The Rationale for Intervention

It is widely agreed that government - where we use this word in a broad sense to include a variety of state institutions - should provide an institutional framework that maintains law and order and fundamental human rights, and provides security for its citizens. But in most, if not all, countries government does far more than this. Government intervenes in the social, cultural and economic spheres in many ways. It does so through its financing and support of various projects, programmes and policy interventions, and through a variety of legal and regulatory frameworks that it establishes.

Ideally, any such intervention should be undertaken only if it can be justified in terms of some underlying rationale. Operating in a way that allows intervention only where that can be justified in terms of a clear, explicit and socially-accepted rationale helps to avoid arbitrary government behaviour, sets limits to the role of the state, and provides a defence against purely rent-seeking behaviour.

In this lesson we begin by examining accepted best practice about the role that should be played in economic appraisal by the establishment of a rationale for intervention. Then, we examine three possible "classes" of justification for intervention:

1. Responding to market failure
2. Responding to pre-existing government failure
3. The pursuit of ethical or equity objectives

Classes 1 and 2 are economic efficiency-based arguments for intervention. Class 3, in contrast recognises that there may be ethical or equity-based justifications for intervention.

A commonly expressed view is that there is trade-off between efficiency and equity objectives: improvement on one of these fronts involves worsening on the other. While this may sometimes be the case, it is not necessarily true. In the final part of this lesson, we consider possible interactions between efficiency and equity objectives.

We have chosen to avoid taking the participant through the technical economic theory literature. That literature provides the theoretical foundation for much of what is covered in this lesson. It is likely that most participants will have covered this in their earlier studies. However, for those interested, or wishing to refresh their memory of this literature, the materials available here in these web pages include two 'Technical Background' papers:

- A. Welfare economics and intratemporal efficiency
- B. Welfare economics and dynamic efficiency

Reading these is entirely optional. You may wish to quickly skim read these now. Alternatively, you might prefer to just dip into them from time to time as you work your way through this course; at various points in this and following lessons, the notes will refer you to particular parts of these Technical Background papers where more formal presentations of ideas are provided.

The 'Technical Background' papers are edited versions of chapters from the textbook "Natural Resource and Environmental Economics" (2003), by Perman, Ma, McGilvray and Common. Section and sub-section numbering in those papers has been left unchanged from those in the original text, to ensure that all cross references remain consistent. Some of the content of these two papers also forms material in the lessons below.

Rationale for Intervention and the ROAMEF Cycle

Page 3 of the 2003 edition of the UK Treasury 'Green Book' contains the following graphic that accompanies a discussion of the ROAMEF cycle.

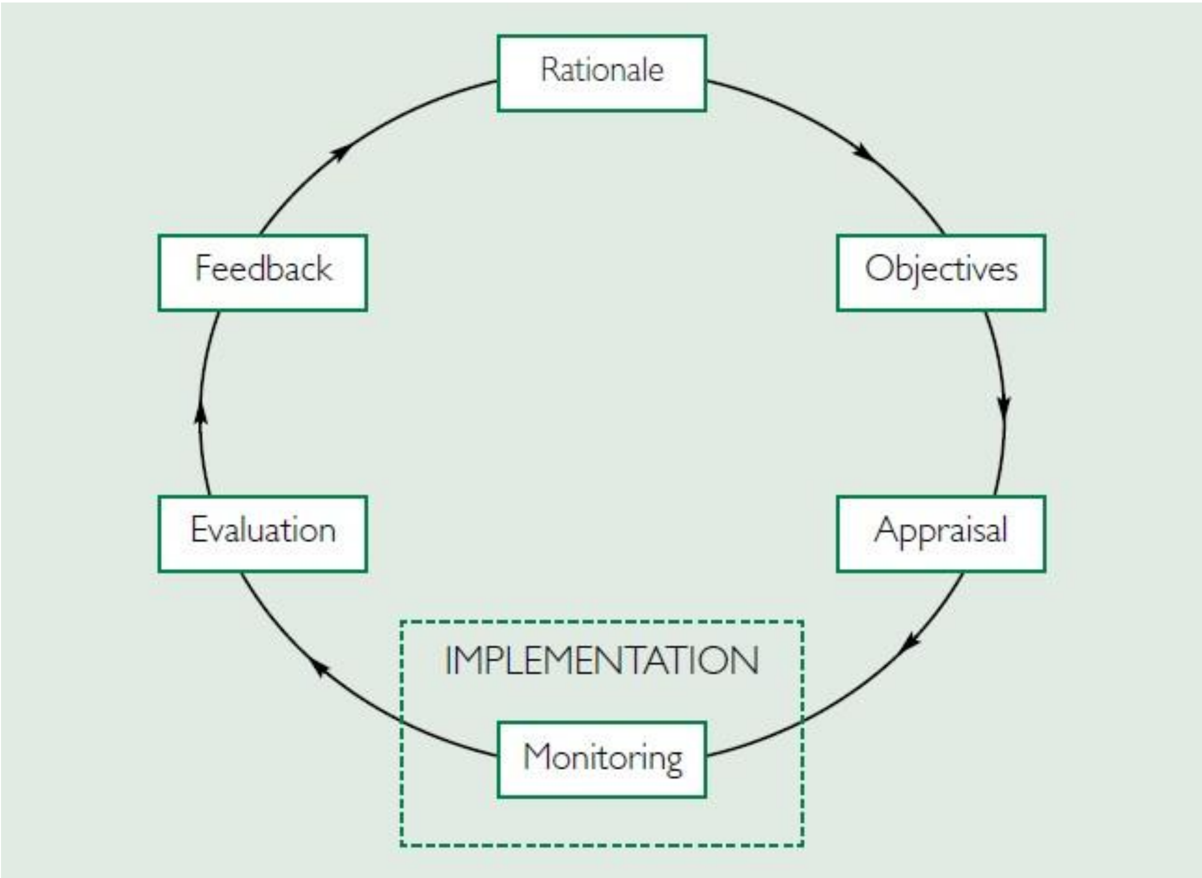


Figure 1.1 The ROAMEF Cycle [Source: Green Book (2003), page 3]

The acronym ROAMEF refers to the six steps that the Green Book regards as best practice in undertaking any economic appraisal. The appraisal processes begins with the process of creating a rationale for intervention. Without an adequate rationale, intervention should not take place. Moving clockwise, the **Rationale**, **Objectives** and **Appraisal** steps constitute the *ex ante* components of economic appraisal. It is the first two of these steps, Rationale and Objectives, which we consider in this lesson.

The **Rationale** step is concerned with justifying action. It is discussed in Chapter 3 of the Green Book. Justification requires that there is a clearly identified **need for intervention**. It is important from the start of this process to recognise that, relative to doing nothing, any intervention is likely to have negative as well as adverse consequences. So as there will be in practice both costs and benefits, the rationale for intervention should also includes a preliminary (and as yet tentative) judgement that a proposed intervention is likely to be worth the cost. Only if there is a need for intervention AND a reasonable likelihood that intervention benefits exceed costs should the appraisal cycle be taken any further.

We shall have more to say later about Objectives and Appraisal. At this point, our task is to consider more carefully what kinds of need for action might provide an acceptable rationale for intervention. The next lesson looks at the first of the three 'generic' rationales for intervention: market failure.

Rationale for intervention: Responding to market failure

This lesson provides some standard economic theory regarding market failure, why market failure leads to inefficient allocations of resources, and how market failure might be corrected through government regulation or other forms of intervention. Working your way through this lesson, the following matters will be looked at:

- the conditions required for an efficient allocation of resources;
- why a market allocation of resources would be an efficient allocation under a particular set of "ideal" circumstances;
- why the absence of one or more of these circumstances can lead to market failure: an outcome in which the conditions for allocatively efficient use of resources is not attained.

In this course, it is assumed that you know the relevant theory already, and so in this lesson we restrict coverage to a quick review of key results.

Whether or not you have covered this material before, you are strongly advised to read the materials here, although you may find that only a quick 'skim read' is required. If you have not covered welfare economics before in an explicit way, or if your knowledge is a little bit sketchy, or if you think you may have forgotten much of what you learned before, a careful study of the lesson notes is probably warranted. In those circumstances, you may also wish to read through the technical background, to be found in Chapters 4 and 11 of the 4th edition of the textbook. These two chapters derive the results more fully and more formally, and are extensions of what is contained in the lesson notes themselves. Reading these, though, is entirely voluntary and you should judge whether that exercise will be valuable to you. Direct links to the two Technical Background papers are provided here (as well as from the course main menu):

On the other hand, if you know the economics of efficiency and market failure well, it may not be necessary for you not to read these chapters, and also to just 'skim read' through this lesson on market failure. But please do not omit reading the lesson notes at all; at the very least, you are likely to find the lesson material rewarding.

A. Conditions required for a first-best efficient allocation of resources

An allocation of resources is said to be efficient if it is not possible to make one or more persons better off without making at least one other person worse off. Conversely, an allocation is inefficient if it is possible to improve someone's position without worsening the position of anyone else. A gain by one or more persons without anyone else suffering is known as a Pareto improvement. When all such gains have been made, the resulting allocation is sometimes referred to as Pareto optimal, or Pareto efficient. A state in which there is no possibility of Pareto improvements is sometimes referred to as being allocatively efficient, rather than just efficient, so as to differentiate the question of efficiency in allocation from the matter of technical efficiency in production.

Efficiency in allocation requires that three efficiency conditions are fulfilled – efficiency in consumption, efficiency in production, and product-mix efficiency. We briefly summarise these conditions for the most simple case of a two person, two good, two input economy. [Results generalise, of course, to a many person, many commodity and many input economy.]

Some notation used in this lesson

- We consider two individuals A and B and two commodities X and Y.
- Prices of X and Y are given by P_X *and* P_Y.
- Utility functions for individuals A and B are given by:

$U^A = U^A(X^A, Y^A)$
$U^B = U^B(X^B, Y^B)$

- Production functions are given by

$X = X(K^X, L^X)$
$Y = Y(K^Y, L^Y)$

- For an individual, the slope of his or her indifference curve between commodities X and Y at a particular point is known as MRUS, the marginal rate of utility substitution, and is given by $MRUS = P_X/P_Y$

Efficiency in consumption	Consumption efficiency requires that the marginal rates of utility substitution for the two individuals are equal: $MRUS^A = MRUS^B$ (5.3)	If this condition were not satisfied, it would be possible to rearrange the allocation as between A and B of whatever is being produced so as to make one better off without making the other worse off.
Efficiency in production	Efficiency in production requires that the marginal rate of technical substitution be the same in the production of both	If this condition were not satisfied, it would be possible to reallocate inputs to production so as to produce more of one of

	commodities. That is: $MRTS_X = MRTS_Y$ (5.4)	the commodities without producing less of the other.
Product-mix efficiency	Product-mix efficiency requires that $MRT_L = MRT_K = MRUS^A = MRUS^B$ (5.5)	Consider a production possibility frontier (PPF) showing the output combinations that the economy could produce using all of its available resources. The slope of this PPF is MRT. It is the rate at which the economy can trade off production of *X* for *Y* and vice versa. Optimality requires that this transformation be equal whether a marginal change in the composition of consumption is realised by switching labour or capital between the two lines of production.

Intuitively, each of these efficiency conditions refers to trade-offs between pairs of things. The most easily understood trade-off concerns the rate at which individuals are willing to trade-off one good for another at the margin. Suppose that I am willing to swap 200 grams of cheese for six eggs, and you are willing to swap 100 grams of cheese for six eggs. Relative to one another, I am an egg lover and you are a cheese lover. The fact that you and I have different relative valuations of the two goods implies that there must exist some mutually beneficial exchange of cheese for eggs between the two of us. For example, if we agreed to exchange at the rate 150 grams of cheese for six eggs, you would benefit by selling me some eggs in return for some cheese; I would also benefit from that transaction. Only where our relative valuations of goods are equal will no such efficiency-increasing exchanges be possible.

All the other efficiency conditions listed above can be interpreted in a similar way, although they will be relative valuations of pairs of things other than goods and between pairs of agents other than individual consumers. I will leave you to think through each of these other cases.

An Important Qualification

The three efficiency conditions, 5.1, 5.2 and 5.3, are required for achievement of Pareto optimality (also known as Pareto efficiency). Provided that income and wealth distributions are ideal according to social preferences (a matter we shall return to later), an allocation of resources that would lead to these conditions being satisfied is known as a first-best allocation of resources.

In order to achieve such an allocation of resources, several technical and institutional conditions must prevail. We shall examine what these conditions are on the following page. It is quite likely, however, that one or more of these conditions are not satisfied. In such cases, a first best allocation of resources may not be feasible. Where a first-best allocation of resources is not possible, then the three efficiency conditions described earlier are no longer valid, and must be modified so as to get the highest possible "second-best" or "third best" allocation of resources.

Unfortunately, this is far more than merely an abstruse technical matter. It has potentially profound implications for the way that resources, commodities and inputs should be valued when doing economic appraisal. At this stage in the course, these complications will be put to one side. We shall return to them at several points later, particularly in Topics 4 and 7.

B. Efficiency given ideal conditions

A variety of institutional arrangements might be employed to allocate resources, such as dictatorship, central planning and free markets. Any of these can, in principle, achieve an efficient allocation of resources. Here, we are particularly interested in the consequences of free-market resource allocation decisions, as modern welfare economics takes it that markets are the way economies are mainly organised.

Welfare economics theory points to a set of circumstances such that a system of free markets would sustain an efficient allocation of resources. The 'institutional arrangements', as we shall call them, include the following:

1. Markets exist for all goods and services produced and consumed.
2. All markets are perfectly competitive.
3. All transactors have perfect information.
4. Private property rights are fully assigned in all resources and commodities.
5. No externalities exist.
6. All goods and services are private goods. That is, there are no public goods.
7. All utility and production functions are 'well behaved'. [Roughly speaking, in regard to utility this means that indifference curves are continuous and have the bowed-toward-the-origin shape that they are usually drawn with in the textbooks; in regard to production, the main point is that increasing returns to scale are ruled out.]

A few brief comments are in order on these conditions required for a market system to be capable of realising allocative efficiency. First, arrangements 5 and 6 are really particulars of 4. Second, note that 4 is necessary for 1 – markets can only work where there are private property rights and a justice system to enforce and protect such rights. Third, that an important implication of 2 is that buyers and sellers act as 'price-takers', believing that the prices that they face cannot be influenced by their own behaviour. No agent, that is, acts in the belief that they have any power in the market. Finally, note that these are a very stringent set of conditions, which do not accurately describe any actual market economy. The economy that they do describe is an ideal type, to be used in the welfare analysis of actual economies as a benchmark against which to assess performance, and to be used to devise policies to improve the performance, in regard to efficiency criteria, of such actual economies.

B.1 A key result from welfare economics

Welfare economic theory establishes the result that an efficient allocation would be the outcome in a market economy populated entirely by maximisers (firms and individuals do the best for themselves that they can in the circumstances that they find themselves in) and where all of these institutional arrangements were in place.

How does this result come about?

Efficiency in consumption.	In the ideal conditions under consideration, all individuals face the same prices. So, for the two-individual, two-commodity market economy, we have $MRUS^A = MRUS^B = P_X/P_Y$ (5.8)

	Comparison of equation 5.8 with equation 5.3 shows that the consumption efficiency condition is satisfied in this ideal market system.
Efficiency in production	Cost-minimising choices of input levels must be characterised by: $MRTS = P_K/P_L$ where MRTS is the slope of a firm's isoquant. In the ideal circumstances under consideration, all firms, in all lines of production, face the same P_K and P_L, which means that $MRTS_X = MRTS_Y$ *and so* $MRTS_X = MRTS_Y = P_K/P_L$ (5.9) which is the same as equation 5.4, the production efficiency condition.
Product-mix efficiency	This follows from profit-maximising behaviour by firms. As the argument is quite lengthy, you are referred to textbook Chapter 4 should you wish to go through the reasoning as to why this leads to the satisfaction of equation 5.5.

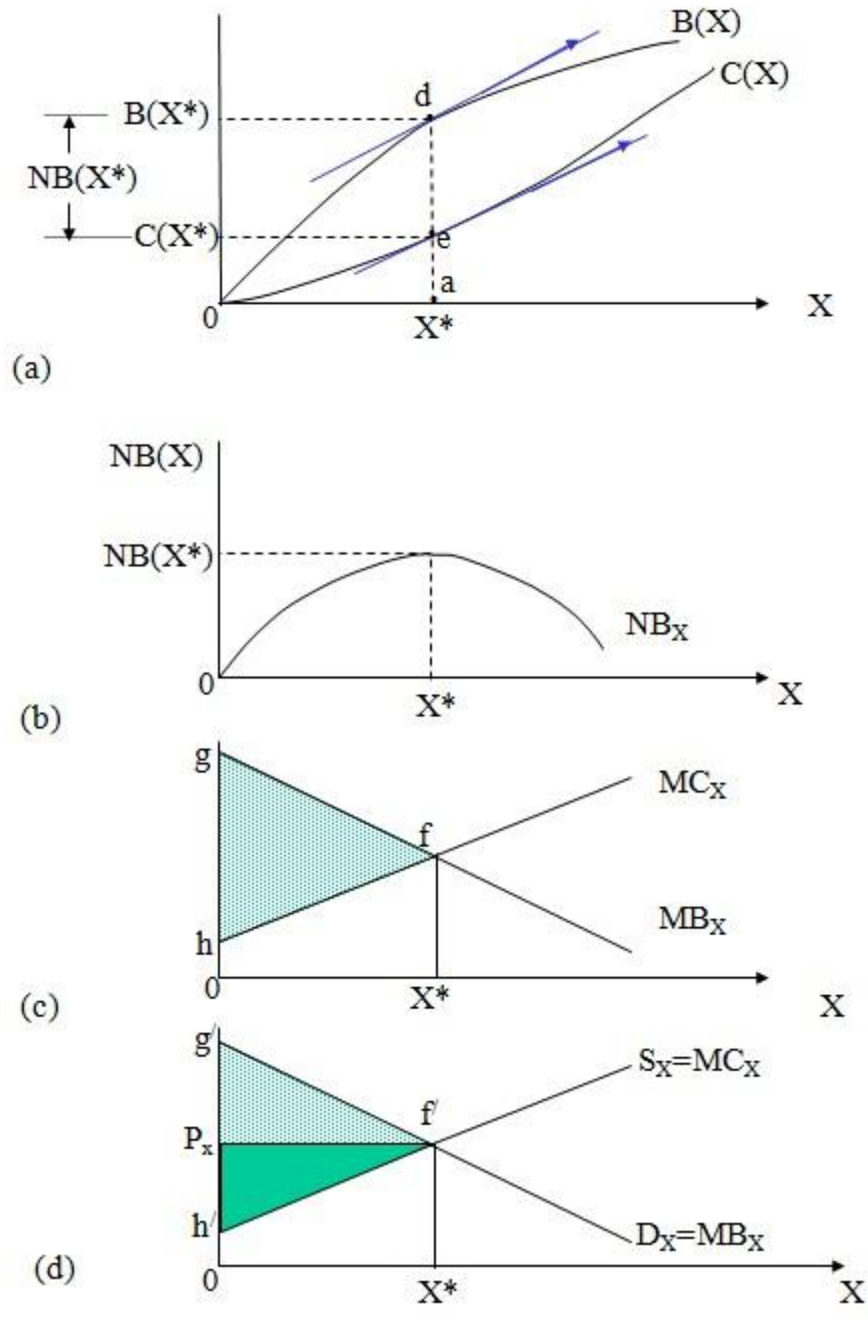
B.2 Partial equilibrium analysis of market efficiency

In examining the concept of allocative efficiency, we have used a general equilibrium approach. This looks at all sectors of the economy simultaneously. Even if we were only interested in one part of the economy – such as the production and consumption of cola drinks – the general equilibrium approach requires that we look at all sectors. In finding the allocatively efficient quantity of cola, for example, the solution we get from this kind of exercise would give us the efficient quantities of all goods, not just cola.

There are several very attractive properties of proceeding in this way. Perhaps the most important of these is the theoretical rigour it imposes. But there are penalties to pay for this rigour. Doing applied work in this way can be expensive and time-consuming. And in some cases data limitations make it impossible.

Given the cost and difficulty of using this approach for many practical purposes, many applications use a different framework that is much easier to operationalise. This involves looking at only the part of the economy of direct relevance to the problem being studied. Let us return to the cola example, in which our interest lies in trying to estimate the efficient amount of cola to be produced. The partial approach examines the production and consumption of cola, ignoring the rest of the economy. It begins by identifying the benefits and costs to society of using resources to make cola. Then, defining *net* benefit as total benefit minus total cost, an efficient output level of cola would be one that maximises net benefit.

Figure 5.11 A partial equilibrium interpretation of economic efficiency.



Let *X* be the level of cola produced and consumed. Figure 5.11(a) shows the total benefits of cola (labelled *B*) and the total costs of cola (labelled *C*) for various possible levels of cola production. The reason we have labelled the curves *B* (*X*) and *C*(*X*), not just *B* and *C*, is to make it clear that benefits and costs each depend on, are functions of, *X*. Benefits and costs are measured in money units. The shapes and relative positions of the curves we have drawn for *B* and *C* are, of course, just stylised representations of what we expect them to look like. However, the reasoning that follows is not conditional on the particular shapes and positions that we have used, which are chosen mainly to make the exposition straightforward.

Given that we call an outcome that maximises net benefits 'efficient', it is clear from Figure 5.11(a) that X^* is the efficient level of cola production. Net benefits (indicated by the distance *de*) are at their maximum at that level of output. This is also shown in Figure 5.11(b), which plots the *net* benefits for various levels of X. Observe the following points:

- At the efficient output level X^* the total benefit and total cost curves are parallel to one another (Figure 5.11(a)).
- The net benefit function is horizontal at the efficient output level (Figure 5.11(b)).

The distance *de*, or equivalently the magnitude NB(X^*), where NB is net benefit, can be interpreted in efficiency terms. It is a measure, in money units, of the efficiency gain that would come about from producing X^* cola compared with a situation in which no cola was made.

These ideas are often expressed in a different, but exactly equivalent, way, using marginal rather than total functions. As much of the economics literature uses this way of presenting ideas, let us see how it is done. We use MC_X to denote the marginal cost of X, and MB_X denotes the marginal benefit of X. In Figure 5.11(c), we have drawn the marginal functions which correspond to the total functions in Figure 5.11(a). We drew the curves for $B(X)$ and $C(X)$ in Figure 5.11(a) so that the corresponding marginal functions are straight lines, a practice that is often adopted in partial equilibrium treatments of welfare economics. This is convenient and simplifies exposition of the subsequent analysis. But, the conclusions do not depend on the marginal functions being straight lines. The results to be stated hold so long as marginal benefits are positive and declining with X and marginal costs are positive and increasing with X – as they are in Figure 5.11(c).

In Figure 5.11(c) we show X^*, the cola output level that maximises net benefit, as being the level of X at which MC_X is equal to MB_X. Why is this so? Consider some level of X below X^*. This would involve MB_X greater than MC_X, from which it follows that increasing X would increase benefit by more than cost. Now consider some level of X greater than X^*, with MC_X greater than MB_X, from which it follows that reducing X would reduce cost by more than benefit, i.e. increase net benefit. Clearly, considering X levels above or below X^* in this way, it is X^* that maximises net benefit.

Can we obtain a measure of maximised net benefits from Figure 5.11(c) that corresponds to the distance *de* in Figure 5.11(a)? Such a measure is available; it is the area of the triangle *gfh*. The area beneath a marginal function over some range gives the value of the change in the total function for a move over that range. So the area beneath MB_X over the range $X = 0$ to $X = X^*$ gives us the total benefits of X^* cola (i.e. B^*), which is equal to the distance *ad* in Figure 5.11(a). Similarly, the area beneath MC X over the range $X = 0$ to $X = X^*$ gives us the total cost of X^* (i.e. C^*), which is the same as the distance *ae* in Figure 5.11(a). By subtraction we find that the area *gfh* in Figure 5.11(c) is equal to the distance *de* in Figure 5.11(a).

Now we turn to the partial equilibrium version of the demonstration that an ideal market system maximises net benefit and secures allocative efficiency. We assume that all of the institutional arrangements listed in the previous section apply, and that all agents are maximisers. Then all those who wish to drink cola will obtain it from the market, and pay the going market price. The market demand curve, D_X, for cola will be identical to the MB_X curve, as that describes consumers' *willingness to pay* for additional units of the good – and that is exactly what we mean by a demand curve. Under our assumptions, cola is produced by a large number of price-taking firms in a competitive market. The market supply curve, S_X, is identical to the curve MC_X in Figure 5.11(c) because, given that firms produce where price equals marginal cost, the supply curve is just the marginal cost curve – each point on the supply curve is a point where price equals marginal cost. S_X shows the cost of producing additional (or marginal) cans of cola at various output levels.

The market demand and supply curves are drawn in Figure 5.11(d). When all mutually beneficial transactions have taken price, the equilibrium market price of the good will be P_X, equal at the margin to both

- consumers' subjective valuations of additional units of the good (expressed in money terms); and
- the costs of producing an additional unit of the good.

Put another way, all consumers face a common market price P_X, and each will adjust their consumption until their marginal utility (in money units) is equal to that price. Each firm faces that same fixed market price, and adjusts its output so that its marginal cost of production equals that price. So we have:

$P_X = MC_X = MB_X$ (5.13)

The equality at the margin of costs and benefits shows that cola is being produced in the amount consistent with the requirements of allocative efficiency. We must emphasise here something that it is sometimes possible to forget when using partial equilibrium analysis. The fact that equation 5.13 holds for the cola, or whatever, market means that the quantity of cola, or whatever, produced and consumed is consistent with allocative efficiency only if *all* the institutional arrangements listed at the start of this section are in place. It is necessary, for example, not only that the cola market be perfectly competitive, but also that all markets be perfectly competitive. And, it is necessary, for example, that all inputs to and outputs from production be traded in such markets. If such requirements are not met elsewhere in the economy, the supply and demand curves in the cola market will not properly reflect the costs and benefits associated with different levels of cola production. Some of the issues arising from these remarks will be dealt with later under the heading of 'the second-best problem'.

Finally here, we can use Figure 5.11(d) to introduce the concepts of *consumers' surplus* and *producers' surplus*, which are widely used in welfare economics and its various applications. The area beneath the demand curve between zero and X^* units of the good shows the total consumers' willingness to pay, WTP, for X^* cans of cola per period. To see this, imagine a situation in which cans of cola are auctioned, one at a time. The price that the first can offered would fetch is given by the intercept of the demand curve, $0g'$. As successive cans are offered so the price that they fetch falls, as shown by the demand curve. If we add up all the prices paid until we get to X^*, and recognising that X^* is a very large number of cans, we see that the total revenue raised by the auction process which stops at X^* will be the area under the demand curve over $0X^*$, i.e. $0g'f'X^*$. But this is not the way the market works. Instead of each can being auctioned, a price is set and all cans of cola demanded are sold at that price. So, the individual who would have been willing to pay $0g'$ for a can actually gets it for P_X. Similarly, the individual who would have been willing to pay just a little less than $0g'$ actually pays P_X. And so on and so on, until we get to the individual whose WTP is P_X, and who also actually pays P_X. All individuals whose WTP is greater than P_X are, when all cans sell at P_X, getting a surplus which is the excess of their WTP over P_X. Consumers' surplus is the total of these individual surpluses, the area between the demand curve and the price line over $0X^*$, i.e. $P_Xg'f'$. Another way of putting this is that consumers' surplus is the difference between total willingness to pay and total actual expenditure, which is the difference between area $0g'f'X^*$ and area $0P_X f'X^*$, which is the area of the triangle $P_X g'f'$.

Producers' surplus in Figure 5.11(d) is the area of the triangle $h'P_X f'$. The reasoning to this is very similar to that for consumers' surplus. As noted above, the supply curve is, given the ideal conditions being assumed here, just the marginal cost curve. The first can of cola costs $0h'$ to produce, but sells in the market for P_X, so there is a surplus of $h'P_X$. The surplus on the production of each further can is given by the vertical distance from the price line to the supply curve. The sum of all these vertical distances is total producers' surplus, the area $h'P_X f'$. An alternative way of putting this is that total revenue is the area $0P_X f'X^*$, while total cost is $0h'f'X^*$, so that producers' surplus is revenue minus costs, i.e. $h'P_X f'X^*$.

C. MARKET FAILURE AND PUBLIC POLICY

In Part A, we laid out the conditions that characterise an efficient allocation. In Part B, we reported the result that, given 'ideal' circumstances concerning institutions and behaviour, a system of markets would produce an efficient allocation. We noted that the ideal circumstances are truly ideal, in that they do not describe any actual economy. Actual market economies depart from the ideal circumstances in a variety of ways, and the allocations that they produce are not efficient. Economists use welfare economics to identify 'market failures' – situations where actual circumstances depart from the ideal – and to recommend policies to correct them so that actual economies perform better in relation to the objective of efficiency.

To recapitulate, we have seen that for markets to produce efficient allocations, it is necessary that:

1. Markets exist for all goods and services produced and consumed.
2. All markets are perfectly competitive.
3. All transactors have perfect information.
4. Private property rights are fully assigned in all resources and commodities.
5. No externalities exist.
6. All goods and services are private goods. That is, there are no public goods.
7. All utility and production functions are 'well behaved'.
8. All agents are maximisers.

We now look at each of these ideal circumstances in turn, noting why the circumstance in question may not prevail and so why a market failure may exist. It will be evident that developing country economies are particularly prone to the absence of reasons one or more of these ideal conditions, and hence why market failure is likely to be so pervasive in the context in which DFID operates.

C.1 The existence of markets and the existence of enforceable property rights

Clearly, condition 1 here is fundamental. If there are goods and services for which markets do not exist, then the market system cannot produce an efficient allocation, as that concept applies to all goods and services that are of interest to any agent, either as utility or production function arguments. Further, 4 is necessary for 1 – a market in a resource or commodity can only exist where there are private property rights in that resource or commodity.

We can define a property right as a bundle of characteristics that convey certain powers to the owner of the right. These characteristics concern conditions of appropriability of returns, the ability to divide or transfer the right, the degree of exclusiveness of the right, and the duration and enforceability of the right. Where a right is exclusive to one person or corporation, a private property right is said to exist.

Conventional Policy Prescriptions

From the standpoint of welfare economics, if a market failure exists because a market does not exist, then the conventional policy prescription is that the state should facilitate the development of markets where they do not exist. This may entail first of all creating private property rights in the good, service or resource in question (as markets may not be viable in the absence of well-defined property rights).

Facilitating the creation of markets where they do not exist: the developed economy context

In an affluent, developed, capitalist economy context, the conventional policy prescription just referred to seems to be both feasible and - at least in many cases - desirable.

Almost by definition, mature capitalist economies are ones where private property rights are pervasive and deeply rooted, and where markets already exist for most goods and services that are intentionally produced. In general there are four areas where markets are absent, and in three out of the four cases there are sound reasons why markets should NOT be used:

1. For resources which political choice mechanisms have chosen that non-market allocation mechanisms should operation. (Examples might include the provision of 'welfare state' services - such as primary and secondary school education, and general primary care and hospital health services - that are provided free at the point of use, and funded out of general tax revenues.) In cases where society chooses to not use market mechanisms, and does so in a well-informed way knowing the costs and benefits of doing so, it would be at the least inconsistent to advocate the use of markets.
2. Where the good or service in question is a public good, for which market allocation mechanisms cannot generate efficient outcomes, and/or where rationing via market mechanism is considered inappropriate for some non-economic reason.
3. Where the good or service is an externality, and so it is produced unintentionally. We look in detail at externalities in a later page of this lesson. At this point we just note that the most common instances in which governments in mature capitalist economies attempt to create markets where they do not previously exist is in connection with markets (or quasi-markets) for externalities. This typically involves the use of Pigovian taxes or subsidies to price adverse or beneficial external effects, and so to create quasi-markets that internalise the externality. We return to this below.
4. Markets versus hierarchies. The work of Ronald Coase and the school known as the 'New Institutional Economists' has demonstrated that in the presence of imperfect information (or 'bounded rationality'), opportunism, and asset specificity, it may be more desirable for resource allocation decisions to be made via administrative processes taking place in 'hierarchies' than through markets. Creations of markets where hierarchies are more efficient allocation mechanisms is clearly inappropriate. See the box below.

Market and Hierarchies: Oliver Williamson - joint winner of the 2009 Nobel Prize for Economics

Nobel Prize Official Link

A good survey by Williamson of his key ideas

Facilitating the creation of markets where they do not exist: the developing country context

For developing countries, there are even more reasons to be sceptical of the standard policy prescription of creating a market where one does not exist already. The first reason is that markets tend to work well where they are widely used as resource allocation mechanisms already. But large swathes of economic activity in some developing countries take place outside the frameworks of market mechanisms; piecemeal use of markets in these circumstances can be unhelpful. This has been noted in regard to water resource management. Creation of market mechanisms and pricing for water has worked can work well, as experiences in the United Kingdom show. But the track record has been far less impressive in developing countries.

Elinor Ostrom has also fundamentally challenged the notion that private property rights are a necessary or sufficient condition for efficiency in resource allocation. In her view, there are many circumstances in which common property rights and mechanisms of collective action are more appropriate - for both efficiency and equity reasons - than the use of private property rights and market mechanisms. For the interested participant, the survey paper below is an excellent introduction to Ostrom's work.

Elinor Ostrom: Common Property Resources - Joint winner of 2009 Economics Nobel Prize.

"Elinor Ostrom has challenged the conventional wisdom that common property is poorly managed and should be either regulated by central authorities or privatized. Based on numerous studies of user-managed fish stocks, pastures, woods, lakes, and groundwater basins, Ostrom concludes that the outcomes are, more often than not, better than predicted by standard theories. She observes that resource users frequently develop sophisticated mechanisms for decision-making and rule enforcement to handle conflicts of interest, and she characterizes the rules that promote successful outcomes."

(Extract from Nobel Prize web pages)

Nobel Prize Official Link

A good survey by Ostrom of her key ideas

C.2 Situations where transactors do not have perfect information

It is clear that market failure can arise from informational shortcomings. What is not so clear is what appropriate policy responses may be. Conventional responses are for public agencies to provide an educative and information-providing role. It is not our task to deal with these questions here, but it may be worth drawing the reader's attention to a major emerging research literature: behavioural economics.

At the time of writing this lesson (October 2009), Wikipedia contains (at the page http://en.wikipedia.org/wiki/Behavioral_economics) a very useful summary of the ideas of this rapidly emerging area of research. The 2002 Nobel Prize in Economics was jointly won by a leading behavioural economist, Daniel Kahneman. (See http://nobelprize.org/nobel_prizes/economics/laureates/2002/kahneman-lecture.html)

Behavioural economics has potentially profound policy implications. It argues that behaviour which appears inconsistent with the predictions of economic theory is not the result of mistakes, of complexity, or of informational shortcomings per se. Rather it is because conventional economics has a narrow and misguided notion of rational behaviour itself.

C.3 Externalities

An external effect, or an externality, is said to occur when the production or consumption decisions of one agent have an impact on the utility or profit of another agent in an unintended way, and when no compensation/payment is made by the generator of the impact to the affected party.

Some authors leave out from the definition of an externality the condition that the effect is not paid or compensated for, on the grounds that if there were payment or compensation then there would be no lack of intention involved, so that the lack of compensation/payment part of the definition as given in the text here is redundant. As we shall see, there is something in this. However, we prefer the definition given here as it calls attention to the fact that lack of compensation/payment is a key feature of externality as a policy problem. Policy solutions to externality problems always involve introducing some kind of compensation/payment so as to remove the unintentionality, though it has to be said that the compensation/payment does not necessarily go to/come from the affected agent.

The stated definition of an external effect is not perhaps very illuminating as to what exactly is involved. Things will become clearer as we work through the analysis. The two key things to keep in mind are that we are interested in effects from one agent to another which are unintended, and where there is no compensation, in respect of a harmful effect, or payment, in respect of a beneficial effect. We begin our analysis of externalities by discussing the forms that externalities can take.

C.3.1 Classification of externalities

In our two-person, two-(private)-commodity, two-input economy we have worked with

$U^A = U^A (X^A, Y^A)$

$U^B = U^B (X^B, Y^B)$

as utility functions, and

$X = X (K^X, L^X)$

$Y = Y (K^Y, L^Y)$

as production functions. Note that here the only things that affect an individual's utility are her own consumption levels, and that the only things that affect a firm's output are the levels of inputs that it uses. There are, that is, no external effects.

External effects can, first, be classified according to what sort of economic activity they originate in and what sort of economic activity they impact on. Given two sorts of economic activity, consumption and production, this gives rise to the sixfold classification shown in Table 5.6. The first column shows whether the originating agent is a consumer or producer, the second whether the affected agent is a consumer or producer, and the third provides an illustrative utility or production function for the affected agent. In Table 5.6, we are concerned only to set out the forms that unintended interdependence between agents could take. Some examples will be provided shortly.

Table 5.6 Externality classification

Arising in	Affecting	Utility/production function
Consumption	Consumption	$U^A(X^A, Y^A, X^B)$
Consumption	Production	$X(K^X, L^X, Y^A)$
Consumption	Consumption	$U^A(X^A, Y^A, X^B)$ and
	and production	$Y(K^Y, L^Y, X^B)$
Production	Consumption	$U^A(X^A, Y^A, X)$
Production	Production	$X(K^X, L^X, Y)$
Production	Consumption	$U^A(X^A, Y^A, Y)$ and
	and production	$X(K^X, L^X, Y)$

In the first row in Table 5.6, an example of a consumption externality is where agent B's consumption of commodity *X* is an argument in A's utility function – B's consumption of *X* affects the utility that A derives from given levels of consumption of *X* and *Y*. In the second row, A's consumption of *Y* is shown as affecting the production of *X*, for given levels of capital and labour input. Row 3 has B's consumption of *X* affecting both A's utility and the production of *Y*. In row 4, the amount of *X* produced, as well as A's consumption of *X*, affects A's utility. Row 5 has the production of *Y* determining, for given capital and labour inputs, the amount of *X* produced. Finally, in row 6 we have a situation where the level of *Y* affects both A's utility and the production of *X*.

Table 5.7 Beneficial and harmful externalities

Effect on others	Originating in consumption	Originating in production
Beneficial	Vaccination against an infectious disease	Pollination of blossom arising from proximity to apiary
Adverse	Noise pollution from radio playing in park	Chemical factory discharge of contaminated water into water systems

The unintended impact that an external effect involves may be harmful or beneficial. Table 5.7 provides examples of both kinds. If an individual has a vaccination that protects them, which is their intention, it also has the unintended effect of reducing the probability that others will contract the disease. An individual playing their radio loudly in the park inflicts suffering on others, though that is not their intention. In these two cases, the external effect originates in consumption and affects individuals. A beneficial externality originating in production, and impacting on production, is the case where a honey producer's bees pollinate a nearby fruit orchard. Pollution, in the bottom right cell, is a harmful externality which most usually originates in production activities. It can affect consumers, or producers, or both.

Another dimension according to which external effects can be classified is in terms of whether they have, or do not have, the public goods characteristics of non-rivalry and non-excludability. While external effects can have the characteristics of private goods, those that are most relevant for policy analysis exhibit non-rivalry and non-excludability. All of the examples in Table 5.7 involve non-rivalry and non-excludability.

C.3.2 Externalities and economic efficiency

Externalities are a source of market failure. Given that all of the other institutional conditions for a pure market system to realise an efficient allocation hold, if there is a beneficial externality the market will produce too little of it in relation to the requirements of allocative efficiency, while in the case of a harmful externality the market will produce more of it than efficiency requires. We shall look in any detail only at harmful externalities here. The market, in the absence of corrective policy, will 'over-supply' the externality. This will be exemplified by looking at three sorts of pollution problem – a consumer-to-consumer case, a producer-to-producer case, and a case where the unintended effect is from a producer to consumers. These three cases bring out all of the essential features of externalities as a market failure problem. In the text we shall use diagrams and partial equilibrium analysis to make the essential points. In Appendix 5.3 we cover the same ground using general equilibrium analysis.

Before getting into these cases in a little detail, we can make a general intuitive point that covers both beneficial and harmful externalities. The basic problem with external effects follows directly from the definition in regard to unintendedness and lack of payment/compensation. These two features of the externality problem are directly related. The lack of intentionality follows from the fact that the impact involved does not carry with it any recompense, in the case of a beneficial effect, or penalty, in the case of a harmful effect. External effects arise where an agent's actions affecting other agents do not involve any feedback – benefit is conferred which is not rewarded, or harm is done which is not punished. Given the lack of reward/punishment, which in a market system would be signalled by monetary payment, an agent will not take any account of the effect concerned. It will be unintended and 'external' to their decision making. Where it is a beneficial effect, it will not be encouraged sufficiently, and there will not be enough of it. Where it is a harmful effect, it will not be discouraged sufficiently, and there will be too much of it. The key to dealing with the market failure that external effects give rise to is to put in place the missing feedbacks, to create a system which does reward/punish the generation of beneficial/harmful effects, so that they are no longer unintentional.

C.3.3 Consumption-consumption externality

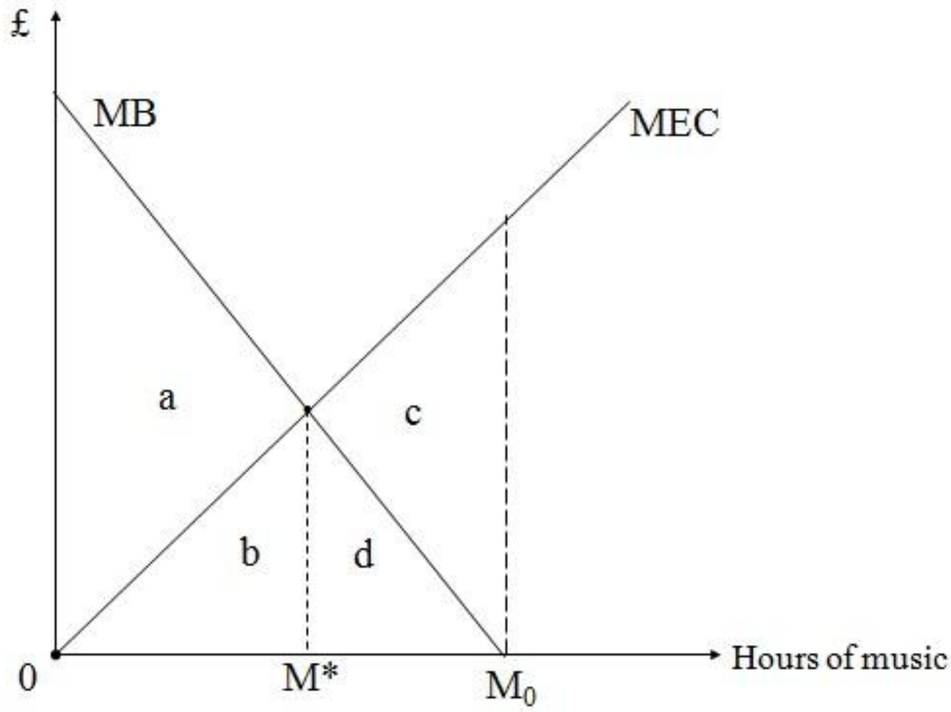
Suppose that A and B live in adjacent flats (apartments). A is a saxophone player, who enjoys practising a lot. B does not like music, and can hear A practising. The utility functions are

$$U^A = U^A (M^A, S^A)$$

$$U^B = U^B (M^B, S^A)$$

where M represents wealth and S^A is the hours that A plays the saxophone each week, with $\partial U^A/\partial M^A > 0$, $\partial U^B/\partial M^B > 0$, $\partial U^A/\partial S^A > 0$ and $\partial U^B/\partial S^A < 0$. In Figure 5.13 we show, as MB, the marginal benefit of playing to A, and, as MEC for marginal external cost, the marginal cost of playing to B. Marginal benefit is the amount that A would pay, if it were necessary, to play a little more. Conversely, MB is the amount of compensation that would be required to leave A as well off given a small reduction in playing. Marginal external cost is the amount that B would be willing to pay for a little less playing. Conversely, MEC is the amount of compensation that would be required to leave B as well off given a small increase in *M* (hours of A's saxophone playing).

Figure 5.13 The bargaining solution to an externality.



Given that A does not in fact have to pay any-thing to play her saxophone in her flat, she will increase her hours of playing up to the level M_0, where MB is equal to zero. At that level, A's total benefit from playing is given by the sum of the areas of the triangles a, b and d, and B's total suffering is measured in money terms by the sum of the areas b, d and c.

This is not an efficient outcome, because at M_0 , MEC > MB. The efficient outcome is at *M** where MEC = MB. At any *M* to the left of *M**, MB > MEC, so that for a small increase in *M*, A would be willing to pay more than would compensate B for that increase. At any *M* to the right of *M**, MEC > MB so that for a small decrease in *M*, B would be willing to pay more for a small decrease in *M* than would be required to compensate A for that decrease. The inefficient level of saxophone playing at M_0 comes about because there are no payments in respect of variations in *M*, no market in *M*, so that the effect on B is unintentional on the part of A.

At the level of principle, the solution to this problem of inefficiency is fairly obvious. The problem is that A does not compensate B because B does not have any legal right to such compensation, does not have a property right in a domestic environment unpolluted by saxophone music. So, the solution is to establish such a property right, to give B the legal right to a domestic environment that is not noise-polluted. Such legal arrangements would support bargaining which would lead to M^* as the level of M. The argument that establishes that M^* would be the outcome under a legal regime where B can claim compensation from A exactly parallels the argument that establishes that M^* is the efficient outcome. To the left of M^*, with MB > MEC, A will be willing to pay more in compensation for a small increase in M than B requires, so will pay and play more. A will not increase M beyond M^* because the compensation that it would be necessary to pay B would be greater than the worth to A of the small increase thereby attained.

The Coase theorem

The idea that, given a suitable assignment of property rights, private bargaining between individuals can correct externality problems and lead to efficient outcomes is generally attributed to the Nobel prize winning economist Ronald Coase, and the result discussed above is often referred to as the 'Coase theorem' (the seminal paper is Coase, 1960). In fact, the result discussed above is only half of the Coase theorem. The other half says that an efficient outcome can also be attained by vesting the property right in the generator of the external effect. In that case, the generator would have the legal right to play, for this example, as much saxophone as she liked. The point is that given that right, it could be in the interests of the victim to offer money to the generator not to exercise their right to the full. Just as the absence of a clear property right vested in the victim inhibits one kind of bargaining, so does the absence of a clear property right vested in the generator inhibit another kind of bargaining.

Suppose then, that in our saxophone-playing example a law is passed saying that all saxophone players have an absolute right to practise up to the limits of their physical endurance. Legally A can play as much as she wants. But, a legal right can be traded. So, the opportunity now exists for A and B to bargain to a contract specifying the amount that A will actually play. That amount will be M^* in Figure 5.13. To the right of M^*, MEC > MB, so B's willingness to pay for a small reduction is greater than the compensation that A requires for that small reduction. Starting at M_0 and considering successive small reductions, B will be offering more than A requires until M^* is reached where B's offer will exactly match the least that A would accept. A and B would not be able to agree on a level of M to the left of M^*, since there B's willingness to pay is less than A requires by way of compensation.

So, what the Coase theorem actually says is that given this kind of externality situation, due to incomplete private property rights, one solution involves creating property rights for either the victim or the generator, and that either assignment will lead to an efficient outcome. It needs to be explicitly and carefully noted here that there are two things that are not being claimed. First, that it is not being said that the outcome will be the same in both cases. Second, that it is not being said that either way of assigning property rights necessarily promotes equity.

In regard to the first point here, note that considering the move from M_0 to M^* in our saxophone music example consequent upon the establishment of the property right and the ensuing bargaining we have:

(a) For the case where B gets the property right – there is an M reduction of (M_0 - M^*) and A pays B an amount equal to the area of triangle b, the money value of B's suffering at the efficient outcome M^*.

(b) For the case where A gets the property right – there is an M reduction of (M_0 - M^*) and B pays A an amount equal to the area of triangle d, the money value of A's loss as compared with the no-property-rights situation.

Clearly, which way the property right is assigned affects the wealth of A or B. To be granted a new property right is to have one's potential monetary wealth increased. In case (a), B experiences less saxophone hours and an increase in wealth by virtue of a payment from A, so that A's wealth goes down with her pleasure from playing. In case (b), B experiences less saxophone hours and a decrease in wealth by virtue of a payment to A, who gets less pleasure from playing. As we have drawn Figure 5.13, in neither (a) nor (b) does the increase in wealth affect the receiving individual's tastes. In case (a), that is, B's willingness to pay for less music hours is not affected by becoming wealthier – the slope of the MEC line does not change. In case (b), A's willingness to pay for more music hours is not affected by becoming wealthier – the slope and position of the MB line do not change. While these assumptions may be plausible in this example, they clearly are not generally appropriate. They were imposed here to produce a simple and clear graphical representation. If the assumption that tastes are unaffected by wealth increases is dropped, then with the case (a) assignment MEC would shift and with the case (b) assignment MB would shift. In neither case then would M^* as shown in Figure 5.13 be the bargaining outcome, and the outcomes would be different in the two cases. Both outcomes would be efficient, because in both cases we would have MB = MEC, but they would involve different levels of M.

So, the first point is that the Coase theorem properly understood says that there will be an efficient outcome under either assignment of property rights, not that there will be the same efficient outcome under either assignment. The second point, concerning equity, is simply that there is no implication that either assignment will have any desirable implications in terms of equity. This follows directly from our earlier discussions of the relationship between optimality and efficiency. In the case of our saxophone example, we have said nothing about the initial wealth/income situations of the two individuals. Clearly, our views on which way the property right should be assigned will, unless we are totally uninterested in equity, be affected by the wealth /income of the two individuals. Given that efficiency criteria do not discriminate between the two possible assignments of property rights, it might seem natural to take the view that the assignment should be on the basis of equity considerations. Unfortunately, this does not lead to any generally applicable rules. It is not always the case that externality sufferers are relatively poor and generators relatively rich, or vice versa. Even if we confine attention to a particular class of nuisance, such as saxophone playing in flats, it cannot be presumed that sufferers deserve, on equity grounds, to get the property right – some may be poor in relation to their neighbour and some rich.

Given the simple and compelling logic of the arguments of the Coase theorem, the question arises as to why uncorrected externalities are a problem. If they exist by virtue of poorly defined property rights and can be solved by the assignment of clearly defined property rights, why have legislatures not acted to deal with externality problems by assigning property rights? A full answer to this question would be well beyond the scope of this book, but the following points are worthy of note. First, as we have seen, the case for property rights solutions is entirely an efficiency case. Legislators do not give efficiency criteria the weight that economists do – they are interested in all sorts of other criteria. Second, even given clearly defined property rights, bargaining is costly. The costs increase with the number of participants. While expositions of the Coase theorem deal with small numbers of generators and sufferers, typically one of each, externality problems that are matters for serious policy concern generally involve many generators and/or many sufferers, and are often such that it is difficult and expensive to relate one particular agent's suffering to another particular agent's action. This makes bargaining expensive, even if the necessary property rights exist in law. The costs of bargaining, or more generally 'transactions costs', may be so great as to make bargaining infeasible. Third, even leaving aside the large numbers problem, in many cases of interest the externality has public bad characteristics which preclude bargaining as a solution.['Public bad' is a term often used for a public good that confers negative, rather than positive, utility on those who consume it.]

C.3.4 Production-production externality

For situations where numbers are small, this case can be dealt with rather quickly. Consider two firms with production functions

$$X = X(K^X, L^X, S)$$

$$Y = Y(K^Y, L^Y, S)$$

where S stands for pollutant emissions arising in the production of Y, which emissions affect the output of X for given levels of K and L input there. As an example, Y is paper produced in a mill which discharges effluent S into a river upstream from a laundry which extracts water from the river to produce clean linen, X. Then, the assumption is that $\partial Y/\partial S > 0$, so that for given levels of K^Y and L^Y lower S emissions means lower Y output, and that $\partial X/\partial S < 0$, so that for given levels of K^X and L^X higher S means lower X.

This externality situation is amenable to exactly the same kind of treatment as the consumer-to-consumer case just considered. Property rights could be assigned to the downstream sufferer or to the upstream generator. Bargaining could then, in either case, produce an efficient outcome. To see this simply requires the reinterpretation and relabelling of the horizontal axis in Figure 5.13 so that it refers to S, with S_0 replacing M_0 and S^* replacing M^*. For profits in the production of X we have

$$\pi^X = P_X X(K^X, L^X, S) - P_K K^X - P_L L^X$$

where $\partial \pi^X/\partial S < 0$. The impact of a small increase in S on profits in the production of X is, in the terminology of Figure 5.13, marginal external cost, MEC. For profits in the production of Y we have

$$\pi^Y = P_Y Y(K^Y, L^Y, S) - P_K K^Y - P_L L^Y$$

where $\partial \pi^Y/\partial S > 0$. The impact of a small increase in S on profits in the production of Y is, in the terminology of Figure 5.13, marginal benefit, MB. With these reinterpretations, the previous analysis using Figure 5.13 applies to the producer-to-producer case – in the absence of a well-defined property right S will be too large for efficiency, while an efficient outcome can result from bargaining based on a property right assigned to either the producer of X or the producer of Y.

An alternative way of internalising the externality would be to have the firms collude so as to maximise their joint profits. That this would produce an efficient outcome is proved in Appendix 5.3. The matter is, however, quite intuitive. The externality arises because the Y producer does not take account of the effects of its actions on the output for given inputs of the X producer. If the Y producer chooses its levels of K^Y, L^Y and S in the light of the consequences for the output of X for given K^X and L^X, and hence on the profits arising in the production of X, then those consequences will not be unintended. On the contrary, the two firms will be operated as if they were a single firm producing two commodities. We know that a single firm producing a single commodity will behave as required for efficiency, given all of the ideal conditions. All that is being said now is that this result carries over to a firm producing two commodities. For the firm that is producing both *X* and *Y* the ideal conditions do apply, as there is no impact on its activities the level of which is unintentionally set by others.

While joint profit maximisation can internalise an externality as required for efficiency, there appear to be few, if any, recorded instances of firms colluding, or merging, so as to internalise an externality. Collusion to maximise joint profits will only occur if both firms believe that their share of maximised joint profits will be larger than the profits earned separately. There is, in general, no reason to suppose that cases where there is the prospect of both firms making higher profits with collusion will coincide with circumstances where there is a recognised inter-firm externality.

C.3.5 Production-consumption externality

The key feature of the case to be considered now is that the external effect impact on two agents, and with respect to them is non-rival and non-excludable in consumption. As is the case generally in this course, ‘two’ is a convenient way of looking at ‘many’ – the two case brings out all the essential features of the many case while simplifying the notation and the analysis. Putting this key feature in the context of the production-to-consumption case aligns with the perceived nature of the pollution problems seen as most relevant to policy determination. These are typically seen as being situations where emissions arising in production adversely affect individuals in ways that are non-rival and non-excludable.

So, in terms of our two-person, two-commodity economy we assume that:

$U^A = U^A (X^A, Y^A, S)$ with $\partial U^A/\partial S < 0$

$U^B = U^B (X^B, Y^B, S)$ with $\partial U^B/\partial S < 0$

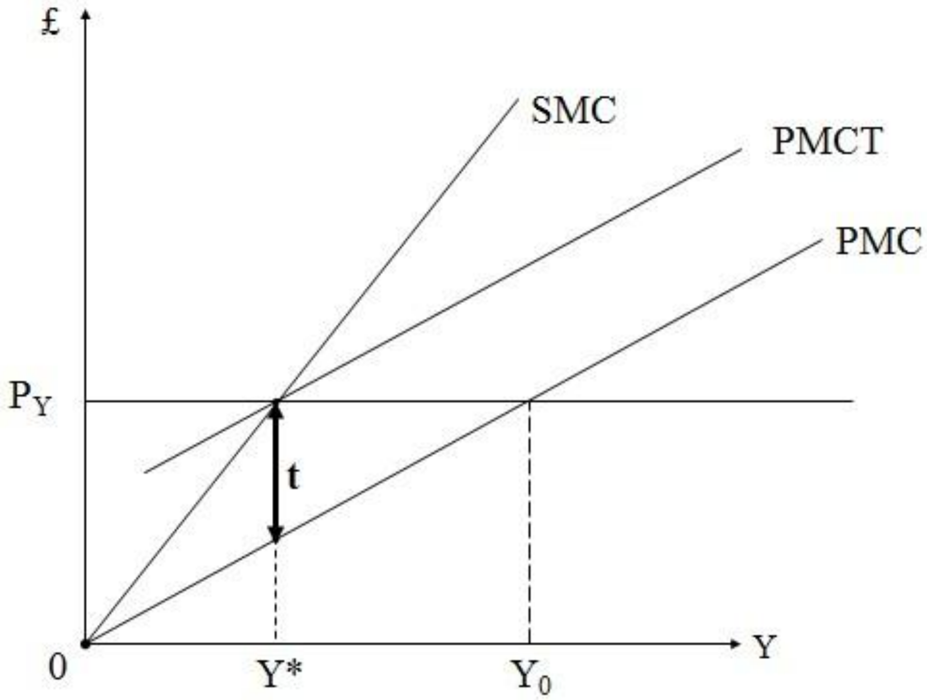
$X = X(K^X, L^X)$

$Y = Y (K^Y, L^Y, S)$ with $\partial Y/\partial S > 0$

Emissions arise in the production of *Y* and adversely affect the utilities of A and B. The pollution experienced by A and B is non-rival and non-excludable. A concrete example, bearing in mind that ‘two’ stands for ‘many’, would be a fossil-fuel-burning electricity plant located in an urban area. Its emissions pollute the urban airshed, and, to a first approximation, all who live within the affected area experience the same level of atmospheric pollution.

Given our earlier discussion of the supply of public goods, we can immediately conclude here that private bargaining based on some assignment of property rights will not deal with the externality problem. And, the joint profit maximisation solution is not relevant. In this kind of situation, correcting the market failure requires some kind of ongoing intervention in the workings of the market by some government agency. There is a range of means of intervention that the government agency, call it an environmental protection agency or EPA, could use. Here, we shall just look at the use of taxation by the EPA, so as to bring out the essential features of the situation where the externality has the characteristics of a public bad. A formal general equilibrium analysis is sketched in Appendix 5.3. Here we shall use partial equilibrium analysis based on Figure 5.14.

Figure 5.14 Taxation for externality correction.



It introduces some new terminology. PMC stands for private marginal cost. Private costs are the input costs that the *Y* producer actually takes account of in determining its profit-maximising output level, i.e.

$C = P^K K^Y + P^L L^Y = C(Y)$

so that PMC = $\partial C/\partial Y$. We introduced the idea of MEC (marginal external cost) in considering the consumer-to-consumer case, as the amount that the sufferer would be willing to pay to reduce suffering by a small amount. In the present case there are two sufferers and MEC is the sum of the willingness to pay of each of them, as consumption of suffering is non-rival and non-excludable. We define social marginal cost as:

SMC = PMC + MEC

Figure 5.14 shows PMC increasing with *Y* in the usual way. The SMC line has a steeper slope than the PMC line, so that MEC is increasing with *Y* – as *Y* production increases, *S* output increases.

To maximise profit, the *Y* firm will produce at Y_0 , where PMC is equal to the output price P_Y. This is not the *Y* output that goes with efficiency, as in balancing costs and benefits at the margin it is ignoring the costs borne by A and B. Efficiency requires the balancing at the margin of benefits and costs which include the external costs borne by A and B. The efficient output level for *Y* is, that is, *Y** where SMC equals P_Y. In the absence of any correction of the market failure that is the external costs imposed on A and B, the marketdetermined level of Y output will be too high for efficiency, as will the corresponding level of S.

To correct this market failure the EPA can tax S at a suitable rate. In Figure 5.14, we show a line labelled PMCT, which stands for private marginal cost with the tax in place. This line shows how the Y firm's marginal costs behave given that the EPA is taxing S at the appropriate rate. As shown in Figure 5.14, the appropriate tax rate is

$t = \text{SMC}^* - \text{PMC}^* = \text{MEC}^*$ (5.16)

that is, the tax needs to be equal to marginal external cost at the efficient levels of Y and S. In Appendix 5.3 we show that another way of stating this is:

$t = P_X\,[\text{MRUS}^A_{XS} + \text{MRUS}^B_{XS}]$ (5.17)

Comparing equations 5.16 and 5.17, we are saying that

$\text{MEC}^* = P_X\,[\text{MRUS}^A_{XS} + \text{MRUS}^B_{XS}]$ (5.18)

This makes a lot of sense. Recall that MRUS stands for marginal rate of utility substitution. The XS subscripts indicate that it is the MRUS for commodity X and pollution S that is involved here. Recall also that the MRUS gives the amount of the increase in, in this case, X that would keep utility constant in the face of a small increase in S. Equation 5.18 says that MEC* is the monetary value of the extra consumption of commodity X by A and B that would be required to compensate them both for a small increase in S, from the efficient level of S. In saying this we are choosing to use the commodity X as the compensation vehicle. We could equally well have chosen the commodity Y for this purpose and derived

$t = P_Y\,[\text{MRUS}^A_{YS} + \text{MRUS}^B_{YS}]$ (5.19a)

and

$\text{MEC}^* = P_Y\,[\text{MRUS}^A_{YS} + \text{MRUS}^B_{YS}]$ (5.19b)

Taxation at the rate MEC* is required to bring about efficiency. Note that the tax rate required is not MEC at Y_0 , is not MEC in the uncorrected situation. In order to be able to impose taxation of emissions at the required rate, the EPA would need to be able to identify Y^*. Given that prior to EPA intervention what is actually happening is Y_0 , identification of Y^* and calculation of the corresponding MEC* would require that the EPA knew how MEC varied with S, i.e. knew the utility functions of A and B. It is in the nature of the case that this information is not revealed in markets. The problems of preference revelation in regard to public goods were discussed above. Clearly, those problems carry over to public bads such as pollution.

Finally here we should note that the basic nature of the result derived here for the case where just one production activity gives rise to the emissions of concern carries over to the case where the emissions arise in more than one production activity. Consider a two-person, two-commodity economy where

$U^A = U^A(X^A, Y^A, S)$ with $\partial U^A/\partial S < 0$

$U^B = U^B(X^B, Y^B, S)$ with $\partial U^B/\partial S < 0$

$X = X (K^X, L^X, S^X)$ with $\partial X/\partial S^X > 0$

$Y = Y (K^Y, L^Y, S^Y)$ with $\partial Y/\partial S^Y > 0$

$S = S^X + S^Y$

Both production activities involve emissions of *S*, and both individuals are adversely affected by the total amount of *S* emissions. In this case, efficiency requires that emissions from both sources be taxed at the same rate, *t* = MEC*.

C.4 Public goods

One of the circumstances required for it to be true that a pure market system could support an efficient allocation is that there be no public goods. Some of the services provided by the natural environment, and by public health and educational systems, for example, have the characteristics of public goods, and cannot be handled properly by a pure market system of economic organisation. So we need to explain what public goods are, the problems that they give rise to for markets, and what can be done about these problems.

Table 5.4 Characteristics of private and public goods

	Excludable	Non-excludable
Rivalrous	**Pure private good**	**Open-access resource**
	Ice cream	Ocean fishery
		(outside territorial waters)
Non-rivalrous	**Congestible resource**	**Pure public good**
	Wilderness area	Defence

C.4.1 What are public goods?

This turns out to be a question to which there is no simple short answer. Public goods have been defined in different ways by different economists. At one time it was thought that there were just private goods and public goods. Now it is recognised that pure private and pure public goods are polar cases, and that a complete classification has to include intermediate cases. It turns out that thinking about these matters helps to clarify some other relevant issues.

There are two characteristics of goods and services that are relevant to the public/private question. These are rivalry and excludability. What we call rivalry is sometimes referred to in the literature as divisibility. Table 5.4 shows the fourfold classification of goods and services that these two characteristics give rise to, and provides an example of each type. Rivalry refers to whether one agent's consumption is at the expense of another's consumption. Excludability refers to whether agents can be prevented from consuming. We use the term 'agent' here as public goods may be things that individuals consume and/or things that firms use as inputs to production. In what follows here we shall generally discuss public goods in terms of things that are of interest to individuals, and it should be kept in mind that similar considerations can arise with some inputs to production.

Pure private goods exhibit both rivalry and excludability. These are ‘ordinary’ goods and services, the example being ice cream. For a given amount of ice cream available, any increase in consumption by A must be at the expense of consumption by others, is rival. Any individual can be excluded from ice cream consumption. Ice cream comes in discrete units, for each of which a consumption entitlement can be identified and traded (or gifted). Pure public goods exhibit neither rivalry nor excludability. The example given is the services of the national defence force. Whatever level that it is provided at is the same for all citizens of the nation. There are no discrete units, entitlement to which can be traded (or gifted). One citizen’s consumption is not rival to, at the cost of, that of others, and no citizen can be excluded from consumption.

Open-access natural resources exhibit rivalry but not excludability. The example given is an ocean fishery that lies outside of the territorial waters of any nation. In that case, no fishing boat can be prevented from exploiting the fishery, since it is not subject to private property rights and there is no government that has the power to treat it as common property and regulate its exploitation. However, exploitation is definitely rivalrous. An increase in the catch by one fishing boat means that there is less for other boats to take.

Congestible resources exhibit excludability but not, up to the point at which congestion sets in, rivalry. The example given is the services to visitors provided by a wilderness area. If one person visits a wilderness area and consumes its services – recreation, wildlife experiences and solitude, for example – that does not prevent others from consuming those services as well. There is no rivalry between the consumption of different individuals, provided that the overall rate of usage is not beyond a threshold level at which congestion occurs in the sense that one individual’s visit reduces another’s enjoyment of theirs. In principle, excludability is possible if the area is either in private ownership or subject to common-property management. In practice, of course, enforcing excludability might be difficult, but, often, given limited points of access to vehicles it is not.

The question of excludability is a matter of law and convention, as well as physical characteristics. We have already noted that as the result of an international agreement that extended states’ territorial waters, some ocean fisheries that were open access have become common property. A similar process may be beginning in respect to the global atmosphere, at least in regard to emissions into it of greenhouse gases. In some countries beaches cannot be privately owned, and in some such cases while beaches actually have the legal status of common property they are generally used on a free-access basis. This can lead to congestion. In other countries private ownership is the rule, and private owners do restrict access. In some cases where the law enables excludability, either on the basis of private ownership or common property, it is infeasible to enforce it. However, the feasibility of exclusion is a function of technology. The invention of barbed wire and its use in the grazing lands of North America is a historical example. Satellite surveillance could be used to monitor unauthorised use of wilderness areas, though clearly this would be expensive, and presumably at present it is not considered that the benefit from so doing is sufficient to warrant meeting the cost.

Box 5.2 Examples of public goods

The classic textbook examples of public goods are lighthouses and national defence systems. These both possess the properties of being non-excludable and non-rival. If you or I choose not to pay for defence or lighthouse services, we cannot be excluded from the benefits of the service, once it is provided to anyone. Moreover, our consumption of the service does not diminish the amount available to others. Bridges also share the property of being non-rival (provided they are not used beyond a point at which congestion effects begin), although they are not typically non-excludable.

Finally, note that many public health measures, including inoculation and vaccination against infectious diseases, have public goods characteristics, by reducing the probability of any person (whether or not he or she is inoculated or vaccinated) contracting the disease. Similarly, educational and research expenditures are, to some extent, public goods.

In the rest of this section we shall consider pure public goods, which we will refer to simply as ‘public goods’.

C.4.2 Public goods and economic efficiency

For our economy with two persons and two private goods, we found that the top-level, product-mix, condition for allocative efficiency was

$MRUS^A = MRUS^B = MRT$ (5.14)

which is equation 5.8 written slightly differently. As shown in Appendix 5.3, for a two-person economy where *X* is a public good and *Y* is a private good, the corresponding top-level condition is:

$MRUS^A + MRUS^B = MRT$ (5.15)

We have shown that, given certain circumstances, the first of these will be satisfied in a market economy. It follows that the condition which is equation 5.15 will not be satisfied in a market economy. A pure market economy cannot supply a public good at the level required by allocative efficiency criteria.

A simple numerical example can provide the rationale for the condition that is equation 5.15. Suppose that an allocation exists such that MRT = 1, $MRUS^A = 1/5$ and $MRUS^B = 2/5$, so that $MRUS^A + MRUS^B < MRT$. The fact that the MRT is 1 means that, at the margin, the private and public commodities can be exchanged in production on a one-for-one basis – the marginal cost of an extra unit of *X* is a unit of *Y*, and vice versa. The fact that $MRUS^A$ is 1/5 means that A could suffer a loss of 1 unit of *X*, and still be as well off if she received 1/5th of a unit of *Y* by way of compensation. Similarly, the fact that $MRUS^B$ is 2/5 means that B could suffer a loss of 1 unit of *X*, and still be as well off if he received 2/5 of a unit of *Y* by way of compensation. Now, consider a reduction in the production of *X* by 1 unit. Since *X* is a public good, this means that the consumption of *X* by both A and B will fall by 1 unit. Given the MRT of 1, the resources released by this reduction in the production of *X* will produce an extra unit of *Y*. To remain as well off as initially, A requires 1/5 of a unit of *Y* and B requires 2/5 of a unit. The total compensation required for both to be as well off as they were initially is 1/5 + 2/5 = 3/5 units of *Y*, whereas there is available 1 unit of *Y*. So, at least one of them could actually be made better off than initially, with neither being worse off. This would then be a Pareto improvement. Hence, the initial situation with $MRUS^A + MRUS^B < MRT$ could not have been Pareto optimal (i.e. efficient).

Now consider an initial allocation where MRT = 1, $MRUS^A = 2/5$ and $MRUS^B = 4/5$ so that $MRUS^A + MRUS^B = MRT$. Consider an increase of 1 unit in the supply of the public good, so that the consumption of X by both A and B increases by 1 unit. Given MRT = 1, the supply of Y falls by 1 unit. Given $MRUS^A = 2/5$, A could forgo 2/5 units of Y and remain as well off as initially, given X^A increased by 1. Given $MRUS^B = 4/5$, B could forgo 4/5 units of Y and remain as well off as initially, given X^B increased by 1. So, with an increase in the supply of X of 1 unit, the supply of Y could be reduced by 2/5 + 4/5 = 6/5 without making either A or B worse off. But, in production the Y cost of an extra unit of X is just 1, which is less than 6/5. So, either A or B could actually be made better off using the 'surplus' Y. For $MRUS^A + MRUS^B > MRT$ there is the possibility of a Pareto improvement, so the initial allocation could not have been efficient.

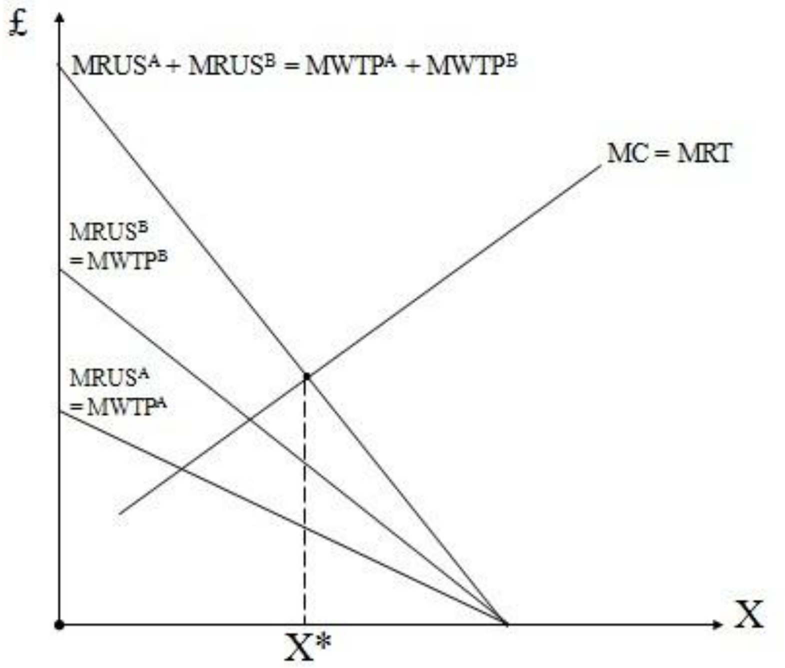
Since both $MRUS^A + MRUS^B < MRT$ and $MRUS^A + MRUS^B > MRT$ are situations where Pareto improvements are possible, it follows that $MRUS^A + MRUS^B = MRT$ characterises situations where they are not, so it is a necessary condition for allocative efficiency.

In the case of a private good, each individual can consume a different amount. Efficiency requires, however, that all individuals must, at the margin, value it equally. It also requires, see equation 5.14, that the common valuation, at the margin, on the part of individuals is equal to the cost, at the margin, of the good. In the case of a public good, each individual must, by virtue of non-rivalry, consume the same amount of the good. Efficiency does not require that they all value it equally at the margin. It does require, see equation 5.15, that the sum of their marginal valuations be equal to the cost, at the margin, of the good.

Markets cannot provide public goods in the amounts that go with allocative efficiency. In fact, markets cannot supply public goods at all. This follows from their non-excludability characteristic. A market in widgets works on the basis that widget makers exchange the rights to exclusive control over defined bundles of widgets for the rights to exclusive control over defined bundles of something else. Usually, the exchange takes the form of the exchange of widgets for money. This can only work if the widget maker can deny access to widgets to those who do not pay, as is the case with private goods. Where access to widgets is not conditional on payment, a private firm cannot function as it cannot derive revenue from widget production. Given that the direct link between payment and access is broken by non-excludability, goods and services that have that characteristic have to be supplied by some entity that can get the revenue required to cover the costs of production from some source other than the sale of such goods and services. Such an entity is government, which has the power to levy taxes so as to raise revenue. The supply of public goods is (part of) the business of government. The existence of public goods is one of the reasons why all economists see a role for government in economic activity.

Given that it is the government that must supply a public good, the question which naturally arises for an economist is: what rule should government follow so as to supply it in amounts that correspond to efficiency? In principle, the answer to this question follows from equation 5.15. In a two-person, two-commodity economy, the efficient level of supply for the public good is the level at which the sum of two MRUSs is equal to the MRT between it and the private good. Actual economies have many individuals and many private commodities. The first point here presents no difficulty, as it is clear that we simply need to extend the summation over all MRUSs, however many there are. As regards the second, it is simply a matter of noting that the MRT is the marginal cost in terms of forgone private goods consumption, so that the rule becomes: supply the public good at the level where the sum of all the MRUSs is equal to the marginal cost. Now, it follows from its definition that the MRUS is the same as marginal willingness to pay, MWTP, so this rule can be stated as: supply the public good at the level where aggregate marginal willingness to pay is equal to marginal cost. The determination of the efficient amount of a public good, for two individuals for convenience, is illustrated in Figure 5.12.

Figure 5.12 The efficient level of supply for a public good.



C.4.3 Preference revelation and the free-rider problem

While the rule for the efficient supply of a public good is simple enough at the level of principle, its practical application faces a major difficulty. In order to apply the rule, the government needs to know the preferences, in terms of marginal willingness to pay, of all relevant individuals. It is in the nature of the case that those preferences are not revealed in markets. Further, if the government tries to find out what they are in some other way, then individuals have (on the standard assumptions about their motivations and behaviour) incentives not to truthfully reveal their preferences. Given that all consume equal amounts of a public good, and that exclusion from consumption on account of non-payment is impossible, individuals will try to 'free-ride' with respect to public goods provision.

To bring out the basic ideas here in a simple way we shall consider an example where the problem is to decide whether or not to provide a discrete amount of a public good, rather than to decide how much of a public good to supply. The nature of the problem is the same in either case, but is easier to state and understand in the 'yes/no' case than in the 'how much?' case. At issue is the question of whether or not to install street lighting. We will first look at this when there is no government. There are two individuals A and B. Both have an endowment of private goods worth £1000. Installing the street lighting will cost £100. The two individuals both have preferences such that they would be willing to pay £60 for the installation of street lighting. The analysis that follows is not dependent on the two individuals being equally well off and having the same preferences, that just makes the story easier to tell initially. An obvious modification of the rule derived for the efficient level of provision of a public good derived above for the 'yes/no' situation is that the decision should be 'yes' if the sum of individuals' willingness to pay is equal to or greater than the cost. In this case it is greater: £60 + £60 = £120.

Now, suppose that A and B agree to proceed in the following way. Each will independently write down on a piece of paper either ‘Buy’ or ‘Don’t buy’. If when the two pieces of paper are brought together, both have said ‘Buy’, they buy the street lighting jointly and share the cost equally. For two ‘Don’t buy’ responses, the street lighting is not bought and installed. In the event of one ‘Buy’ and one ‘Don’t buy’, the street lighting is bought and the individual who voted ‘Buy’ pays the entire cost. The four possible outcomes are shown in the cells of Table 5.5 in terms of the monetary valuations on the part of each individual, that of A to the left of the slash, that of B to the right.

Table 5.5 The preference revelation problem

		B	
		Buy	Don’t buy
A	Buy	1010/1010	960/1060
	Don’t buy	1060/960	1000/1000

In the bottom right cell, the decision is not to go ahead. Neither incurs any cost in regard to street lighting and neither gets any benefit, so both are in their initial situations with £1000. Suppose both responded ‘Buy’. Then with the street lighting installed, as shown in the top left cell, the situation for both can be expressed in monetary terms as £1010. Each has paid £50, half of the total of £100, for something valued at £60, so gaining by £10 as compared with the no street lighting situation. Suppose A wrote ‘Buy’ and B wrote ‘Don’t buy’. The lighting goes in, A pays the whole cost and B pays nothing. A pays £100 for something she values at £60, and goes from £1000 to £960. B pays nothing for something he values at £60, and goes from £1000 to £1060. This is shown in the top right cell. The bottom left cell has the entries of that cell reversed, because B pays the whole cost.

Now, clearly both are better off if both write ‘Buy’ and the street lighting is bought. But, either will be even better off if, as in the bottom left or top right cell, they can ‘free-ride’. For each individual thinking about what to write on their piece of paper, writing ‘Don’t buy’ is the dominant strategy. Consider individual B. If A goes for ‘Buy’, B gets to £1010 for ‘Buy’ and to £1060 for ‘Don’t buy’. If A goes for ‘Don’t buy’, B gets to £960 for ‘Buy’ and to £1000 for ‘Don’t buy’. Whatever A does, B is better off going for ‘Don’t buy’. And the same is true for A, as can readily be checked. So, while installing the lighting and sharing the cost equally is a Pareto improvement, it will not come about where both individuals act independently to serve their own self-interest. What is needed is some kind of co-ordination, so as to bring about the Pareto improvement which is going ahead with the street lighting.

Given what we have already said about public goods, government would seem the obvious way to bring about the required coordination. It can, in principle, ascertain whether the installation of street lighting is justified on efficiency grounds, and if it is install it and cover the cost by taxing each individual according to their willingness to pay. However, in practice, given self-seeking individuals, the free-rider problem also attends this programme. The problem comes up in trying to get the individuals to reveal their true preferences for the public good.

Suppose now that a government does exist, and that it wants to follow efficiency criteria. It knows that installing the street lighting will cost £100, and that it should install it if total willingness to pay is equal to or greater than that. It does not know the preferences, in terms of willingness to pay, of the two individuals who, in this simple example, constitute the citizenry. The obvious thing for it to do is to ask them about it. It does that, stating that the cost of installation will be met by a tax on each individual which is proportional to their willingness to pay and such that the total tax raised is equal to the cost of installation. If each individual truly reports willingness to pay £60, the street lighting will go ahead and each will pay £50 in tax. This represents a Pareto improvement – see the top left cell in Table 5.5. The problem is that the incentives facing each individual are not such as to guarantee truthful preference revelation. Given that tax liability will be proportional to stated willingness to pay, there is an incentive to understate it so as to reduce the tax liability if the street lighting goes ahead, and to get something of a free ride. In the example of Table 5.5, if B states willingness to pay as £40 and A tells the truth, the street lighting will go ahead – stated aggregate willingness to pay £100 – and B will pay 40%, rather than 50%, of £100. If A also understates willingness to pay by £20, the government's estimate of aggregate willingness to pay will mean that it does not go ahead with the lighting. The attempt to free-ride may fail if many make it.

The problem of securing truthful preference revelation in regard to the supply of public goods has been the subject of a lot of investigation by economists. It turns out to be very difficult to come up with systems that provide the incentives for truthful revelation, and are feasible. Here we will, in order to indicate the nature of the difficulties, simply note one idea that is intended to overcome the free-riding incentives generated by the system just discussed. There the problem was that an individual's tax liability depended on stated willingness to pay. This could be avoided by the government's asking about willingness to pay on the understanding that each individual would, if the installation went ahead, pay a fixed sum. Suppose that the government divided the cost by the number of individuals, and stated that the fixed sum was £50 per individual. For both individuals, true willingness to pay is £60. Both have an incentive now to overstate their willingness to pay. Both value the street lighting at more than it is going to cost them so they want to see it installed. Both know that this is more likely the higher they say that their willingness to pay is, and that however much in excess of £60 they report they will only pay £50.

In this case overstating willingness to pay produces the right decision. The street lighting should be installed on the basis of true aggregate willingness to pay, and will be installed on the basis of reported willingness to pay. If the lighting is installed, each individual is better off, there is a Pareto improvement. Suppose, however, that A's willingness to pay is £55 and B's is £40. In that case, aggregate willingness to pay is £95, less than the cost of £100, and the street lighting should not be installed. In this case, on the understanding that each would pay a tax of £50 if the lighting is installed, A would have an incentive to overstate her willingness to pay as before, but B would have an incentive to understate his. In fact, it would make sense for B to report willingness to pay as £0 – if the lighting goes ahead he pays £50 for something worth just £40 to him, so he will want to do the most he can to stop it going ahead. Whether it does go ahead or not depends on how much A overstates her willingness to pay by. If A reports £200 or more, despite B reporting £0, the street lighting will be installed when on efficiency grounds it should not be.

Finally, this simple example can be used to show that even if the government could secure the truthful revelation of preferences, public goods supply is still a difficult problem. Suppose that A's true willingness to pay is £60 and B's is £41, and that somehow or other the government knows this without needing to ask the individuals. The government has to decide how to cover the cost. It could tax each in proportion to willingness to pay, but given that A and B are initially equally wealthy in terms of private goods, this is in practice unlikely as it would be regarded as unfair. Taxing each at equal shares of the cost would be likely to be seen as the 'fair' thing to do. In that case, A would pay £50 for a benefit worth £60, and B would pay £50 for a benefit worth £41. In monetary terms, as the result of installing the lighting, A would go from £1000 to £1010 and B would go from £1000 to £991. Since there is a loser this is not a Pareto improvement, though it is a potential Pareto improvement – we are into the domain of the Kaldor–Hicks–Scitovsky test.

By looking at equally wealthy individuals, we avoided the problem that efficiency gains are not necessarily welfare gains. Suppose that the gainer A were much richer than the loser B. Then, the question arises as to whether gains and losses should be given equal weight in coming to a decision.

For a government to make decisions about the supply and financing of public goods according to the criteria recommended by economists requires that it have lots of difficult-to-acquire information, and can involve equity questions as well as efficiency questions.

This is a 'game' with the structure often referred to as 'the prisoner's dilemma' because of the setting in which the structure is often articulated. A 'game' is a situation in which agents have to take decisions the consequences of which depend on the decisions of other agents. In the prisoner's dilemma setting, the agents are two individuals arrested for a crime and subsequently kept apart so that they cannot communicate with one another. The evidence against them is weak, and the police offer each a deal – confess to the crime and get a much lighter sentence than if you are convicted without confessing. Confession by one implicates the other. If neither confesses both go free. If both confess, both get lighter sentences. If only one confesses, the confessor gets a light sentence while the other gets a heavy sentence. The dominant strategy is confession, though both would be better off not confessing.

Other forms of market failure

We conclude our discussion of market failure as a potential rationale for intervention by considering two others forms of market failure.

The ideal conditions required for market economies to generate an efficient allocation of resources included:

- All markets are perfectly competitive.
- All utility and production functions are 'well behaved'.

In practice, of course, markets will often not be perfect: where they are not, they will be imperfectly competitive to some degree. Competition policy (or anti-trust policy as it is known in the USA) deals with this form of market failure.

An important exception to the well-behaved production function condition is that where the industry production function has the property that scale economies are present over the whole range of potential industry output. This implies that marginal costs are everywhere below average costs, and so efficiency pricing (at which price = marginal cost) is not financially viable for a private firm. This is the familiar natural monopoly situation.

These issues lie outside the scope of this course, and so are mentioned here for the sake of completeness only.

Appendices

Appendix 4.1, 4.2 and 4.3 (see textbook companion website)