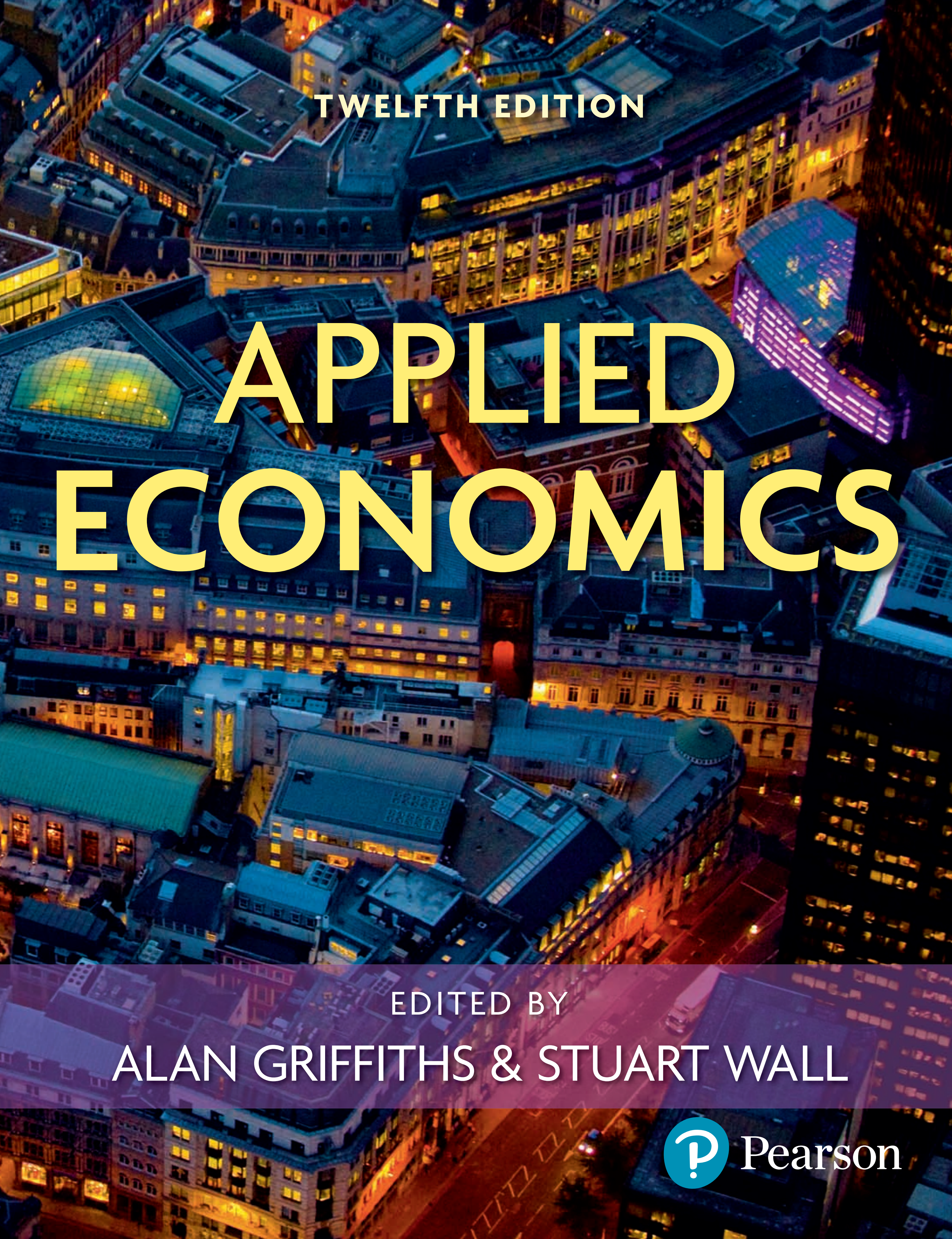

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Chapter 10

The economics of the environment

In recent years, there has been considerable interest in the impact of economic decisions on the environment. In this chapter we start by reviewing the position of the environment in models of national income determination. We then look at a number of important contemporary issues involving the environment, such as the debates on sustainable growth and global environmental change. The application of cost–benefit principles to environmental issues is also considered, together with problems of valuation. The use of market-based incentives in dealing with environmental problems, such as taxation and tradeable permits, is reviewed, as is the use of 'command and control' type regulations. We conclude by examining a number of case studies which show how environmental considerations can be brought into practical policy-making, paying particular attention to global warming and transport-related pollution.

The role of the environment

The familiar circular flow analysis represents the flow of income (and output) between domestic firms and households. Withdrawals (leakages) from the circular flow are identified as savings, imports and taxes, and injections into the circular flow as investment, exports and government expenditure. When withdrawals exactly match injections, then the circular flow is regarded as being in 'equilibrium', with no further tendency to rise or fall in value.

All this should be familiar from any introductory course in macroeconomics. This circular flow analysis is often considered to be 'open' since it incorporates external flows of income (and output) between domestic and overseas residents via exports and imports. However, many economists would still regard this system as 'closed' in one vital respect, namely that it takes no account of the constraints imposed upon the economic system by environmental factors. Such a 'traditional' circular flow model assumes that natural resources are abundant and limitless, and generally ignores any waste disposal implications for the economic system.

Figure 10.1 provides a simplified model in which linkages between the conventional economy (circular flow system) and the environment *are* now introduced. The natural environment is seen as being involved with the economy in at least three specific ways.

1. *Amenity Services* (*A*). The natural environment provides consumer services to domestic households in the form of living and recreational space, natural beauty and so on. We call these 'Amenity Services'.
2. *Natural Resources* (*R*). The natural environment is also the source of various inputs into the production process such as mineral deposits, forests, water resources, animal populations and so on. These natural resources are, in turn, the basis of both the renewable and non-renewable energy supplies used in production.

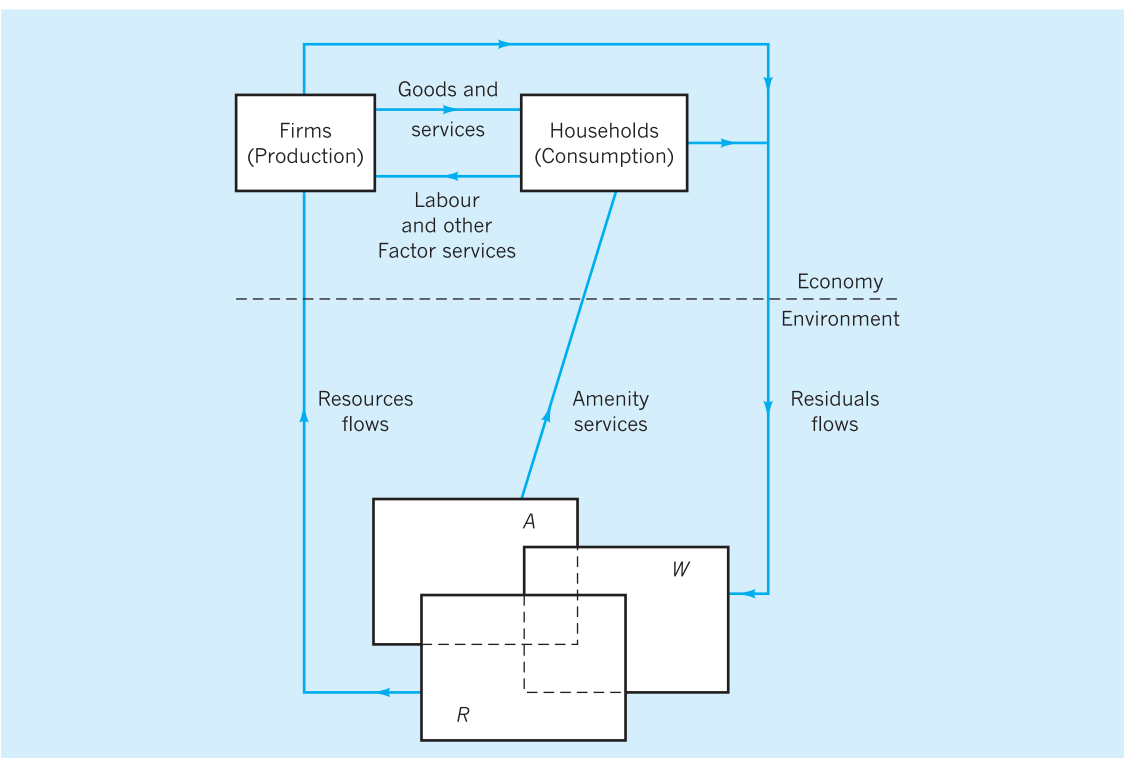

Fig. 10.1 Economy/environment linkages.

3 *Waste Products* (*W*). Both production and consumption are activities which generate waste products or residuals. For example, many productive activities generate harmful by-products which are discharged into the atmosphere or watercourses. Similarly, sewage, litter and other waste products result from many consumption activities. The key point here is that the natural environment is the ultimate dumping place or 'sink' for all these waste products or residuals.

We have now identified three *economic* functions of the environment: namely, it functions as a direct source of consumer utility (*A*), as a resource supplier (*R*) and as a waste receptor and assimilator (*W*). Moreover, these functions interact with other parts of the economic system and also with each other. This latter point is the reason for showing the three boxes *A*, *R* and *W* as overlapping each other in Fig. 10.1. For example, a waterway may provide amenity services (*A*) to anglers and sailors, as well as aesthetic beauty to onlookers. At the same time, it may also provide water resources (*R*) to firms situated alongside which can be used for power, for cleaning, as a coolant or as a direct input into production. Both consumers and producers may then discharge effluent and other waste products (*W*) into the waterway as a consequence of using this natural resource. All three functions may readily co-exist at certain levels of interaction. However, excessive levels of effluent and waste discharge could over-extend the ability of the waterway to assimilate waste, thereby destroying the amenity and resource functions of the waterway. In other words, the three economic functions of the natural environment constantly interact with each other, as well as with the economic (circular flow) system as a whole. Later in the chapter, we shall look at ways of providing economic incentives or regulations which might bring about *optimum* levels of interaction between each function and within the economic system as a whole.

By bringing the environment into our modelling of the economy, we are essentially challenging the traditional view that the environment and the economy can be treated as separate entities. Everything that happens in the economy has a potential environmental impact. For example, excessive price support for agricultural products under the Common Agricultural Policy (CAP – see Chapter 29) will encourage over-production of agricultural produce. Land which might otherwise be left in its natural state may then be brought into agricultural use, and increased yields may be sought by additional applications of fertilizers and pesticides. Hedgerows may be cut back to provide larger and more economical units of cultivation, and so on. In other words, most types of economic policy intervention will impact upon the environment directly or indirectly. Equally, policies which seek to influence the environment will themselves impact upon the economic system. As we shall see, attempts to reduce CO_2 (carbon dioxide) emissions may influence the relative attractiveness of different types of energy, causing consumers to switch between coal, gas, electricity, nuclear power and other energy forms. There will be direct effects on output, employment and prices in these substitute industries and, via the multiplier, elsewhere in the economy. We must treat the traditional economic system and the environment as being dynamically interrelated.

Sustainable economic welfare

Rather more sophisticated attempts to capture environmental costs within a national accounting framework have been made in recent years. For example, an Index of Sustainable Economic Welfare (ISEW) has been calculated for the US and UK. Essentially, any increase in the GNP figure is *adjusted* to reflect the following impacts which are often associated with rising GNP:

- monies spent correcting environmental damage (i.e. 'defensive' expenditures);
- decline in the stock of natural resources (i.e. environmental depreciation);
- pollution damage (i.e. monetary value of any environmental damage not corrected).

By failing to take these environmental impacts into account, the conventional GNP figure arguably does *not* give an accurate indication of *sustainable economic welfare*, i.e. the flow of goods and services that an economy can generate without reducing its future production capacity. Suppose we consider the expenditure method of calculating GNP. It could be argued that some of the growth in GNP is due to expenditures undertaken to mitigate (offset) the impact of environmental damage. For example, some double-glazing may be undertaken to reduce noise levels from increased traffic flow, and does not therefore reflect an increase in economic wellbeing, merely an attempt to retain the status quo. Such 'defensive expenditures' should be subtracted from the GNP figure (item 1 above). So too should be expenditures associated with a decline in the stock of natural resources. For example, the monetary value of minerals extracted from rock is included in GNP, but nothing is subtracted to reflect the loss of unique mineral deposits. 'Environmental depreciation' of this kind should arguably be subtracted from the conventional GNP figure (item 2 above). Finally, some expenditures are incurred to overcome pollution damage which has not been corrected; e.g. extra cost of bottled water when purchased because tap water is of poor quality. Additional expenditures of this kind should also be subtracted from the GNP figure, as should the monetary valuation of any environmental damage which has *not* been corrected (item 3 above).

We are then left with an *Index of Sustainable Economic Welfare* (ISEW) which subtracts rather more from GNP than the usual depreciation of physical capital.

ISEW = GNP *minus* depreciation of physical capital
minus defensive expenditures
minus depreciation of environmental capital
minus monetary value of residual pollution

The effect of such adjustments is quite startling. The UK GNP per capita (unadjusted) has grown by around 2.0% in real terms as an annual average in the UK since 1950. However, the adjustment outlined above for each year over the period gives an ISEW per head for the UK which corresponds to a mere 0.5% average annual growth in real ISEW over the period. Such 'environmental accounting' is suggesting an entirely different perspective on recorded changes in national economic welfare.

Valuing the environment

A number of approaches may be used in seeking to place a 'value' on environmental changes, whether 'favourable' (benefits) or 'unfavourable' (costs). Sometimes the market mechanism may help in terms of monetary valuations by yielding prices for products derived from environmental assets. However, these market prices may be distorted by various types of 'failure' in the market mechanism (e.g. monopolies or externalities), so that some adjustment may be needed to these prices. For example 'shadow prices' may be used, i.e. market prices which are adjusted in order to reflect the valuation to *society* of a particular activity.

On other occasions there may be no market prices to adjust, in which case we may need to use questionnaires to derive *hypothetical* valuations of 'willingness to pay' for an environmental amenity or 'willingness to accept' compensation for an environmental loss. These 'expressed preference' methods of valuation differ from 'revealed preference' methods which seek to observe how consumers *actually* behave in the marketplace for products which are substitutes or complements to the activities for which no market prices exist.

The issue of *time* is particularly important for monetary valuation of environmental impacts which may take many years to materialize. It is therefore important to pay close attention to the process of calculating the *present value* of a stream of future revenues or costs, using the technique of discounting (see Chapter 17, p. 341).

We return to these valuation techniques below, but first it will be useful to consider why valuing environmental costs and benefits is so important to policy-makers.

Finding the socially optimum output

Figure 10.2 presents a simplified model in which the marginal pollution costs (*MPC*) attributable to production are seen as rising with output beyond a certain output level, Q_A. Up to Q_A the amount of pollution generated within the economy is assumed to be assimilated by the environment with zero pollution costs. In this model we assume that pollution is a 'negative externality', in that firms which pollute are imposing costs on society that are not paid for by those firms.

At the same time the marginal *net* private benefit (*MNPB*) of each unit of output is assumed to decline as the level of economic activity rises. *MNPB* is the addition to private benefit received by firms from

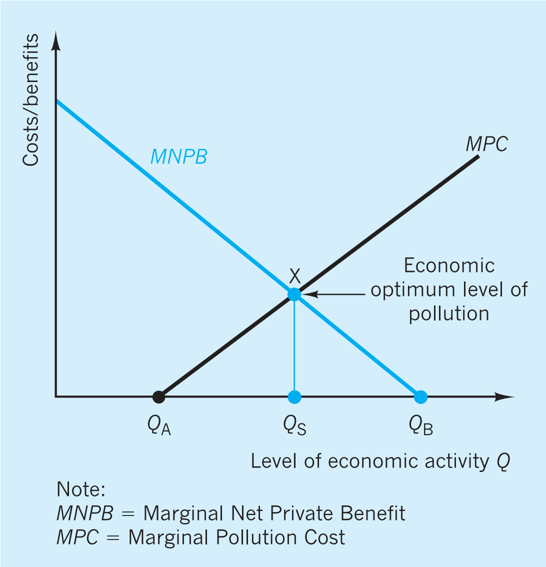

Fig. 10.2 Finding an optimum level of pollution.

selling the last unit of output minus the addition to private costs incurred by producing that last unit of output.

If the pollution externality was *not* taken into account, then firms would produce up to output Q_B at which *MNPB* = 0. Only here would total net private benefit (i.e. total profit) be a maximum. However, the *socially optimum* level of output is Q_S, where *MNPB* = *MPC*. Each unit of output *beyond* Q_S adds more in pollution costs to society than it does to net private benefit, and is therefore socially inefficient to produce. Equally it would be socially inefficient to forsake producing any units *up to* Q_S, since each of these units adds more to net private benefit than to pollution costs for society.

Note that in this analysis the social optimum does *not* imply zero pollution. Rather it suggests that the benefits to society are greatest at output Q_S, with pollution costs being positive at Q_SX. We return to this idea of seeking 'acceptable' levels of pollution below.

The valuation issue

A key element in finding any socially efficient solution to the negative environmental effects of increased production clearly involves placing a *monetary value* on the marginal private and social costs (or benefits) of production. In terms of Fig. 10.2 we need some monetary valuation which will permit us to estimate both the *MNPB* and the *MPC* curves.

Using 'shadow prices'

Where market prices exist, it is at least feasible to obtain monetary valuations of future net revenues from an environmental asset. However, where one or more market failures occur, these prices may be deemed 'inappropriate' and in need of adjustment to reflect more accurately the true benefits and costs to society. Such adjustments give rise to '*shadow prices*', i.e. prices which do not actually exist in the marketplace but which are assumed to exist for purposes of valuation.

Demand curve methods

'Expressed preference' and 'revealed preference' methods are widely used here.

Expressed preference methods

Where no market price exists, individuals are often asked, using surveys or questionnaires, to express how much they would be *willing to pay* for some specified environmental improvement, such as improved water quality or the preservation of a threatened local amenity. In other words, an 'expressed preference' approach is taken to valuation. An example of the use of this approach was used in Ukunda, Kenya, where residents were faced with a choice between three sources of water – door-to-door vendors, kiosks and wells – each requiring residents to pay different costs in money and time. Water from door-to-door vendors cost the most but required the least collection time. A study found that the villagers were willing to pay a substantial share of their incomes – about 8% – in exchange for this greater convenience and for time saved. Such valuations can be helpful in seeking to make the case for extending reliable public water supply even to poorer communities. Questionnaires and surveys of willingness to pay have been widely used in the UK to evaluate the recreational benefits of environmental amenities. They can help capture 'use value' (see p. 193) where market prices are inappropriate or do not even exist, as well as 'option' and 'existence' values.

These 'expressed preference' methods are sometimes referred to as 'contingent valuation' methods, since the user's 'willingness to pay' (WTP) is often sought for different situations 'contingent upon' some