the immediate buyer or seller. Spillovers are also termed **externalities** because they are benefits and costs that affect some individual or group *external* to the market transaction.

Spillover costs

When production or consumption of a commodity inflicts costs on some third party without compensation, these are termed **spillover costs**. An example of a spillover or social cost is environmental pollution. When a chemical manufacturer dumps wastes into a lake or river, swimmers, people who fish and sail, and whole communities that want a decent water supply suffer spillover costs. When a petroleum refinery pollutes the air with smoke or a paint factory creates distressing odours, the community carries spillover costs for which it is not compensated.

Figure 17.1(b) shows how spillover (or external) costs affect the allocation of resources. When spillover costs occur, producers shift some of their costs onto the community and their production costs are lower than otherwise. That is, the supply curve, which shows the *marginal private cost* of production, does not include, or 'capture', all the costs that can be legitimately associated with the production of the good. Hence, the producer's supply curve, SS, understates the *marginal social cost* of production and therefore lies below the supply curve that would include all costs to society of producing additional units of output, S_tS_t. By polluting (that is, by creating spillover costs), the firm enjoys lower costs and the supply curve SS.

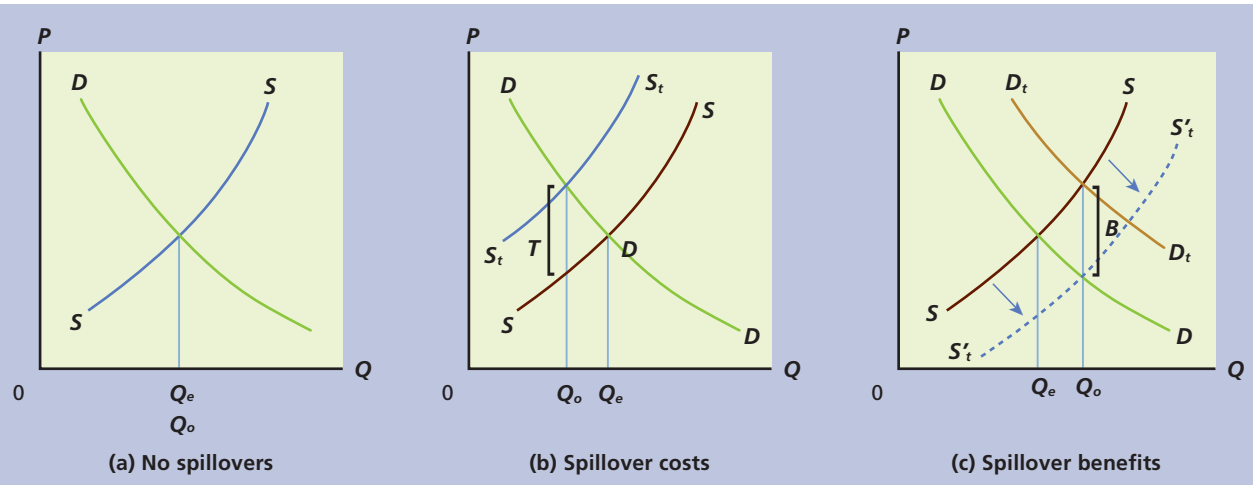


Figure 17.1 *Spillovers and the allocation of resources*
Without spillovers, as in (a), the equilibrium output Q_e is also the most efficient, or optimal, output Q_o. But with spillover costs, as in (b), resources are overallocated to production; that is, the equilibrium output exceeds the optimum output. Conversely, spillover benefits, as in (c), cause an underallocation of resources in that the optimum output exceeds the equilibrium output.

The result, as shown in Figure 17.1(b), is that the equilibrium output Q_e is larger than the optimum output Q_o. The market system will *overallocate* resources to the production of the commodity because the producer is not required to *internalise* the additional costs imposed by society from its production. Efficiency requires that the output level of the industry be reduced by an amount equal to Q_eQ_o. At Q_o, the marginal social cost—equal to the marginal private cost plus T in Figure 17.1(b)—is equivalent to the *marginal social benefit* of production, as indicated by the demand curve.

The problem of the commons

Why, we might ask, are firms able to impose some of these spillover costs, such as pollution, on the rest of the community? The answer lies, in some cases, in the presence of resources that are common property to society as a whole.

The **problem of the commons** refers to a situation in which the members of a society face choices over the use of commonly held resources such as air or water. Selfish, individualistic, or uncooperative decisions, though seemingly rational in terms of the short-term benefits accruing to separate individuals, may produce undesirable consequences for other members of society or negative long-term consequences for society as a whole. Many of these decisions are made possible because no one has clear property rights over the resources in question; society, rather than any one individual or group, controls their allocation.

Resources held as common property often have low prices or are not priced at all by the market. This suggests that these resources are likely to suffer from overuse or misallocation in the production process.

Spillover benefits

Spillovers may also take the form of benefits. Production or consumption of some goods and services may confer spillover (or external) benefits, for which payment or compensation is not required, on third parties or the community at large. Polio immunisation, for example, results in direct benefits to the immediate consumer. The prevention of a contagious disease, however, gives widespread and substantial spillover benefits to the entire community, reducing both the social and economic costs of disease.

Education is another standard example of the **spillover benefit**. It provides benefits to individual consumers—'more educated' people generally achieve higher incomes than do 'less educated' people. But education also confers sizeable benefits on society, such as smaller outlays in the areas of crime prevention and law enforcement.

Figure 17.1(c) shows the impact of spillover benefits on resource allocation. The market demand curve reflects only *marginal private benefit*—the private benefit derived at the margin by individuals. This understates the *marginal social benefit* available to society as a whole from consumption of each successive unit of the good or service. The market demand curve fails to capture all the benefits associated with the provision and consumption of goods and services that involve spillover benefits.

DD in Figure 17.1(c) indicates the marginal benefits that private individuals derive from education; D_tD_t is drawn to include these private benefits *plus* the additional spillover benefits affecting society at large. While market demand DD and supply SS would yield an educational output of Q_e, this output would be less than the optimum output Q_o. The market system would not produce enough education; that is, resources would be *underallocated* to education. Efficiency requires an increase in the allocation of resources to the production of education services, and an increase in output of these services of Q_eQ_o. At Q_o, the marginal social benefit (equal to the marginal private benefit plus B) will be equal to the marginal social cost of production of education services, as shown by the height of supply curve SS.

A second, and common, problem occurs when spillover benefits are extremely large. This leads us into a discussion of public goods and services.

Public goods and services

Private goods, which are produced through the market system, have certain characteristics. They are *divisible*, because they come in units small enough to be bought by individual buyers. Further, private goods such as jeans and pizzas are subject to the **exclusion principle**, since the people who are willing and able to pay the equilibrium price will consume the product, but the people who are unable or unwilling to pay are excluded from the benefits provided by that particular product.

Exclusion principle: when those who do not pay for a product are excluded from its benefits.

There are certain kinds of goods and services called **public goods**, which would not be produced at all by the price system because their characteristics are opposite to those of private goods. Public goods are *indivisible*, involving such large units that they cannot be sold to individual buyers. More importantly, however, the exclusion principle often does *not* apply to many products, particularly some types of services. Thus there is no effective way of excluding individuals from the benefits available from the consumption of public goods once these goods and services have been produced. Goods and services that have both characteristics—they are indivisible and are not subject to the exclusion principle—are referred to as **pure public goods**.

Public goods: goods and services that are not provided by the market system, as they are indivisible and often not bound by the exclusion principle.

Pure public goods: goods and services that are both *indivisible* and *not subject to the exclusion principle*.

Illustrations

A classic example of a public good is a lighthouse on a dangerous coast. The construction of any lighthouse might be economically justified because benefits (fewer shipwrecks) exceed production costs. However, the benefit obtained by each individual user would not justify the purchase by that user of such a large and indivisible product. Once in operation, the warning light is a guide to *all* ships. There is no practical way to exclude certain ships from its benefits. Then why should any shipowner voluntarily pay for the benefits received from the light? The light is there for all to see, and a ship's captain cannot be excluded from seeing it if the shipowner chooses not to pay. Economists call this the **free-rider problem**—people can receive benefits from a good or service without contributing directly to its costs.

Free-rider problem: when people can receive benefits from the consumption of a good or service without contributing directly to its costs.

Given the inapplicability of the exclusion principle, there is no economic incentive for private enterprises to supply lighthouses. If the services of the lighthouse cannot be priced and sold, it will clearly be unprofitable for private firms to devote resources to lighthouses. Here is a service that yields substantial benefits, but for which the market would allocate no resources.

National defence and flood-control programs provide other examples of public goods. If society is to enjoy such goods and services, they may be provided by the public sector and financed by compulsory charges in the form of taxes.

Graphical analysis

Figure 17.2(a) presents a graphical analysis of the underprovision implied by the presence of the characteristics of pure public goods. Assume that the costs to society of the supply of units of output of the public good can be represented by the smooth curve *SS*. The demand for the public good by a representative individual in society is represented by the curve *dd*. Clearly, market output of the public good is zero in this case. The value placed on consumption by the first individual in society to 'purchase' units of output of this product, and the free-rider problem, mean that the producer cannot get a price that is sufficient to cover the costs of production. Thus output Q_e, zero, a socially inefficient output level, is produced under pure competition.

Figure 17.2(b) illustrates the socially optimum output level for the public good given the benefits that would be received by all potential consumers from its provision and use. Note that due to non-rivalry in consumption—the fact that consumption of the pure public good by one individual does not preclude its consumption by another—the market demand curve for the public good, *DD*, must be constructed differently from that for a private good. Rather than being composed of the horizontal summation of all individuals' demand curves, as would be

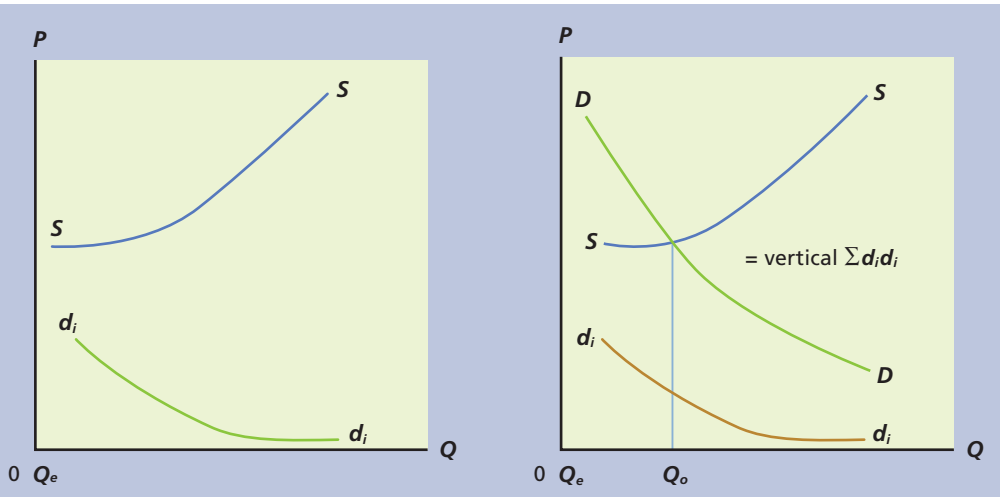


Figure 17.2 *Individual and total demands for public goods*
In (a), the demand for the public good by a representative individual in society is represented by the curve $d_i d_i$. The limited capacity of the individual to pay and the free-rider problem mean that the producer cannot get a price that is sufficient to cover the costs of production. Output Q_e, a socially inefficient output level, is produced. Non-rivalry in consumption implies that the market demand curve for the public good (*DD*) comprises the *vertical summation* of the demand curves of all individuals ($d_i d_i$). The socially optimum output level, Q_o, is indicated in (b), but will not be achieved in the absence of intervention.

the case with the market demand curve for a private good, it is composed of the *vertical summation* of the demand curves of all individuals, $d_i d_i$. Thus the social optimum, Q_o, involves a positive level of output for the public good, whereas market provision will see it supplied in amount Q_e (Figure 17.2(b)), implying output of zero in the absence of intervention.

Large spillover benefits

Although the inapplicability of the exclusion principle clearly distinguishes public from private goods, a variety of other goods and services are provided by government, even though the exclusion principle could be applied. Such goods and services as education, streets and

Business insight

The politics of externalities

It seems strange that the suggested presence of positive externalities or spillovers could actually provide the basis for economic damage to third parties. However, the potential to argue the presence of these effects can have a powerful political impact. In the case of agriculture, the suggested presence of positive externalities in the form of environmental protection, rural employment and the maintenance of culture provides part of the argument used for continued agricultural protection by the governments of Japan and Europe. This, of course, comes at the expense of Australian farmers. The implication is that not all of the good arguments in economics are necessarily good economic arguments. You can't forget the political dimension to economics when examining potential markets.

highways, police and fire protection, preventive medicine and sewage disposal could be subject to the exclusion principle—that is, they could be priced and provided by private producers through the market system. These are all services, however, that entail substantial spillover benefits and therefore might be underproduced by the market system. Government, therefore, undertakes or sponsors their provision to avoid the underallocation of resources that would otherwise occur. Such goods and services are sometimes called **quasi-public goods**. We can easily understand the long-standing controversies surrounding the status of medical care or education. Are these private goods, to be provided through the market system, or are they quasi-public goods, to be provided by government? Over the past several years there has been a move towards the privatisation of many of these goods in Australia.

CHECKPOINT

- Economists recognise two main types of market failure—spillovers and public goods.
- Spillovers, which are also referred to as externalities, result in the competitive price system producing the 'wrong' amounts of goods and services. Spillovers may take the form of spillover costs, in which case the market overallocates resources to the production of the product, or spillover benefits, in which case the market underallocates resources to the production of the product.
- Spillover costs may result from the problem of the commons, by which we find that many socially controlled resources are inadequately or zero priced.
- The characteristics of public or social goods—indivisibility and the inability to exclude individuals from consumption—may lead to the market failing to allocate any resources to the production of goods and services whose output is economically justified.
- Large externalities are implied by provision of some goods and services even where the exclusion principle may be applied. These goods and services are often provided by government and are referred to as quasi-public goods.

Solutions to market failure

You should by now have a clear understanding of the nature and sources of the two basic forms of market failure. We will now discuss some of the solutions that may be applied to remedy market failure. Each requires a form of intervention by government in the market economy. We may ask whether we have a means of assessing the extent to which this involvement should be taken. This will bring us to a discussion of cost–benefit analysis.

Correcting for spillover costs

Two basic types of corrective action are common—legislative action and specific taxes. There is also a third solution that has been proposed by some economists—the allocation of property rights and individual bargaining on this basis.

Legislation

In our examples of air and water pollution, the most direct action is simply to pass *legislation* that prohibits or limits pollution. Such legislation forces potential polluters to carry the costs of properly disposing of industrial wastes. Firms must buy and install smoke-abatement equipment or facilities to purify water that has been contaminated by manufacturing processes. Such action forces potential offenders, under the threat of legal action, to bear *all* the costs associated with their production. Legislation can shift the supply curve SS towards S_tS_t in Figure 17.1(b), tending to bring the equilibrium and optimum outputs into equality.

Specific taxes

A second, and less direct, action is for government to levy a *special tax* that approximates the spillover costs per unit of output. Through this tax, government attempts to place back onto the offending firm those external, or spillover, costs that private industry would otherwise avoid. Specifically, a special tax equal to T per unit in Figure 17.1(b) will increase the firm's costs and therefore shift the SS curve towards S_tS_t. The existing overallocation of resources to this product will be corrected; Q_e will move towards Q_o.

Property rights and individual bargaining

In some situations, externalities might be solved through individual bargaining. The **Coase theorem** suggests that negative or positive spillovers do not require government intervention where:

- property ownership is clearly defined
- the number of people involved is small
- bargaining costs are negligible.

Government should confine its role under these circumstances to encouraging bargaining between affected individuals or groups. Because the economic self-interests of the parties are at stake, bargaining with one another will enable them to find an acceptable solution to the problem. Property rights enable the parties to place a price tag on an externality through negotiation, creating opportunities for both sides.

Under this arrangement, the owner of the property rights can negotiate with the party causing the negative externality. The owner will seek compensation for the cost of the externality, an amount of T, referring to Figure 17.1(b). This additional cost to the party causing the negative spillover leads to a reduction in output to the socially desirable level at Q_o. A strong incentive emerges for the parties to find ways to solve the externality problem.

Unfortunately many negative externalities involve large numbers of affected parties, high bargaining costs, and community property such as air and water. Private bargaining in these situations will not remedy the spillover costs. For example, the acid rain problems experienced in Europe and North America affect millions of people spread out over many nations. The vast number of affected parties could not independently negotiate an agreement to remedy this problem. In such an example, societies expect governments to negotiate acceptable solutions. The Coase theorem does remind us, however, that clearly defined property rights can be a positive factor in remedying some spillover effects.

Correcting for spillover benefits

How could the underallocation of resources associated with the presence of spillover benefits be corrected?

Subsidise buyers

Government could subsidise the consumers of the product. For example, in the case of inoculation against a contagious disease, government could give each mother of a young baby a voucher to be used to obtain the inoculation. This would reduce the private cost to the consumer up to the full price. In terms of Figure 17.1(c) the program could increase the demand for inoculations from DD to D_tD_t with a subsidy per service of B. The number of inoculations would rise from Q_e to the optimum Q_o.

Subsidise producers

Assuming that the spillover or social benefits are not extremely large when compared with the benefits received by individual purchasers, government can encourage the production of such

goods and services by subsidising their output. Subsidies are simply specific taxes in reverse; taxes impose an extra cost on producers, whereas subsidies reduce their costs. In Figure 17.1(c), a subsidy of B per unit to producers will shift the supply curve from SS to $S'_tS'_t$ and increase the equilibrium output Q_e to bring it into correspondence with the optimum output Q_o. Hence, the underallocation of resources will be corrected. The government might choose to subsidise consumers, shifting the demand curve from DD to D_tD_t. However, in practice it is usually more convenient to subsidise producers.

Allocating resources to public goods

The market system may fail to allocate resources for public goods and thus underallocate resources for quasi-public goods. What, then, is the mechanism by which such goods are produced?

Public goods may be purchased or provided through the government on the basis of group, or collective, choices, in contrast to private goods, which are purchased from private enterprises on the basis of individual choices. In a democracy, the types and quantities of the various public goods produced are determined, in principle, by political means, that is, by voting. The quantities of the various public goods consumed are a matter of public policy. These group decisions, made in the political arena, supplement the individual choices of households and businesses in answering the five fundamental questions (see Chapter 2).

Assuming group decisions have been made, how are resources reallocated from the production of private goods to the production of public goods? In a full-employment economy, government is faced with the task of freeing resources from private employment to make them available for the production of public goods. A way of releasing resources from private uses is to reduce private demand for them. This is accomplished by levying taxes on businesses and households, so diverting some of their potential purchasing power out of the private income expenditure streams. With lower incomes, businesses and households will be forced to reduce their investment and consumption spending. *Taxes tend to diminish private demand for goods and services, and this decrease in turn prompts a drop in the private demand for resources*. By diverting purchasing power from private spenders to government, taxes free resources from private uses.

Cost–benefit analysis

Government expenditure from tax proceeds absorbs resources and can be used to provide for an efficient output of public goods. In its role as a provider of public goods, the government deliberately reallocates resources to bring about significant changes in the composition of the economy's total output. But what amount of resources allocated to public goods will best maximise society's welfare? Economic analysis, in a variety of forms including **cost–benefit analysis**, can provide some guidance on this issue.

Concept

Suppose government is contemplating a specific project, such as a flood-control project. The economising problem (see Chapter 2) tells us that any decision to use more resources in the public sector will involve both a benefit and a cost. The benefit is the extra satisfaction resulting from the output of more public goods; the cost is the loss of satisfaction associated with the related decline in the production of private goods (or some alternative public good). Should the resources under consideration be shifted from the private to the public sector? The answer is 'Yes' *if* the benefits from the extra public goods exceed the cost resulting from having fewer private goods. The answer is 'No' *if* the value or cost of the private goods given up is greater than the benefits associated with the extra public goods.

Cost–benefit analysis can do more than simply indicate whether a public program is worth undertaking. It can also provide guidance concerning the *extent* to which a given project should be pursued. Economic questions, after all, are not questions to be answered by a simple 'Yes' or 'No' but, rather, in terms of 'how much' or 'to what extent'.

In our case of flood control we note, first, that a flood-control project is a public good and that the exclusion principle is not readily applicable. Now, should government undertake a flood-control project in a given river valley? If so, what is the proper size or scope for the project?

Illustration

Table 17.1 lists a series of increasingly ambitious and increasingly costly flood-control plans. To what extent, if at all, should government undertake flood control? The answers depend on costs and benefits. Costs in this case are largely the capital costs of constructing and maintaining levees and reservoirs; benefits are reduced flood damage.

Table 17.1
Cost–benefit analysis for a flood-control project

1 Plan	2 Total annual cost of project ($)	3 Extra or marginal cost ($)	4 Total annual benefit (reduction in damage) ($)	5 Extra or marginal benefit ($)	6 Net benefit (4) – (2) ($)
Without protection	0		0		
		3 000		6 000	
A: Levees	3 000		6 000		3 000
		7 000		10 000	
B: Small reservoir	10 000		16 000		6 000
		8 000		9 000	
C: Medium reservoir	18 000		25 000		7 000
		12 000		7 000	
D: Large reservoir	30 000		32 000		2 000

SOURCE: Otto Eckstein, *Public Finance*, 4th edn, © 1979, p. 21. Adapted by permission of Pearson Education, Inc., Upper Saddle River, NJ.

A glance at all the plans indicates that, in each plan, total benefits (column 4) exceed total costs (column 2), indicating that a flood-control project on this river is economically justifiable. This is seen directly (in column 6) where total annual costs are subtracted from total annual benefits.

What is the optimum size or scope for this project? The answer is determined by comparing the additional, or *marginal*, costs and the additional, or *marginal*, benefits associated with each plan. The guideline to follow is this: pursue an activity or project as long as the marginal benefits (column 5) exceed the marginal costs (column 3). Stop the activity or project at, or as close as possible to, that point at which marginal benefits equal marginal costs.

In this case plan C—the medium-sized reservoir—is the best plan. Plans A and B are too modest; in both cases marginal benefits exceed marginal costs. Plan D entails marginal costs ($12 000) in excess of marginal benefits ($7000) and therefore is not economically justifiable; it involves an overallocation of resources to this flood-control project. Plan C is closest to the optimum.

Explained differently, the marginal benefit – marginal cost rule will determine which plan entails the maximum excess of total benefits (column 4) over total costs (column 2) or, in other words, which plan yields the largest net gain to society. We can confirm directly (in column 6) that the maximum *net* benefit is associated with plan C.

Cost–benefit analysis explodes the myth that 'economy in government' and 'reduced government spending' are synonymous. 'Economy' is concerned with efficiency in resource use. If a government program yields marginal benefits that are less than the marginal benefits attainable from alternative private uses at similar marginal costs, then the proposed public program should not be undertaken. But if the reverse is true—if extra benefits exceed extra costs—then it would be uneconomical or 'wasteful' *not* to spend on that government program. Economy in government does not mean the minimisation of public spending; rather, it means allocating resources between the private and public sectors until no net benefits can be realised from additional reallocations.

Measurement problems

Cost–benefit analysis is helpful in thinking about the public sector and is useful in actual studies of projects such as flood control and highway construction. The benefits and costs associated with public goods are, however, partially spillovers and these are difficult to measure. Consider the possible benefits and costs associated with the construction of a new freeway in a major metropolitan area. In addition to estimating the obvious costs—land purchase and construction costs—the responsible agency must also estimate the spillover cost of additional air pollution that results from a larger flow of traffic. Further, more traffic may call for increased expenditures for traffic police.

What about benefits? Improved transport means a widening of markets, more competition and a greater opportunity for the community to specialise. But what is the monetary value of this benefit? The freeway may make jobs in the outer suburbs accessible to the inner-city unemployed. What is the dollar value of these benefits? The full costs and benefits associated with government programs are not easily calculated, and cost–benefit analysis is often difficult to apply.

CHECKPOINT

- Spillover costs can be corrected by legislation, specific taxes or, where coordination costs are low, the assignment of property rights and individual bargaining.
- Legislation, specific taxes and individual bargaining all aim to get the party producing the negative externality to internalise the costs imposed on other members of society, thus equating the private and social marginal and total costs of production. This leads to output adjusting towards the socially optimum level.
- Spillover benefits can be corrected by subsidies to producers or government provision. Subsidies encourage a greater demand for the product that is generating the positive externality, increasing the allocation of resources to its production and leading to an output level that is closer to that of the social optimum.
- Government may provide public goods because such goods are indivisible and involve benefits from which non-paying consumers cannot be excluded. Governments also tend to provide goods and services for which externalities are thought to be very large.
- Government provision of public and other goods and services requires a reallocation of resources from the private to the public sector. This is achieved through the collection of taxes, which reduces private investment and consumption expenditure.
- Cost–benefit analysis can provide useful guidance as to the economic desirability and the most efficient scope of public goods output. However, it suffers several shortcomings in its application due to difficulties in measuring the value of certain costs and benefits in practice.

The pollution problem: the effluent society?

The central fact about all the economic activity discussed in Chapters 1 to 16 is that it both involves and depends on the natural environment. As well as making life possible at all, the natural environment serves three key economic functions:

- It represents the source of all inputs of natural resources to the production process, providing a basis for the wealth of each nation.
- It receives back the wastes arising from production and consumption—the pollution of the effluent society.
- It produces amenity services for individuals in such forms as ecotourism, parks and other recreational facilities.

High population densities in cities make the pollution problems associated with the production and consumption of goods and services more acutely obvious than in less developed areas. Although city pollution problems in Australia have not reached the average levels experienced in New York or Tokyo, the increasing seriousness of water, air and solid-waste pollution has been well documented. For example, a freshwater system such as the Yarra River in Melbourne has been highly polluted through its use as an industrial and municipal sewer. The dumping of thousands of megalitres of sewage in the Pacific Ocean by Sydney councils has polluted nearby beaches. Each day sewerage plants discharge hundreds of megalitres of treated effluent into the Hawkesbury–Nepean river system. In New South Wales, stormwater is regarded as a major pollutant of the coastal environment, containing waste derived from pets, vehicles and industry emissions.

Cities are also contributors to air pollution. Motor vehicles are a major source of emissions and outdoor air pollution. For example, in Melbourne, vehicles emit nearly half of the particles in summer although this drops to around 10 per cent in winter when smoke from wood fires dominates. Although average pollution levels in both Sydney and Melbourne may be low, particularly for ozone, they occasionally approach those in New York or Tokyo. Air pollution in industrial areas such as Port Kembla, Broken Hill and Port Pirie is more severe. In Port Pirie with a population of around 15 000, the world's largest pyrometallurgical lead smelter has been operating for over a hundred years, and lead emissions into the air have exceeded recommended standards.

Longer run consequences of environmental pollution are even more disturbing. Some scientists argue that the concentrations of industry, people, structures and cement that constitute the world's cities might create air and heat pollution sufficient to cause irreversible and potentially disastrous changes in the earth's climate and weather patterns through the greenhouse effect. Australia's gross greenhouse gas emissions contribute between 1 and 2 per cent of total global emissions. These emissions have grown over the last 30 years and continue to grow because of population growth and industrialisation.

Causes: the law of conservation

The law of conservation of matter and energy illustrates the origin of the pollution problem. This law holds that matter can be transformed to other matter or into energy, but can never vanish. All inputs (fuels, raw materials, water and so on) used in the economy's production processes will ultimately result in a roughly equivalent residual of wastes. The economy takes in millions of tonnes of minerals, food and forest products, which are transformed into consumer goods. Society must later dispose of the end products, whether these are soft-drink cans, worn-out refrigerators or human excreta.

Fortunately, the ecological system has the self-regenerating capacity that allows it, within limits, to absorb or recycle such wastes. But the volume of such residuals has tended to outrun this absorptive capacity. Four important causes of this can be highlighted.

Population density

There is the simple matter of population growth. An ecological system that can accommodate 20 million people may begin to break down under the pressures of 30 or 40 million. A city may cope with 3 million people but start to collapse when there are 5 million.

Rising incomes

Economic growth means that each person consumes and disposes of more output. Paradoxically, the affluent society helps to spawn the effluent society. A rising GDP (gross domestic product) means a rising 'GDG' (gross domestic garbage). Thus a high standard of living permits Australians to own millions of cars. But cars are a major source of air pollution and there is the problem of disposing of thousands of abandoned cars each year.

Technology

Technological change can also contribute to pollution. The expanded use of pesticides, herbicides and insecticides has proved to be a deadly enemy of our fish and bird populations. The addition of lead to petrol posed a serious threat to human health, and so unleaded fuel was introduced. The development and widespread use of throwaway containers made of virtually indestructible aluminium or plastic add substantially to the solid-waste crisis. Some detergent soap products break down into biologically harmful constituents.

Incentives

As outlined in Chapter 9, profit-seeking manufacturers naturally choose the least-cost combination of inputs and bear only unavoidable costs. If they can dump waste chemicals into rivers and lakes rather than pay for expensive reprocessing and proper disposal, businesses are inclined to do so. Similarly, manufacturers tend to discharge smoke and hot water (used to cool machinery) rather than purchasing expensive abatement and cooling facilities. The result is spillover costs in the form of air and water pollution. Enjoying lower 'internal' costs than if they had not polluted the environment, the producers can sell their products more cheaply, expand production and make larger profits.

We should not place the entire blame for pollution at the door of industry. A well-intentioned firm that wants to operate in a socially responsible way with respect to pollution may find itself in an awkward position. If an individual firm 'internalises' all its external or spillover costs by installing, say, water treatment and smoke abatement equipment, it may find itself at a cost disadvantage in comparison to its polluting competitors. The socially responsible firm will have higher costs and be forced to raise its product price. The 'reward' may be a declining market and diminished profits, and even bankruptcy. This suggests that effective action to combat pollution may have to be undertaken collectively under government supervision.

Ironically, given that an important function of government is to correct the misallocation of resources that accompanies spillover costs, many government instrumentalities have been contributors to pollution. Power plants have created air pollution, and many city councils have discharged untreated or inadequately treated sewage into rivers or oceans because it is cheap and convenient.

Anti-pollution policies

Economists have explored several approaches, mostly involving the possibility of government intervention, to solve the problems of spillover costs such as pollution. We have already examined the basis for these solutions in an earlier part of this chapter; however, a review may

be useful at this point, focusing on the applications and effectiveness of the solutions specifically in the context of pollution.

Individual bargaining and liability rules and lawsuits

Our discussion of the Coase theorem earlier in the chapter suggested that the allocation of property rights to individuals might allow them to negotiate with polluters so that they are compensated for the damage caused by pollution. Private negotiation, where it does not prove too costly to the individual, provides an avenue to force polluters to internalise the externalities that they impose on others.

Global watch

Energy usage per capita

The amount of energy used per capita differs greatly across the regions of the world, as is illustrated in the table below. Note that energy usage figures are quoted as kilograms of oil equivalent, and that high-income countries—including Australia, the United States, Japan and Singapore—use large amounts of energy per capita. The use of kilograms of oil equivalent as our energy-use measure reminds us that, in general, the energy used per capita is coming from the world's limited stockpile of resources, and that the use of energy produces pollution, just as the burning of oil does.

Region	Commercial energy use per capita (kg of oil equivalent), 1999	Average annual growth (%), 1980–99
Low- and middle-income countries	*979*	*2.6*
East Asia and Pacific	920	3.0
Europe and Central Asia	2628	3.9 (to 1996)
Latin America and Caribbean	1171	0.6
Middle East and North Africa	1279	2.0
South Asia	441	1.8
Sub-Saharan Africa	671	−0.6
High-income countries	*5448*	*1.0*
Europe EMU	3785	0.9
World	**1671**	**1.1**

SOURCE: World Bank, *2002 World Development Indicators.*

Questions

1. Why do you think that high-income nations use more energy per capita than low- and middle-income nations? Calculate the percentage differences in energy usage by region relative to the high-income countries.
2. At current growth rates, how long will it take the consumption of energy in the countries of Europe and Central Asia to reach the energy consumption levels of the high-income countries?
3. Given that energy resources such as oil and gas are limited, is it possible for the rest of the world to attain energy consumption levels equal to those in the high-income nations? Is it desirable that this happens, given the impact on the environment that this increase in energy usage would suggest? Justify your answer, and consider arguments both for and against it.

Although private negotiations may not be a realistic solution to most externality problems, clearly established property rights may be helpful in another way. Government has established a framework of laws that define private property and protect it from damage done by other parties. These laws permit those suffering spillover costs to sue for damages.

Clearly defined property rights and government-specified liability rules provide an avenue for remedying some externality problems. They do so directly by forcing the perpetrator of the harmful externality to pay damages to those injured. They do so indirectly by discouraging firms and individuals from generating negative externalities, for fear of being sued. It is not surprising, therefore, that many externalities do *not* involve private property, but rather property held in common. It is the *public* bodies of water, the *public* lands and the *public* air where ownership is less clear, which often bear the brunt of negative externalities.

Like private negotiations, private law cases to resolve externalities also have limitations. Legal cases are expensive and time-consuming, with uncertain outcomes. Large legal fees and major time delays in the court system are common. Also, the uncertainty associated with the legal outcomes reduces the effectiveness of this approach.

Government intervention: direct controls and taxes

Other approaches to achieving economic efficiency may be needed when externalities in the form of pollution affect large numbers of people or when community interests are at stake. Specifically, direct controls and taxes can be used to counter the spillover costs of pollution.

Direct controls: legislated standards

One approach is for government to pass legislation that prohibits or regulates pollution. Legislation may establish minimum standards for air and water that polluters must observe, or face legal sanctions. **Legislated pollution standards** presumably force polluters to install water treatment and air-filter equipment and so bear costs that would otherwise be shifted to society. An example of a legislated standard is Commonwealth legislation requiring car manufacturers to meet exhaust-emission standards. This raises the marginal private cost of production, helping to bring it more closely into alignment with the marginal social benefits from production of the good or service.

Legislated standards do not, however, necessarily lead to an efficient allocation of pollution rights among different producers; nor do these standards ensure that the marginal social cost of implementing them equates to the marginal social benefit derived from their introduction. Refer to Figure 17.1(b)—legislated standards will ensure an efficient outcome only if the increase in the private cost of production equates to T, the social cost of the pollution.

Specific taxes: emission fees

A second approach is to levy special charges or taxes—**effluent or emission fees**—on polluters; that is, a special tax or fee is assessed per unit of pollutant discharged into the air or water. Fees are set so that spillover costs are exactly covered and each producer's cost curve reflects all production costs. In terms of Figure 17.1 (b), the private supply curve is shifted upwards from SS to S_tS_t. Equilibrium price increases, and equilibrium output declines from Q_e to the allocatively efficient level Q_o.

The key problem with this approach is related to determination of the value of the emission fee to be attached per unit of pollution output. Who is most qualified to determine this? How much pollution should be allowed to remain under this system? Each of these problems remains less than fully resolved.

Problems

As noted, there are substantial problems involved in establishing and administering each of our anti-pollution proposals. First, individual negotiation or the use of the legal system may prove too costly to the individual or group affected by pollution.

Second, pollution standards are difficult to establish because of incomplete and disputed technological and biological information. We simply do not know with certainty the effects—the economic and human costs—of certain pollutants. This lack of information is important because it is not economically rational to prohibit or flatly eliminate pollution; rather, we should use cost–benefit analysis to determine the optimum extent to which anti-pollution programs should be pursued. This involves the difficult problem of calculating the marginal benefits and marginal costs of such programs.

Third, the administration and enforcement of legislated controls or standards can be both complex and costly. Government activity uses valuable resources that must be allocated away from other activities. Finally, government agencies—the very institutions we would expect to create and enforce anti-pollution policies—are often major polluters.

In the next section we will explore another alternative, the establishment of a market for pollution rights, which may resolve some of these problems.

CHECKPOINT

- The term 'effluent society' recognises that the environment plays not just a central role in providing resources inputs to the production process, but also acts as a receptacle for the by-products of our economic system.
- Pollution reflects the law of conservation of matter and energy—matter can be transformed but never vanishes. Pollution may also be seen as a problem of spillover or external costs.
- Reasons for the growth of the pollution problem are:
  - increasing population densities and the pressure they place on ecological systems
  - rising incomes and the consumption of greater output associated with this
  - technological change and its accompanying forms of new materials and by-products
  - incentives to avoid the internalisation of social costs by the private producer.
- The solutions proposed for the control of the pollution problem include:
  - the allocation of property rights and the use of liability rules and lawsuits
  - legislated controls and standards
  - emission fees
  - markets for pollution rights.

  Most of these solutions aim to internalise the spillover costs of pollution within offending firms.

A market for pollution rights

A policy suggestion to handle the pollution problem is to create a **market for pollution rights**. The rationale for this proposal is that the air, rivers, lakes, oceans and public lands, such as parks and streets, are all primary objects for pollution because the rights to use these resources are either held 'in common' by society—that is, the problem of the commons applies—or are unspecified by law. No specific private individual or institution has any incentive to restrict the use or maintain the purity or quality of these resources because no one has the right to realise a monetary return from doing so.

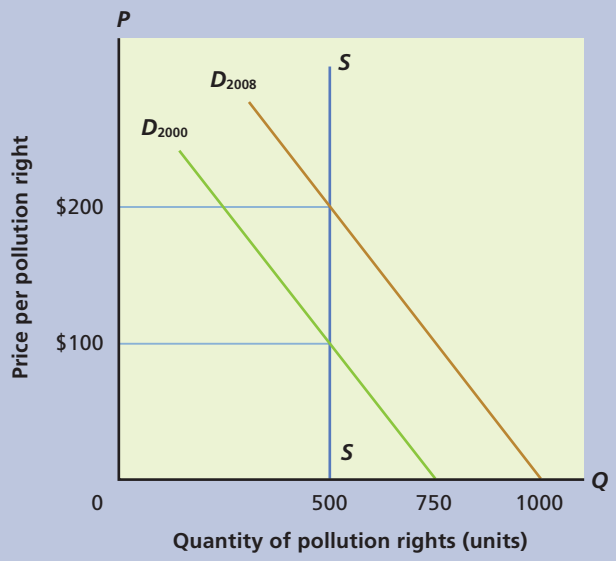
You may maintain a property you *own*, for example by periodically painting and repairing it, because you will recoup the value of these improvements at the time of resale. But, as long as the 'rights' to air, water and certain land resources are commonly held and these resources are made freely available, there will be no incentive to maintain them or restrict their use. Hence, these natural resources are 'overconsumed' and become polluted.

Creating a market: an example

The proposal is that an appropriate pollution-control agency determines the amount of pollutants that can be discharged into the water or air of a given region each year while

maintaining the quality of the water or air at an acceptable standard. For example, the agency may determine that 500 units of pollutants may be discharged into a lake and be 'recycled' by nature. Hence, 500 pollution rights, each entitling the owner to dump 1 unit of pollutants into the lake in the given year, are made available for sale each year. The resulting supply of pollution rights is fixed and therefore perfectly inelastic, as shown in Figure 17.3.

Figure 17.3
The market for pollution rights
Pollution can be controlled by having a public body determine the amount of pollution that the atmosphere or a body of water can safely recycle, and sell these limited rights to polluters. The effect is to make the environment a scarce resource with a positive price. Economic and population growth will increase the demand for pollution rights over time, but the consequence will be an increase in the price of pollution rights rather than more pollution.



The demand for pollution rights—in this case D_{2000}—will take the same down-sloping form as will the demand for any other input. At high prices, polluters either stop polluting or pollute less by acquiring pollution-abatement equipment. An equilibrium market price for pollution rights—in this case $100 for 2000 demand—arises, at which an environment-preserving quantity of pollution rights is rationed to polluters. Note that without this market, 750 units of pollutants would be discharged into the lake and it would be 'overconsumed', or polluted, to the amount of 250 units.

Business insight

Making money by keeping it clean

The growing importance of environmental factors to consumers is providing big business opportunities for Australian companies. An example of this is the success of King Island products (produced on King Island in the Bass Strait), which owe part of their success to the clean environment in which their cheeses and other products are made. The result, for King Island products, is the ability to charge price premiums for their high-quality products. The implication is that some consumers will pay more for 'clean' or 'natural' products, and companies that can provide these products will have an edge over other companies.

As human and business populations expand, demand increases, as from D_{2000} to D_{2008}. Without a market for pollution rights, pollution would occur in 2008 in the amount of 500 units beyond that which can be assimilated by nature. With the market for pollution rights, price will rise from $100 to $200 and the amount of pollutants will remain at 500 units—the amount the lake can recycle.

Advantages

The proposal has several advantages over direct controls. Most important, it reduces society's costs because pollution rights can be bought and sold. For example, assume it costs a paper mill $50 per unit each year to reduce a noxious water discharge by 1 unit but costs a chemicals factory $300 per unit. Also, assume that the chemicals factory increases its output such that it needs to reduce its pollution discharge by 1 unit.

Without the sale of pollution rights, the cost of reducing pollution by 1 unit would be $300. But the chemicals factory will find it cheaper to buy 1 unit of pollution rights for the $100 price shown in Figure 17.3, rather than reduce pollution at a cost of $300. The paper mill will be willing to sell a unit of pollution rights for $100, incurring the expense of $50 for reducing its own discharge by 1 unit. The total economic cost will therefore be $50 rather than $300.

Asia in focus

Warning of water shortages in China

Although many may see too much water as a problem in the tropical areas of Asia, one of our major Asian neighbours has a different set of problems—too little water, too much wastage of this precious resource, and poor-quality water due to pollution of its waterways.

China will face severe water shortages by 2030 when the per capita share of resources is expected to have plunged by up to 20 per cent, official media reported.

Issuing a rallying call for World Water Day, on Wednesday, Minister for Water Resources Wan Shucheng said that there would be a serious threat of water shortages as population increased.

China's population of 1.24 billion is expected to reach 1.6 billion by 2030, according to mainland experts.

More than half of the mainland's 668 cities suffer from water problems, and these create difficulties for authorities trying to improve the living standards of city dwellers.

The *China Daily* said shortages were worsened by wastage of water, which has reached 60 per cent compared with 30 per cent in the rest of the world.

The newspaper also cited pollution problems affecting 700 major waterways.

SOURCE: Agence France-Presse, 'Warning on Water Shortages', *South China Morning Post*, 25 March 2000.

Questions

1. Which problem related to the ownership and pricing of resources (as discussed in this chapter) is illustrated by the wastage of irrigation water in China?
2. Which features of the organisation of China's economic system might lead to the problem referred to in the previous question?
3. What economic solutions would you propose to encourage the conservation of water for irrigation? Would these fit in with China's system of economic organisation? Why or why not?

These market-based proposals have other advantages. Potential polluters are confronted with an explicit monetary incentive not to pollute. They must buy rights to pollute. Conservation groups can fight pollution by buying up and withholding pollution rights, so reducing pollution below government-determined standards. As the demand for pollution rights increases over time, the growing revenue from the sale of the given quantity of pollution rights could be devoted to environment improvement. Similarly, with time, the rising price of pollution rights should stimulate the search for improved techniques to control pollution.

CHECK POINT

- A market for pollution rights requires the establishment of an allowable amount of pollution—in line with the ability of the environment to recycle—by a pollution-control agency. This would be associated with the development of a set of 'rights' (permits) to create units of pollution.
- These rights would be sold or auctioned in the market.
- Polluters would bid for pollution rights up to the point at which the cost of the pollution right exceeds the private cost of pollution abatement.
- A market for pollution rights ensures an efficient allocation of rights between producers, reflecting the marginal cost to each of controlling its output of pollution, and hence the marginal benefit attained from the right to pollute.

summary

1 Economists recognise two main types of market failure—spillovers and public goods. Spillovers, which are also referred to as externalities, result in the competitive price system producing goods and services in quantities that are not socially optimal. Spillovers take the form of spillover costs or spillover benefits.

2 Spillover costs lead to the market overallocating resources to the production of the product. Spillover costs may result from the problem of the commons, by which we find that many socially controlled resources are inadequately priced or zero priced.

3 Spillover benefits are associated with the market underallocating resources to the production of the product.

4 Public or social goods reflect the characteristics of *indivisibility* in the product, implying large-scale production to produce any output, and the *inability to apply the exclusion principle* to individuals who have not paid.

5 The inability to ensure that consumers of the product pay for their consumption, reflecting non-rivalry in consumption of output, may lead to the market failing to allocate any resources to the production of public goods whose output is economically justified. Producers cannot recover their costs of production in these cases.

6 Quasi-public goods are goods and services that are often provided by government. Although the exclusion principle may be applied to these goods and services, the potentially large externalities associated with their consumption justify government provision.

7 Spillover benefits can be corrected by subsidies to producers or government provision. Subsidies encourage a greater demand for the product that is generating the positive externality, increasing the allocation of resources to its production and leading to an output level that is closer to that of the social optimum.

8 Government provision of public and other goods and services requires a reallocation of resources from the private to the public sector. This is achieved through the collection of taxes, which reduces private investment and consumption expenditure.

9 Cost–benefit analysis can provide useful guidance about the economic desirability and the most efficient scope of public goods output. As its name suggests, cost–benefit analysis requires a careful evaluation and comparison of the total and marginal costs and benefits of any proposed program. However, it suffers from several shortcomings in its application due to difficulties in measuring the value of certain costs and benefits in practice.

10 The term 'effluent society' recognises the central role played by the environment in our economy. The environment provides resource inputs to the production process, acts as a receptacle for the by-products of our economic system, and provides amenity services to individuals.

11 Pollution reflects the law of conservation of matter and energy—matter can be transformed but never vanishes. Pollution may also be seen as a problem of spillover or external costs.

12 The sources of growth in the pollution problem are:
(a) increasing population density, particularly in cities, and the pressure that this places on ecological systems, particularly on the air and water systems
(b) rising incomes and the consumption of greater amounts of goods and services associated with them
(c) technological change, which is often associated with the creation of new forms of materials and by-products
(d) the incentive provided by the profit system for producers to avoid the internalisation of all social costs associated with their production.

MaxMARK

Max your marks!
Thirty interactive questions on market failure and resource allocation are available now at the Online Learning Centre that accompanies this book: www.mhhe.com.au/jackson7e_micro (for access to MaxMark, please refer to the front of this text).

13 The solutions proposed for the control of the pollution problem include:
(a) the allocation of property rights and the use of liability rules and lawsuits
(b) legislated controls and standards
(c) emission fees
(d) markets for pollution rights.

These proposed solutions attempt to force offending firms to internalise the spillover costs of pollution they create.

14 A market for pollution rights requires the establishment of an allowable amount of pollution by a pollution-control agency. This allowable amount of pollution would be set in line with the ability of the environment to recycle the harmful by-products of industry. The setting of a total pollution limit would be associated with the development of a set of 'rights' (permits) to create units of the allowable level of pollution.

15 Rights to pollute would be sold or auctioned off to polluting firms, providing a market for pollution rights. Polluters would bid for the pollution rights up to the point at which the cost of the pollution right exceeds the private cost of pollution abatement.

16 A market for pollution rights assures an efficient allocation of rights between producers, reflecting the marginal cost to each of controlling its output of pollution, and hence the marginal benefit attained from the right to pollute.

Key terms and concepts

Coase theorem	442	private goods	439
cost–benefit analysis	443	problem of the commons	438
effluent or emission fees	449	public goods	439
exclusion principle	439	pure public goods	439
free-rider problem	439	quasi-public goods	441
legislated pollution standards	449	spillover (or externality)	437
market failure	436	spillover benefits	438
market for pollution rights	450	spillover costs	437

review questions

1 What do we mean by the term 'spillovers'? What implications do spillovers have for output under a competitive market system?

2 Explain why, in the absence of spillovers, equilibrium and optimum output are identical in competitive markets.

3 What are the basic characteristics of public goods? What are quasi-public goods? How does each of these types of goods or services differ from the other?

4 Explain the significance of the exclusion principle to the private provision of goods or services with public goods characteristics. Why might it be unprofitable for a private producer to supply a public good?

5 By what means may government provide public goods? What are the implications for society of this provision?

6 What is cost–benefit analysis? What is its role in the evaluation of the provision of public goods by government?

7 What methods might be used to cause companies and individuals to internalise spillover costs? How efficient is each method at achieving a socially optimum level of production and consumption of the product? Explain.

8 To what does the 'effluent society' refer? What are the main causes of environmental pollution and its increase over time?

9 What methods have been proposed for and applied to the control of pollution?

10 Describe the operation of a market for pollution rights.

problem-solving exercises

1 Using your knowledge of the characteristics of private and public goods, decide whether the following should be provided through the market system or government:
(a) pizzas
(b) street lighting
(c) bridges
(d) parks
(e) local swimming centres
(f) medical care
(g) postal delivery
(h) housing
(i) air traffic control
(j) telephone services.

2 Categorise each product in the previous question according to the following table:

		Exclusion principle applies	
		Yes	**No**
Rivalry in consumption	Yes	Pure private good	Quasi-public good
	No	Quasi-public good	Pure public good

Does your categorisation of each product match your choice of whether the good should be provided through the market system or by government? Explain.

3 What divergences arise between equilibrium and optimum output when (a) spillover costs and (b) spillover benefits are present? Use graphs to illustrate your answers.

4 In what way does the construction of the 'market' demand curve for a public good differ from that for a private good? Use diagrams to show the difference in the construction of the two types of market demand curve from individual demand curves, assuming that there are four individuals in each market. What specific assumption must be made about the public goods consumption to make the construction of the total demand curve valid? Explain.

5 The table below shows the total costs and total benefits in millions of dollars for four different anti-pollution programs of increasing scope. Which program should be undertaken? Why?

Program	Total cost ($ million)	Total benefit ($ million)
A	3	7
B	7	12
C	12	16
D	18	19

application questions

1. 'Clean air and water have become increasingly scarce and valuable resources precisely because they have been treated in the past as if they were free and unlimited in supply.' What does this statement mean, and what is the source of the problem referred to in it? Find some examples of situations in Australia where this statement applies, and describe policies that have been applied to remedy the problem.
2. Is Australia a good environmental citizen? What environmental protocols are we party to? Visit the website of the Department of Environment and Heritage at:
   www.environment.gov.au
   Find out about Australian environmental protection policies. List five areas in which Australia has been particularly active on the environmental front during the last year. What are the potential economic costs and benefits of each of these activities?

Economics in reality

Inside story enough to make you ill

This article examines an air-quality problem that has not received very much public attention but may require significant intervention and new government regulations.

In 1999, the CSIRO's Dr Stephen Brown estimated that the air quality inside Australia's buildings—that's your home and mine, as well as our workplaces and classrooms—was so pathologically bad that it was adding up to $11 billion per annum to the nation's health bill. This $11 billion included sick leave, medical expenses, insurance costs, and building audits and remediation. No one took much notice.

To put Dr Brown's estimate in some perspective: HIH is thought to have lost about $4 billion, and the Victorian Government's entire 2002 tax revenues are less than $9 billion.

Seven years earlier, in 1992, there had been similarly little outcry when the Royal Australian Institute of Architects, having surveyed Melbourne buildings, found that one in four people suffered from 'Sick Building Syndrome' (SBS). Effects included infections, allergies, irritations, toxic effects and psychological problems.

The World Health Organization says that 'most indoor air pollutants directly affect the respiratory and cardiovascular systems'. Frequently, contagious respiratory infections result from outdoor micro-organisms that have bred in the indoor environment. Adding its own concerns, Australia's National Environment Protection Council (NEPC) says: 'There is evidence that cancer, birth defects, genetic damage, immunodeficiency, respiratory and nervous system disorders can be linked to exposure to occupational levels of "air toxics".'

As for specific causes, a 2001 NSW Public Works Committee report names 'poor design of heating, cooling and ventilation systems' as well as 'artificial lighting and air'. It concludes that 40–60 per cent of offices may suffer from SBS.

But the elementary reasons for poor indoor air quality may be expressed best in a 1999 report from the World Health Organization. The report blames 'modern building design which has favoured tighter structures with lower rates of ventilation' and 'products and materials that emit . . . chemical and biological pollutants'.

Dr Brown is principal research scientist in the CSIRO's Air Quality Control Science section. He says pollutants that arise from within buildings include 'combustion gases from unflued gas heaters, especially nitrogen dioxide . . . carbon monoxide from faulty heaters . . . formaldehyde from wood-based panels such as particleboard, MDF and plywood, especially in mobile homes, offices, classrooms and caravans . . . car exhausts in inner-city buildings, or in any building with attached garage, or in cars travelling in heavy, slow-moving traffic . . . lead from old paints, and environmental tobacco smoke'. ▶

Experts interviewed by The Age believe solutions begin with the better design and regulation of buildings and their interiors. 'We need a government agency to take the lead on regulatory control,' agrees Dr Brown.

But no one seems to be putting their hand up . . . We spend 90 per cent of our time indoors—and 7 per cent in cars, and only 3 per cent outdoors—which magnifies the indoor problem considerably.

Dr Brown believes the antidote to indoor air pollution should include increased building ventilation, air-cleaning devices, and reducing emissions from source materials . . . It is Dr Brown's opinion that a product-labelling scheme would be an excellent start. He points to Denmark's and Norway's voluntary Indoor Climate Labelling scheme, which has developed standard methods of rating toxicity of indoor materials such as paints, carpets, partitions, wall systems, flooring, furniture and cabinets, based on their chemical emissions and their 'odour/irritancy' potential . . .

In the meantime, what can ordinary people do to prevent indoor air pollution? 'The simplest answer I can give is to avoid using products, in any indoor setting, that emit unacceptable levels of pollutants,' says Dr Brown.

In Victoria, regulatory controls on industry, backyard burning and vehicle emissions have recently seen outdoor levels of 'air toxics' such as benzene and toluene fall to 1993 levels. This suggests that we could yet find the will to staunch this multi-billion dollar wound to our national productivity and individual health . . .

SOURCE: J. Macgregor, *Age*, 2 September 2002, The Culture Section, p. 4.

Questions

1. Explain the indoor air-quality problem using the economic tools outlined in this chapter, particularly the concept of spillover costs.
2. What is the range, nature and extent of these costs?
3. What kinds of regulatory schemes could be used in order to reduce these costs?
4. Do you think government intervention is inevitable, and must it take the form of regulation?

Search for more on market failure and resource allocation on PowerWeb, available from the Online Learning Centre that accompanies this book: www.mhhe.com.au/jackson7e_micro (for access to PowerWeb, please refer to the front of this text).