THE COMMON PROPERTY APPROACH:
A NEW PARADIGM IN THE ECONOMICS OF THE ENVIRONMENT

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Thesis submitted in partial fulfilment of the requirements for the degree of Master of Economics, Australian National University.

July 1983
STATEMENT

Except where otherwise acknowledged, all work contained in the thesis is that of the author.

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ACKNOWLEDGEMENTS

I would like to thank my supervisor, Tony Chisholm, whose teaching stimulated the germination of the ideas in this thesis and whose comments and criticisms have helped them to reach their current state of development. I would also like to thank my colleagues in the Bureau of Agricultural Economics, both for direct inputs to this thesis, and for the provision of a stimulating and challenging intellectual environment.
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APPENDIX - THE TAXONOMY OF COMMON PROPERTY
In recent years, economists have paid increasing attention to property rights and their implications for economic behaviour. Given the market-oriented approach of neoclassical theory, it is not surprising that the term 'property' has usually been equated with 'private property'. The archetypal private property right, costlessly enforced and freely tradeable, has been set up as an ideal against which other forms of property rights may be measured.

While this approach has led to some important insights, it has had unfortunate consequences for the analysis of common property. The term has frequently been used to apply to a situation of open access, where no property rights of any kind exist. This has led to major analytical errors when economists have been confronted with actual and historical common property situations. Even when these errors have been avoided, there has been a general presumption that common property institutions are an inefficient substitute for genuine private property rights.

A particularly important area where a private property rights paradigm has been widely applied (and misapplied) has been the class of environmental problems usually referred to as 'externalities'. The object of this thesis will be to develop an analysis of these problems based on the concept of common property. It is argued that many of the analytical difficulties which have arisen with previous approaches to these problems have been the result of common property aspects of the situation, which these approaches have tended to obscure.

Chapter 1 describes the common property approach and highlights its divergences from the private property rights paradigm. Common property is considered, both as an institutional framework and as a conceptual tool of analysis. Some of the difficulties involved in the analysis of property rights structures solely in terms of private property rights are examined, with particular reference to externality problems. A topic of major interest is the conflict between the need for security in individual property rights and the need for flexibility in the overall property rights structure. It is argued that these needs may be reconciled in a common property framework. As well as being used in the
description of property rights structures, the concept of common property may be used as the basis for a formal analysis of resource usage problems, particularly those involving externalities. The central concept in this analysis is that of the value of a common property asset to a group of users, whose actions collectively determine the level of asset quality.

Chapter 2 examines, from a common property perspective, alternative approaches which have been taken to the economic analysis of environmental problems. The approaches considered are the Pigouvian externality analysis, Coase's private property rights approach, the Mohring/Boyd asset utilisation framework and the theory of clubs. The chapter provides a general critique and also contains an analysis of some important applications of these approaches. Difficulties arising with these applications are shown to result from inadequacies in the paradigms on which they are based. For example, Baumol and Oates' (1975) attempt to draw a distinction between 'depletable' and 'undepletable' externalities is examined, and their conclusions shown to be untenable. The Pigouvian analysis of the issue of compensation for victims of detrimental externalities is also criticised. It is shown that non-distorting compensation can be paid to the victims of such externalities on the basis of the reduction in value of a common property asset. The Coasian analysis is criticised mainly for its treatment of externality problems in terms of private 'activity' rights, rather than common property rights over assets. This criticism is backed by a re-examination of some cases in the law of nuisance, originally cited by Coase (1960).

Chapter 3 provides an analysis of institutions and pricing rules for 'externality' situations. First, the analytical concepts of the common property approach, developed in Chapter 1, are used to derive optimal pricing rules. Then the actual pricing rules likely to develop under common and private property institutions are considered, and compared to the optimal policies. In particular, conditions under which private ownership of assets will yield a Pareto-optimal pattern of resource use are derived and discussed.
Chapter 4 gives some applications of the common property approach. These are an analysis of the open field system of common property, which prevailed in medieval Europe, two aspects of salinity problems in agriculture, and a discussion of the economics of invention, patenting and Plant Variety Rights.

The discussion thus covers a very broad range of topics. This has had the effect that many topics are examined in less detail than they might merit in the absence of limitations on time and space. Such an approach is necessitated by the nature of the concept of common property which is advocated here, and by the wide range of analytical and methodological frameworks which have been applied to problems involving common property. Thus, whereas the theory of clubs has generally been placed in a separate compartment from the schools of Pigou and Coase, it has been necessary to consider all three approaches here. Indeed, it would be easy to add to the list with relevant bodies of literature, such as those concerned with the pricing of public goods and with Tiebout's (1956) concept of local public goods. However, a detailed analysis of these interesting, but peripheral, topics would take up too much space to be justified in the present thesis.

A similar compromise has been made in the selection of applications presented in Chapter 4. All of these applications are related to agriculture, reflecting the professional affiliations of the author. A range of examples, reflecting different facets of the common property approach, has been selected in preference to a detailed empirical analysis of a single problem. However, this range could easily have been extended to include other examples, such as multiple-use forestry land, and strata titles in real estate.

The ideas presented here have been developed over a significant period of time, and the discussion may in some places reflect what Keynes (1936, p vii) called the 'struggle of escape from habitual modes of thought and expression'. I believe that economists' 'habitual modes of thought and expression' regarding the concept of common property have been constricting and misleading, and that the struggle to escape them has been both necessary and worthwhile.
Chapter 1

THE COMMON PROPERTY APPROACH

1.1 Introduction

The phenomena usually described as externalities play a major role in a number of areas of economic analysis. The most notable of these is environmental economics, but externalities are also significant in areas such as agriculture, health, and transport economics. When the related area of public goods is taken into account, the importance of these phenomena, and of the analytical and policy problems they raise, may be seen to be very great.

It is, perhaps, not surprising then, that a number of different approaches have been used to analyse these problems. These approaches differ radically both in the tools of analysis they employ, and in the policy proposals they yield. Indeed, the differences are so great that a number of the approaches may be regarded, not merely as alternative theories, but as competing paradigms in the sense of Kuhn (1970).

The first of these analyses to emerge was that based on the concept of 'externality', put forward by Pigou (1924). The central idea was that problems of market failure arise when some of the costs of production or consumption are not borne by the relevant producer or consumer, but are imposed on some other individual.¹ The standard example, and one of the most important in practice, is that of the damage done by smoke from factories. An example of a consumption externality is given by the discomfort and health damage suffered by non-smokers sharing confined spaces with smokers.

The Pigovian analysis treats externalities as divergences between private and social marginal costs. It yields the policy recommendation that a tax which equalises the two should be imposed on the generator of

¹ More rarely, there may be positive externalities, in which other individuals benefit from the production or consumption activity which is undertaken).
the externality. In this way, the usual optimality properties for a competitive economy can be restored.

The most prominent critique of the Pigovian position is that developed by Coase (1960), who advanced an alternative analysis based on the concepts of 'property rights' and 'transactions costs'. Coase observed that rights to generate externalities were legally limited by the laws of nuisance and other torts. Thus, he argued, for any possible externality, two possible regimes could be distinguished - 'polluters rights' in which the externality may be legally generated and 'victims rights' in which the victim may prevent this (say, by injunction), or at least obtain compensation for damages. In the absence of transactions costs, it would make no difference to resource allocation which regime applied. Bargaining among the parties, perhaps involving 'side-payments' or 'bribes', would lead to an optimal allocation. However, Coase argued, if transaction costs prevented this happy outcome from occurring, it could not be stated a priori that either 'polluters rights' or 'victims rights' was a preferable regime. In particular, he rejected the Pigovian claim that polluters should always pay taxes equal to the (marginal) damages they cause. Rather, the choice between the two regimes should depend on which would promote efficiency in any particular case. After examining a number of English and American tort cases, Coase suggested that the allocation of property rights by courts was roughly in accordance with the dictates of efficiency.

A third approach to the problem arose out of the 'increasing cost' controversy between Pigou and Knight (1924). Pigou interpreted increasing cost industries in terms of negative externalities among the producers (an example was a congested road), and argued that such industries would expand more than was socially desirable. Knight refuted Pigou's argument, pointing out that his example was based on the use of a fixed asset, the road, for which there was no charge.

Mohring and Boyd (1971) sought to develop and extend the Knightian 'asset utilisation' approach to externality problems. They contrasted this approach with that of Pigou which they said was based on 'direct interaction' between individuals, a concept alien to an economic theory based on the price mechanism. More surprisingly, perhaps, they classed
the Coasian property rights analysis as a direct interaction approach. Their argument was that the rights Coase described were general rights to undertake particular actions rather than property rights over specific assets. Mohring and Boyd argued that 'externality' problems can be analysed in terms of specific assets, and that the adoption of 'competitive' pricing principles for such assets would yield an optimal allocation of resources.

Each of these approaches will be discussed in greater detail below. For the present, it is sufficient to note that none of them has proved completely satisfactory. In this thesis a new approach is introduced, based on the concept of 'common property'. It is essentially a modification of the Knightian approach, in that it is based on the interpretation of 'externality' problems in terms of asset utilisation. However it avoids the problematic notion of competitive pricing and focuses instead on the manner in which the value of the asset to its users may be maximised.

The choice of the term 'common property' is deliberate. This term has frequently been used as a synonym for open access to an asset - see, for example, in the case of fisheries, Gordon (1954) and Smith (1969). This is a misnomer. In such a situation, no property rights at all have been assigned. The standard terminology thus carries the implication that private property rights are the only possible form of property rights. In fact, however, many systems of common property have existed, and others can be imagined. In such systems, the decisions regarding access to, and use of, property which would be made by a private owner are arrived at through some group process such as consensus or majority vote. A 'common property' situation can, of course, ultimately be resolved as a complex of constrained private property rights, and in some situations this will be useful. However, such an analysis would be clumsy and unworkable in many cases, and would therefore not render a concept of 'common property' superfluous. The analysis of the corporate firm provides a simple example. It is possible, and useful, to consider such a firm as a set of contractual relationships. However, for a large part of economic analysis it must be considered as an entity in itself, with objectives determined by its owners as a group.
As well as referring to a possible institutional arrangement, the concept of common property is useful as an abstract tool of analysis. This will facilitate examination of the optimal use of an asset in which there are no property rights, or in which the existing arrangement of property rights is unsatisfactory. Sections 1.2 to 1.5 will deal with aspects of common property institutions, while Sections 1.6 and 1.7 will develop the concept of common property as a tool of analysis.

1.2 Common Property as an Institutional Framework

As has already been noted, economists have typically used the term 'common property' to denote a situation of open access. The natural corollary of such a usage is that the assignment of private property rights is a necessary precondition for any progress in the resolution of such problems as over-exploitation of fisheries, conflicts in land-use relating to forestry and environmental pollution.

Ciriacy-Wantrup and Bishop (1975, p. 714) attack this usage, arguing that it is 'at odds with the long-standing meaning of the concept, sometimes to the point of being self-contradictory'. They go on to point out that:

"The meaning of the concept 'common property' is well established in formal institutions such as the Anglo-Saxon common law, the German land law, the Roman law and their successors. It is also well-established in informal institutional arrangements based on custom, tradition, kinship and mores.

Sometimes both the institution and the resources subject to the institution are called the 'commons'. It is helpful, however, to differentiate between the concept, the institution, which in many variations makes the concept operational in reality, and the particular resource that is subject to the institution. In any event, economists are not free to use the concept 'common property resources' or 'commons' under conditions where no institutional arrangements exist. Common property is not 'everybody's property'. The concept implies that potential resource users who are not members of a group of co-equal owners are excluded. The concept 'property'
has no meaning without this feature of exclusion of all who are not either owners themselves or have some arrangement with owners to use the resource in question. For example, to describe unowned resources (res nullius) as common property (res communes), as many economists have done for years in the case of high seas fisheries, is a self-contradiction. The problems of managing fisheries in territorial waters and those on the high seas have similarities - they are fugitive resources - but they are very different in actual and potential institutional regulation).

By examining historical and contemporary examples of common property institutions, Ciriacy-Wantrup and Bishop refute the idea summed up in the phrase 'the tragedy of the commons' used by Hardin (1968) and Crowe (1969), namely that common property will necessarily be overused and ultimately degraded. They cite the example of common grazing land which was the dominant institution in the medieval European economy and which survives to a limited extent to the present day. There were strict limits on usage (op. cit. p. 719).

"The beginning and end of the grazing season were set uniformly in accordance with forage availability. Grazing was permitted only during the daylight hours. Strong controls on grazing were maintained by the simple requirement that each individual livestock owner have sufficient feed base at his command to support his stock in the non-grazing season and during the night. In cases where overgrazing was a threat even with the feed base restrictions e.g. with an increase in aggregate feed base due to the intensification of agriculture, common users were assigned quotas of animals they could graze on the commons during the grazing seasons, e.g. 1 horse, 2 cows, 10 hogs, 6 geese, a process which the English called 'stinting'."

This 'open field' system of common grazing has been examined in some detail by Dahlman (1980). Like Ciriacy-Wantrup and Bishop, he refutes the idea that common property institutions necessarily led to overgrazing, stating (p.95)
"The communal grazing rights were stinted, and the courts went to a
great deal of trouble to see that each individual did not over-use
the land for grazing purposes".

Dahlman's analysis will be discussed in more detail in Section 4.2. Its
most important feature is a demonstration that the disappearance of the
open field system was not the result of inherent inefficiency or
overgrazing, but a response to changes in technology and market structure.

It is clear that the 'open access' concept of common property used by
most economists cannot be applied to actual common property institutions.
The only alternative in the existing paradigm is to treat common property
institutions in terms of some set of underlying private property rights.
The most widespread approach has been to postulate the existence of
private rights to use the common property resource in a particular way.
Thus, in the example of the 'stinted' commons, each individual might be
supposed to have a private right to graze a certain number of animals.
However, the specification of such 'activity' rights rapidly becomes a
very complex task. For example, the severity of stinting practices
depended to some extent on climatic fluctuations. Thus, the rights must
be specified in terms of a set of possible contingencies. This may be
satisfactory when the set of possible outcomes, and preferably their
probabilities, is known in advance. However, severe difficulties arise
when it is necessary to modify practices such as 'stinting' in response
to unforeseen contingencies. Events of this kind are frequently treated
as changes in property rights. Since one of the principal requirements of
a property rights system is that rights should be stable and enforceable,
such an interpretation raises substantial problems, which are discussed
in the following section.

1.3 Changes in Property Rights

One of the most important areas of distinction between the common
property analysis and previous property rights theories is in the
treatment of changes in the structure of property rights. Property rights
theorists in the past have insisted on the importance of security in
property rights, but have also said that property rights structures must
develop and change in response to technological developments or changing
tastes.
Two types of change in property rights must be distinguished at the outset. The first is the voluntary exchange of rights between individuals within a given structure. This process of exchange has always been a major subject of economic analysis - indeed, in some formulations, it is virtually the only subject of analysis. While there are many interesting problems in this analysis, they are outside the scope of this study.

The second type of change arises from action by the state, taken in a broad sense to include courts, statutory authorities and similar bodies, which can call on the coercive powers of the state to define and enforce property rights. These actions may include changes in the structure of property rights, changes in the set of rights which are enforced within a given structure and changes in the distribution of rights between individuals. Changes of this type have been analysed by property rights theorists using the concepts of 'attenuation' and 'development' of rights. However, the tension between these two concepts has gone very largely unremarked.

The concept of attenuation is normally used in the analysis of particular property rights. Any limitation on the way in which property rights may be used constitutes attenuation. The attenuation of property rights is, in general, viewed as undesirable (see, for example, the discussion in Furubotn and Pejovich 1974, Chapter 1). At the very least, it makes the owners of the property rights concerned worse off. The most extreme form of attenuation, is of course, the abrogation of rights, and any possibility of this will significantly affect the value of existing rights.

By contrast, the idea of development is usually applied to property rights structures, rather than to individual property rights. The central idea here is outlined by Demsetz (1967, p.348), who states 'property rights develop to internalise externalities when the gains of internalisation become larger than the costs'. Thus, as technology and tastes change, the structure of property rights changes, to eliminate those externalities which become 'sufficiently' important to warrant it. A similar, but more broad-ranging hypothesis, is put forward by Posner (1972).
The tension between the concepts of 'attenuation' and 'development' is most apparent when we ask - how stable should property rights be? If we are concerned with development, it seems that the structure of rights should be flexible. As technology and tastes change, so does the most efficient structure of rights, and the existence of 'transactions costs' means that the necessary changes cannot be achieved by voluntary exchange alone. On the other hand, a concern with attenuation would suggest that rights should be as stable as possible. The absence of security in property rights reduces their value, both to their owners and to society at large.

This conflict has not received much attention in the literature on property rights. One reason is that analysts using the concept of attenuation have largely confined their attention to 'static' problems, involving the best allocation of resources for given technology and tastes. Analysis of the development of property rights, on the other hand, has focused mainly on the emergence of 'new' property rights. Typical cases include the imposition of property rights on previously open access resources, where the confusion between common property and open access frequently reasserts itself, or the consequences of new discoveries such as radio. Contradictions emerge in an acute form only when it is recognised that the creation of 'new' rights normally involves the abrogation or attenuation of old ones. For example, individual rights to clean air involve an attenuation of industrialists' rights to use their assets as they please.

The example of 'stinting' is of particular interest. Consider the case when unforeseen changes in soil fertility mean that the optimal grazing level is reduced. Under a regime of stinting, this will lead to a reduction in the number of animals each villager is permitted to graze. If the property rights over grazing land are interpreted as individual rights to graze a set number of animals, it is clear that this reduction requires a substantial attenuation of existing rights. This should make each individual owner of grazing rights worse off since, in the private property rights paradigm, attenuation of rights invariably reduces their value. On the other hand, since the new structure of rights yields a more

2 An exception is Ciriacy-Wantrup (1952).
efficient level of grazing, pasture users are collectively better off as a result of the change in stinting practices.

The resolution of this paradox - the fact that 'stinting' is applied 'across the board' rather than to particular individuals - is clear enough intuitively, but is very difficult to incorporate in a theory of private property rights. It must be supposed that the initial right - to graze a certain number of animals - includes a complex bundle of claims to rights in any future property rights structure which may emerge.

A common property analysis offers a much simpler resolution of this apparent paradox. 'Stinting' does not involve a change in the property rights of the common owners. Rather, these rights are exercised so as to achieve a desirable change in land use. Indeed, on this interpretation, the imposition of fixed individual grazing rights would represent an 'attenuation' of the rights of the common owners to manage their property.

The use of a common property framework cannot, of course completely solve the problems of stability and flexibility in property rights. For example, common property rights over grazing land would not solve problems arising from fertiliser runoff into drinking water. In this case, some adjustment of the land-use rights of the common owners might be necessary. This will normally require legislative action. It may be noted that the powers to undertake such action are derived from the theory of 'eminent domain', which states that the ultimate ownership of all land is vested in the sovereign. In a democratic society, this theory may be regarded as an expression of common property rights held by the population as a whole.

1.4 Exclusion, Alienation and Property Rights

The discussion so far has concentrated on one aspect of private and common property rights - rights of use or benefit. Two other aspects which must be considered in relation to any system of property rights are rights of exclusion, and rights of alienation.

3 It might, however, reduce the number of independent parties involved and facilitate the attainment of a negotiated solution).
A resource can only be made the subject of property rights if there exists a person or group which has, at least potentially, the power to prevent some types of use. This statement would seem to imply that pure public goods cannot be the subject of property rights. However, almost all the standard examples of public goods are in some sense local, and therefore subject to exclusion by governments. For instance, an individual can be excluded from the benefits of national defence, by the simple expedient of deportation. For this reason, and because of interest in the private provision of public goods much of the recent literature has analysed perfectly excludable public goods.

An example of a resource which is not subject to exclusion (at present) is the ozone layer of the earth's atmosphere. This layer yields benefits, varying with location and skin pigmentation, to all human beings in the form of protection from ultraviolet radiation. It has also had a conflicting use, in the view of some scientists, as a receptacle for fluorocarbons from spray-cans etc. In the absence of enforceable international agreements, no property-based solution to this problem could be found. Fortunately, the correlation between skin pigmentation and aerosol use is strongly negative, and a number of governments, including that of the U.S., were willing to act unilaterally to reduce fluorocarbon emissions.

It is more difficult to find interesting examples of goods which are inherently inalienable, and it is, tautologically, true that all goods must be capable of providing a benefit. However, the possibility of providing a right does not mean that such a right will exist in a given legal system. For example, systems which involve the entailment of land severely limit its alienability. Similarly, there may be no structure of rights regarding certain goods, or certain uses of goods. This may occur either because the legal system leaves the resource subject to open access, or because use of the resource is forbidden altogether (e.g. wild marijuana plants).

In addition to determining whether a good may be subject to property rights at all, alienability and excludability characteristics constrain the type of rights system which may be imposed. For example, rights to benefit from national defence or other national public goods cannot be
separated from rights of residence within a country. However, these constraints are not sufficient, in most cases, to determine a single system of property rights which must be applied. The same resource may be subject, at different times and places, to either common or private ownership, or some mixture of the two.

The goods with which economic analysis has traditionally dealt are typically subject to pure private property rights, that is rights of use, exclusion and alienation are all held by a single individual at any given time. Market transactions consist of exchanges of private rights between individuals. The basic programme of laissez-faire economists may be summarised as the extension of pure private rights to cover as much of economic life as possible.

A major part of this programme has been support for increasingly finer division of the different possible activities involving a particular resource which may be the subject of separate property rights. This process has been put forward as an alternative to regulation, which has the effect of attenuating more broadly defined property rights.

The polar alternative of pure common property may be defined as a situation where rights of use, alienation and exclusion are held by a group of co-equal owners, and the way in which these rights are exercised is determined by a decision rule which gives all individuals equal weight. By contrast with private property rights, a common property structure is strengthened if a single basic property right covers all actual and potential uses of a given resource.

Rights of exclusion and alienation pose major problems for advocates of a (private) 'property rights' analysis of environmental and resource-use problems. An example which illustrates these problems is that of a smoker who is in the same room as a non-smoker who suffers disutility from 'passive smoking'. The property rights analysis would suggest that the smoker was the owner of a customary right to smoke. The appropriate solution would not be the imposition of legal restrictions or Pigouvian taxes; rather bargaining could take place between the smoker and the non-smoker, and the smoker could be bribed to forgo his/her rights. The converse situation would apply if custom allocated rights to
the non-smoker. In either case, the situation may be described as one in which a particular individual has a right to use a section of the atmosphere as she/he sees fit (within some bounds). This right may be enforced against other individuals (exclusion) and may be alienated through market transactions.

Suppose, however, that the smoker 'gives up' while the non-smoker becomes addicted. The ex-smoker, who formerly appeared as the owner of a property right, now seems to have none, while the former victim has acquired a set of property rights. Yet no market transaction has taken place. Clearly, this apparently simple example must be made quite complex if it is to be analysed in terms of pure private rights.

A common property analysis which illuminates these difficulties may be described as follows. The two regimes 'smokers rights' and 'non-smokers rights' may be regarded as representing different usage rules associated with common property in the atmosphere. In one case everybody is entitled to smoke, and in the other to breathe clean air. In neither case is exclusion permitted. Finally, alienation of the relevant rights requires unanimous consent.

This example illustrates the point that changes in property rights can be analysed adequately only if both private and common property rights are considered. Problems of particular interest arise when the change in question involves the conversion of common property to private ownership.

1.5 Conversion of Common Property to Private Property

The conversion of common property to private property is an important part of the program of orthodox property rights theorists. However, because of their lack of an adequate concept of 'common property', they have been unable to give a useful analysis of the process of conversion. Indeed, this process is seen as, simply, the imposition of (private) property rights, where none existed before.

^ Note that this is not logically necessary; in former times the right to smoke was confined by custom to men, but women sometimes had a right to exclude 'gentlemen'.

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This conception is by no means new. Perhaps its most influential proponent was John Locke, whose 'Treatise on Government' (1963) was a spirited defence of the rising capitalist order, based on private property and contractual exchange of property rights. Locke's analysis began with a 'state of nature', in which all land was common property. An individual appropriated land to his own private possession by 'mixing his labour with the soil'.\(^5\) Locke's conception has remained influential, being reflected in the work of writers such as Nozick (1971), and Buchanan (1975), as well as in more practical senses, such as the U.S. opposition to 'common property' aspects of the Law of the Sea treaty.

Whatever its value as a philosophical debating-point, the Lockean concept of the acquisition of property has little to commend it in an economic sense. A 'rent-seeking' analysis would suggest that substantial resources would be expended on activities which would secure property rights. Indeed, the value of the resources expended would approach the value of the rights to be secured. It is for this reason that the concept of allocating rights by auction, or some other method which involves transfers, rather than expenditure, of resources, has been advocated by more recent property rights theorists.

A common property analysis requires examination, not only of the new private ownership rights, but also of the way in which existing common rights are alienated. The simplest case to consider is when a complete common property asset is to be sold, either to a single owner or to a new group of common owners. In this case the alienation rules discussed in Section 1.4 determine the procedure for conversion. It is of somewhat more interest to consider cases which are similar to that described by Locke, in that an individual can appropriate a part of a common property asset. In contrast to the Lockean case, however, the interests of the

\(^5\) It may be noted that this is a doctrine with more appeal for crop-growers than for hunters or nomadic herders. Indeed, the colonisation of the New World was, to a large extent, carried out on Lockean principles which permitted the appropriation of land which was 'desert' i.e. subject to common rather than private property rights. Thus, while native populations who were engaged in agriculture received some limited recognition of their rights, hunters and nomads were simply dispossessed.
common owners must be considered. Rather than an acquisition by natural right, the process must be one of mutual benefit.

There are a number of reasons why this may occur. One of the most important arises from activities which improve the value of a common asset, such as upgrading the carrying capacity of grazing land, or providing amenities for recreational use of a lake. It is, of course, possible for the owners of an asset to hire factors of production to perform these tasks. However, it may be difficult to monitor their work, or markets may be too 'thin' to permit an efficient determination of prices. In such cases, an alternative solution is to permit those carrying out the improvements to appropriate all or part of the benefits arising from their work. This may be done either directly (e.g. allowing exclusive grazing rights to those who upgrade pastures) or by assignment of the right to levy charges on asset users, that is, by a transfer of rights of exclusion.

It must be noted that, in general, efficiency requires that less than the full value of benefit be appropriated. This is because the total benefit includes not only the contribution of those making improvements, but also the pre-existing value of the common property asset. If the entire value can be appropriated, then the difficulties noted with the Lockean concept will re-emerge.

The limitation on appropriability may be obtained by such methods as levying a 'rental' charge or by restricting the duration for which private rights may be granted. These issues will be discussed in more detail in Chapter 4, in connection with the patenting of inventions and Plant Variety Rights.

1.6 Common Property as a Tool of Analysis

Sections 1.2 to 1.5 have dealt with various aspects of common property as an institutional framework. However, as indicated above, the concept of common property may also be used as a tool of analysis. The common property approach draws on both the 'externality' and 'asset utilisation' frameworks. Its analytical basis is interaction between individuals, mediated by an asset, rather than 'direct interaction'. That
is to say, the impact of one individual's actions on another does not arise directly through the utility or production function of the 'victim', as in the externality approach, but as a result of changes in the quality and quantity of services yielded by the asset. To this extent, the common property approach is similar to the Knightian asset utilisation approach. However, unlike the Knightian approach, it is not principally concerned with the determination of competitive pricing principles.

The crucial analytical concept is that of the value of an asset, to an individual and to a group. The asset may be a natural resource such as a river or an air basin, or it may be a produced good such as a road. The value of the asset depends on the interaction between the quantity and quality of the services yielded by the asset and the level of asset usage.

The concept of asset value may be clarified by considering a given asset in relation to a fixed group of users. Each individual may use the asset in a number of different ways. In the simplest case, the individual has only two possible actions - using the asset or not using it. More generally, there may be a range of different activities each of which may be pursued at different levels of intensity.

The utility derived from the asset by any individual will be determined by his/her own use of the asset, and by the quality of the services provided by the asset which, in turn, will depend on the total level of asset usage. It will also be convenient to adopt a definition, in terms of equivalent variation, which permits the asset value to be expressed as a monetary quantity. An equivalent variation measure implies a comparison with some 'base level' of asset usage and the associated level of asset quality. For example, in the simple two-option case referred to above, it would be natural to specify the base level as one where nobody used the asset. The equivalent variation may then be expressed as the sum of money which would be equivalent to the increase

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6 This distinction is not as vital as may be supposed since 'productive' activities of various kinds may enhance the usefulness of natural resources.
(or decrease) in utility associated with a shift from the base level to some different usage level, which would typically involve a change in both the asset quality and the individual's asset usage.

Thus for each level of asset quality, i.e. of total asset usage, the equivalent variation can be expressed as a function of the individual's asset usage. The maximum of this function may be described as the value of the asset to the individual for a given quality level.

This apparently straightforward definition has important consequences. The most important relate to the cost associated with a change in asset quality (and to the opportunity cost of maintaining the current usage pattern). The cost of pollution to victims is commonly, and erroneously, evaluated on the assumption that the victims' actions are unchanged. However, the present definition would suggest that the change in the value of the asset associated with a change in asset quality should be evaluated by comparing the values of the asset given that the victim makes optimal use of it for each quality level.

A useful example to consider is pollution of a beach. The appropriate measure of the damage is not the cost which would be incurred if swimmers continued to use the beach at the level prevailing before the beach was polluted. Nor can it be evaluated ex post, in terms of the marginal cost to the few hardy individuals who continue to venture out. Rather it must be measured in terms of the losses of asset value to those who used to swim and now cannot do so (or do so and enjoy it less). While this is quite a simple point, the use of the Pigovian and Coasian frameworks tends to obscure it, and this has led many users of these approaches into difficulty.

The concept of the value of an asset to an individual may be extended to that of the aggregate value of an asset to a group of individuals. The central problem of common property theory is, then, to establish a usage pattern which maximises the total value of an asset to a group of owners.

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7 This formulation is based on the assumption that each individual's usage is negligible. Strictly speaking, we should refer to total usage by all other individuals.
This optimal allocation may be viewed in terms of an extension of the Pigouvian rule that marginal private benefit should equal marginal social cost. An optimum is a point where the benefits to any individual of changing resource use would be exceeded by the associated reduction in the value of the asset to all other users.

1.7 A Formal Model

In this section, the ideas discussed in the previous section are presented in a formal mathematical model. Although the model employs standard economic tools such as the calculus of optimisation, it may appear somewhat unfamiliar in nature. This reflects the deep divergences between the standard externality approach and the common property approach. Individuals' actions affect others, neither through direct changes in utility and production functions, nor through market prices, but through changes in the quality of a common property asset.

The asset is considered in relation to a set of n individuals and a range of m possible activities. Each individual i may choose between possible vectors of activities $a_i \in \mathbb{R}^m$. The set of activity vectors available to each individual is denoted $A_i$ and is a subset of $\mathbb{R}^m$.

The total usage of the asset is denoted by $a$, where

$$(1.7.1) \quad a = \sum_i a_i$$

Asset quality $q(a)$ is a function of total usage. Since asset quality may have a number of different aspects, $q$ will be assumed to be a vector $q \in \mathbb{R}^k$.

Each individual's utility will depend on his/her use of the asset and on asset quality. Thus,

$$(1.7.2) \quad U_i = U_i (a_i, y_i, q)$$

In order to convert these utility levels to monetary equivalents it is necessary to specify a base level of usage $a_i^o$ for each individual. The base level of usage $a_i^o$ and asset quality $q_i^o$ are defined as above.
It is now possible to define an equivalent variation measure of the value of the asset to individual i under any other pattern of usage. The asset value \( v_i (a_i, y_i, q) \) is defined by

\[(1.7.3) \quad U_i (a_i, y_i + v_i, q^0) = U_i (a_i, y_i, q). \]

In 1.7.3 the quality measure \( q \) depends on the actions of individual i. It is frequently more useful to define the quality of the asset as a function of the use made of the asset by individuals other than i. This may be written as

\[(1.7.4) \quad \bar{a}_i = a_i^0 + \sum_{j \neq i} a_j \]

and \( \bar{q}_i \) may be defined as \( q(\bar{a}_i) \). The equivalent variation \( v_i \) may be written as \( v_i (a_i, y_i, q_i) \) and the maximum value of the asset to individual i is defined as

\[(1.7.5) \quad \bar{v}_i (y_i, \bar{q}_i) = \max v_i (a_i, y_i, q_i). \]

(In cases where the individual's impact on asset quality is negligible \( \bar{q}_i \) may be equated to \( q \).)

The most general social optimisation problem yielded by this model is that of maximising a social welfare function \( W(U_1, \ldots, U_n) \). A more tractable problem is that of maximising the total value of the asset

\[(1.7.6) \quad V = \sum_i v_i. \]

In order for the solutions of these problems to coincide fairly stringent conditions must apply. The most important are that the 'distributional weights' attached by the social welfare function \( W \) to each individual should be equal and that the solution to (1.7.6) should be independent of the choice of base levels \( a_1, \ldots, a_n \).

The first of these problems may be dealt with, if necessary, by replacing (1.7.6) with an appropriate weighted sum. This problem will not
be considered explicitly in most of what follows. The second condition will apply if \( v_1 \) is always 'small' in relation to \( y_1 \), so that equivalent variations between different positions are additive (and equal to compensating variation). Except where income effects play a major role in the analysis, terms in \( y_1 \) will be dropped from now on, in the interests of analytical simplicity.

The set \((a_1, a_2, \ldots, a_n)\) of activities which maximise \( V \) may be determined for the general case by an iterative procedure. Although specific cases will often admit simpler solutions, the general procedure illustrates important problems in the apparently simple concept of 'asset value'. Failure to consider these problems has led users of other approaches into serious error.

Beginning from the base position \( a^0 \), it is clearly possible to define for any individual \( i \), the activity vector \( a_i^* \) which maximises \( v \) (on the assumption that all other individuals remain at their base activity). We have

\[
(1.7.7) \ V = v_i (a_i, q^0) + \sum_{j \neq i} v_j (a_j^0, q) .
\]

If (1.7.7) is differentiable, we may write the maximising conditions as

\[
(1.7.8) \ \partial v_i / \partial a_i + \sum_{j \neq i} \partial v_j / \partial q \partial q / \partial a_i = 0 .
\]

A number of points may be made about (1.7.8). First, it is essentially equivalent to the standard externality formulation. The first term of the LHS represents marginal private benefit (or cost) while the second term represents marginal external effects. Moreover, a condition of this kind is necessary for an optimum, except for a corner solution where the condition will involve Kuhn-Tucker multipliers. This may be proved by considering the case when the (arbitrarily chosen) base activities are equal to the optimal activities for all individuals other than \( i \).

However, conditions (1.7.8) holding for all individuals 1, 2...n are not sufficient for an optimum. Global convexity in addition to these conditions would, of course be sufficient. However, as has been shown by Baumol and Oates, externalities tend automatically to generate...
non-convexities (see section 2.2). If we are to approach a solution in the presence of non-convexities, we must go further.

Since the choice of base is arbitrary, the argument above establishes the possibility of defining

\[(1.7.9) \ V^*_{i} = \max_{a_i} V(a_1, \ldots, a_i, \ldots, a_n) \]

for any set \((a_1, \ldots, a_{i-1}, a_{i+1}, \ldots, a_n)\). Thus we may define

\[(1.7.10) \ V^*_{ij} = \max_{a_i} (V^*_{i}) = \max_{a_i} (\max_{a_j} (V(a_i, \ldots, a_n))) \]

Equation (1.7.10) has a particularly interesting interpretation when there are only two individuals, a polluter (individual 1) and a pollutee (individual 2). The pollutee is defined by the fact that his actions have no effect on asset quality and hence on the utility of the polluter. Thus

\[(1.7.11) \ \max_{a_1, a_2} V(a_1, a_2) = v(a_1, q(a_1)) + \max_{a_2} v(a_2, q(a_1)) = v_1 + v_2 \]

Thus we may derive the optimising condition for the polluter as

\[(1.7.12) \ \frac{\partial v_1}{\partial a_1} + \frac{\partial v_2}{\partial q} \frac{\partial q}{\partial a_1} = 0 \]

The difference between this condition and (1.7.8) is that what is referred to is the change in the maximum value of the asset. That is, instead of evaluating the impact of the change in asset quality on the pollutee, assuming that a particular activity is undertaken at all times, the pollutee's adjustment to changed asset quality is taken into account. This point will be discussed further in section 2.2.

The step from (1.7.9) to (1.7.10) may be repeated iteratively, so as to obtain for any \(i\)
(1.7.13) \[ V^* = \max_{ai} (\max (V(a_1, a_2...a_n))) \]

Once again there is a particularly simple interpretation if individual \(i\) is unaffected by any quality changes created by the remaining individuals. If we write

(1.7.14) \[ \bar{V}_i = \sum_{j \neq i} v_i \]

then

(1.7.15) \[ \max V(a_1, a_2...a_n) = v_i(a_i, q^0) + \max \bar{V}_i(a_1, a_2...a_n) \]

Thus, the maximising problem (1.7.13) involves two separate parts; the value of the asset to individual \(i\), and the impact of his/her actions through asset quality, on the maximum value of the asset to all other users combined.

This simple separation does not apply strictly when the determination of the optimal activities for other users must take into account their effects on individual \(i\). However, in cases involving large numbers, \(V_i\) will usually be approximately equal to \(V\), and the optimal actions for the group of users excluding \(i\) will be approximately the same whether or not their effect on \(i\) is considered. Thus, we can assert that the social benefits of \(i\)'s choice of activity are equal to the private benefits plus the change in the value of the asset to other users.

The converse case arises when the actions of individual \(i\) have no effect on asset quality, and hence on the welfare of the other users. In this case, maximisation of \(V^*\) with respect to \(a_i\) is equivalent to maximising \(v_i\), and this is true regardless of the activities of the other individuals. Thus, (1.7.13) yields

(1.7.16) \[ V^* = \max (v_i(a_i, q) + \sum_{j \neq i} v_i) \]

Thus, while individual \(i\) will achieve the optimal activity level without considering anything but private costs and benefits, the other individual's choice of action must take his/her interests into account.
Chapter 2

COMMON PROPERTY AND COMPETING PARADIGMS

2.1 Introduction

In this chapter, the main existing approaches to the problems under discussion will be analysed in detail. A number of well-known difficulties with these approaches will be discussed from a common property approach, and some new problems will be raised. These problems arise because the basic paradigms used in the traditional approaches cannot be applied simply to the majority of real-world problems of interest. Erroneous conclusions arise when the problem is simplified so as to fit the solution method. Alternatively, if the problem is treated in its full complexity, it may be impossible to reach any useful conclusions.

The chapter will focus on the work of a number of major writers using the existing approaches and will seek to show where they have fallen into error, and how a common property approach might have dealt with the problem. This form of critique is not new. Coase (1960) used it in his attack on the externalities approach developed by Pigou, and Mohring and Boyd (1971) in turn criticised both Coase and Pigou stating that 'analysis of any technological externality problem is both easier and less prone to error' if their asset utilisation framework is employed. It will be shown that this framework was not enough to prevent Mohring and Boyd themselves from falling into error.

In view of the debate and critical analysis which has already gone on, on many of the problems discussed here will be fairly well known. However, a critical analysis from a common property viewpoint casts a new light on a number of these arguments.

2.2 The Externality Framework

Pigou's (1924) externality analysis was the first important attempt to provide a framework for dealing with pollution and similar problems. Despite the criticisms of Coase and others, it is still extremely
influential. Indeed, it has largely set the tone of the debate, even for those who do not accept the externality approach. In particular, the elementary case of a unilateral externality with a single 'polluter' and a single 'victim' has continued to be the focus of attention, and has been generalised to cover more complex problems such as congestion. By contrast, the locus classicus of economics in general has been the large numbers case of competitive markets, with two-person problems such as bilateral monopoly receiving only limited attention.

In other respects, however, the externality analysis is firmly in the neoclassical tradition. In particular, the concept of externality put forward by Pigou is essentially marginal, and the policy thrust of the analysis is the re-establishment of the equality between private and social marginal costs and benefits, which is the basis of the claim that competitive markets yield an optimal allocation of resources.

Unfortunately, marginal analysis is not very useful unless production and consumption sets are convex, and detrimental externalities tend in themselves to generate non-convexities. This may be seen easily in the case of a two-output one-input economy with linear technology in each industry. A detrimental externality implies that the output produced in one industry will be reduced if the other operates so that the production set is a subset of the convex hull formed by the two points of complete specialisation i.e. the production set is non-convex. This point is analysed in detail by Starrett (1972) and Baumol and Bradford (1972) and is presented in a non-technical fashion in Baumol and Oates (1975, Ch. 8).

A possibility of particular interest is that of complete specialisation in the industry which generates the externality. In this situation, the externality is, in the terminology of Buchanan and Stubblebine (1962), 'inframarginal'. That is, a marginal change in the level of the 'polluting' industry has no effect on any other firm. Moreover, it is not even clear that the externality is 'relevant' in the Buchanan-Stubblebine sense, since no existing firm is affected, although potential firms are prevented from operating. Indeed, in the case of local specialisation (discussed by Baumol and Oates), this technological externality may be mistaken for a pecuniary one. By making a particular locality unsuitable for pollution-sensitive activities, the polluting...
activity pushes up the price of land elsewhere, and this is the only way in which its effects are felt.

From a common property viewpoint, of course, the effects of the polluting activity on the usefulness of land (and/or) air are the crux of the problem. Only in special cases can these effects be measured by marginal costs actually imposed on individuals. In the case of local specialisation, there are no such effects at all, and hence no basis for the formulation of a Pigovian tax. By contrast, the effects of the polluting activity on the value of surrounding land can be measured in the market place (see e.g. Ridker and Henning 1967, or Lind 1973) and an appropriate charge imposed on the polluter.

An alternative possibility raised by this discussion is that of 'internalising the externality'. It is frequently argued that, if the polluting firm and the affected firms are merged (in this case through land purchase by the polluter), there will be no problems. This may be true if the polluter is forced to pay the pre-pollution land value, since the effect is the same as levying a charge for damage. If, however, the polluter is free to pay the market price, then the process simply amounts to allowing the victims to take their losses in a lump sum rather than as a reduced stream of income. Moreover, while efficiency is restored ex-post, the incentive effects of this solution are disastrous, since there is, if anything, a positive incentive to pollute. Those who advocate this solution are guilty of what Demsetz (1969) calls, 'if only people were different' fallacy.

The discussion thus far has centred on the limitations imposed by marginal analysis in the externalities framework. More fundamental problems arise from the fact, pointed out by Mohring and Boyd, that the externality framework is based on the analysis of direct interaction between individuals rather than on asset utilisation. Mohring and Boyd point out some of the difficulties this creates in the analysis of congestion. Another area where the 'direct interaction' perspective creates problems is that of compensation to victims.

In the externality framework, compensation is typically assessed in terms of the difference between the victim's welfare in the presence of
the externality, and that which would apply if the polluter were constrained to adopt some base level or 'zero' action, while the victim's actions were unchanged. In general, payment of compensation on this basis does not give victims any incentive to reduce the impact of pollution. Compensation is, therefore, opposed in most cases by economists working in the Pigouvian framework (the exception is in cases of 'depletable' externality which will be discussed in the following section). By contrast, the common property approach suggests that compensation should be based on the change in the value, to the victim, of the asset as a result of the polluter's move from the base level. As defined in Section 1.6, the asset value is the equivalent variation associated with the action which maximises the victim's welfare for a given level of asset quality. This value depends, in principle, only on the asset quality, and not on the course of action adopted by the victim. Thus, the change in asset value associated with pollution is independent of the victim's actions, and the payment of compensation has no efficiency effects. The equity effects of compensation will, of course, depend on the determination of the base situation.

The difficulties arising from the direct interaction approach are particularly severe when compensation is considered in a situation of congestion. Consider, for example, a congested road used by n identical motorists. Each motorist generates and incurs the same amount of damage from congestion. Thus, a proposal to levy a Pigouvian tax and pay compensation would have no effect whatsoever. Moreover, the imposition of a tax without compensation would generally make all road users (though not the recipients of the tax money) worse off. The point is, of course, that each motorist must drive in order to obtain their share of the compensation. The common property solution would be to pay compensation depending only on the total level of congestion, while charging taxes which depended on the individual's road usage.

The discussion in this section has raised some general difficulties with the externality approach. In the following section a specific

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8 Of course, if the victim chooses a sub-optimal course of action, measurement difficulties may arise in practice.

9 Or, more precisely, compensation based on the congestion attributable to all other drivers.
application of the approach - Baumol and Oates' (1975) analysis of
deplicable and undepletable externalities - will be critically examined.
The problems encountered in this analysis may be traced, in large
measure, to the fundamental defects in the externality framework which
have been described above.

2.3 Depletable Externalities and Common Property

The claim that the various problems usually described as
'externalities' can be dealt with by an appropriate allocation of private
property rights is almost as old as the concept of externality itself. It
has been upheld in various forms by Knight (1924), Coase (1960) and
Mohring and Boyd (1971).

Baumol and Oates (1975) make a more limited version of this claim by
distinguishing between depletable (or private) and undepletable (public)
externalities. They define (p. 19) an undepletable externality as one for
which 'an increase in the consumption of the good by one individual does
not reduce its availability to others'. They go on to argue that, in
general, it will be inappropriate to make any charge on, or payment to,
consumers of an undepletable externality, and hence that the definition
of private property rights will not be sufficient to achieve an optimal
allocation of resources.

By contrast, they claim, we may regard 'depletable externalities not
as externalities at all but as cases where institutional impediments make
it impossible to impose the appropriate price'. However, the implicit
definition of depletable externalities quoted above (and hence the scope
of the claim made about them) is somewhat ambiguous. It could be
interpreted as applying to any externality which is not undepletable.
Alternatively, it could be taken to apply only to those externalities for
which consumption of a given amount by one individual leads to an equal
reduction in the amount consumed by others. This second interpretation
would leave a range of intermediate cases corresponding to congestion.

Unfortunately, Baumol and Oates give support for both
interpretations. They first (p.22) consider fisheries as an example of a
deplicable positive externality. In particular, they examine a lake, to
which all fishermen have free access and where 'the haul of one fisherman
reduces the expected size of the catch of others, a clear case of a depletable externality'. They go on to argue that an optimal allocation of resources could be achieved under private ownership of the lake either through a profit-maximising access charge, or by the operations of a firm which hired fishermen.

This example corresponds to the first definition of depletable externality, since the total catch is not fixed, but increases with the number of fishermen. On the other hand, their formal analysis of depletable externalities (pp. 45-48) employs the second definition. Intermediate cases involving congestion are analysed as consisting of a combination of depletable and undepletable externalities. It is argued that these 'mixed' externalities cannot, in general, be dealt with adequately by private ownership. Thus, the results for private ownership are claimed to apply only on the second definition. Hereafter, we shall refer to externalities satisfying this strict definition as 'fully depletable'.

In order to see how Baumol and Oates' analyses yield apparently contradictory results, it useful to consider in greater detail the examples they give. Some further examples will then be given to illustrate a wider range of possibilities.

The fisheries example is presented in graphical form, but an algebraic approach will be used here. The fishermen are assumed to be identical and to receive an average catch of \( f(N) \), where \( N \) is the total number of fishermen and \( f'(N) < 0 \). If \( f(N) \) is expressed in monetary terms, \( N \) will increase until the average return is \( W \), the wage available in alternative employment. However, because of the reduction in the catch of others, the social marginal product of a new fisherman at this point is less than \( W \), and it may even be negative.

In considering the role of private ownership, we may note that an access charge \( P \) must satisfy the condition

\[
(2.3.1) \quad P = f(N) - W
\]

(10) For simplicity, Baumol and Oates' own notation will be followed.
Hence, the problem of maximising profits from an access charge is the same as that of maximising $N(f(N) - W)$, the total social surplus arising from the lake. This is also the profit which would be earned by a firm which hired fishermen. The marginal condition is

\[(2.3.2) \quad f(N) + NF'(N) = W \]
'customary' solution in which visitors were admitted without charge, would be optimal (although it is not clear that this is also a competitive equilibrium).

The second crucial feature of the fishing problem arises from the assumption that all fishermen receive the same average catch (given the total number of fishermen). This in turn implies that the effect of any additional fishermen is the same for all existing fishermen. Similarly the effect of removing any one fisherman is the same for all those remaining (and is independent of which fisherman is removed). Note that these 'symmetry' conditions also apply for an undepletable externality, since the external effect on any marginal consumer is zero by definition. The effect of removing this assumption may be illustrated by a modification of the fisheries example.

Suppose that, instead of commercial fishermen, the lake is used by sports fishermen who vary in ability and tastes. As in the previous example, the presence of other fishermen reduces the welfare of others, either by direct crowding effects or by reducing the expected catch per user.

The value to fisherman $i$ of a day on the lake is given by

$$v^i = v^0_i q(n)$$

where $v^i$ is the value in the absence of any crowding, and asset quality $q(n)$ is a monotonically decreasing function of the number of users. If the fishermen are ordered so that $i > j$ if and only if $v(i) < v(j)$, and there are sufficiently many fishermen that $n$ may be treated as continuous, we may write the problem of maximising the value of the lake as

$$\max_n W(n) q(n),$$

where

$$W(n) = \int_0^n v^i \, di.$$
The first order condition is

\[(2.3.6) \quad q'(n) W(n) + q(n) W'(n) = q'(n) W(n) + q(n) v(n) = 0.\]

By contrast a profit-maximising firm would earn a revenue equal to \(nv(n)\) if the admission fee was set so as to yield \(n\) users. Thus the condition for profit maximisation is

\[(2.3.7) \quad v^o n q(n) + nq(n) \frac{\partial v^o}{\partial n} + q'(n) v^o = 0.\]

Condition (2.3.7) differs from (2.3.6) in two ways. First, the lake owner acts as a monopolist and sets prices to take account of the downward sloping demand curve which arises from differences in tastes. This accounts for the term \(nq(n) \frac{\partial v^o}{\partial n}\). Second, the firm takes account of crowding effects but only insofar as they affect the price which can be charged and hence the revenue received. This accounts for the term \(nq(n) \frac{\partial v^o}{\partial n}\) which is smaller in absolute magnitude than the corresponding term \(q'(n) W(n)\) in (2.3.6).

The first of these differences tends to contract output and the second to expand it, relative to the 'socially optimal' level. The influence of monopoly behaviour may be removed by setting up an 'almost competitive' model as follows. Suppose that fishing lakes are supplied by a range of competing firms. Marginal users are indifferent between lakes, assuming the crowding effects are the same, while some 'inframarginal' users prefer particular lakes e.g. because of convenient locations. Then, if the price for a lake \(j\) with \(q_j(n_j) = 1\) is denoted \(p^*\), the value of a day on lake \(i\) is given by \(p^* q_i(n_i)\). Condition (2.3.7) is now replaced by

\[(2.3.8) \quad p^* q_i(n_i) + np^* q_i'(n_i) = 0.\]

(Note that there will be a second local optimum satisfying (2.3.7) in which only 'inframarginal' individuals use the lake. If the optimal number of marginal users given by (2.3.8) is small, this will be the global optimum.)
In the 'almost competitive' case, the number of users is unambiguously greater than is required for efficiency. The opposite result could only arise if inframarginal users are less sensitive to crowding than marginal users, and this somewhat implausible case is precluded by the functional form used in our example.

The examples given above have covered a wide range of externalities which are not fully depletable. They show that the contradictions in the results derived by Baumol and Oates arise from different assumptions about the nature of the asset from which the externalities arise. There is, however, a third assumption, which is common to both of the examples given by Baumol and Oates, and is crucial to their argument that private ownership of the asset in question will resolve the problems associated with a fully depletable externality. This is the assumption that consumption of the externality is independent of any other activity undertaken by the individual in question. This means that, in the case of a fully depletable externality, each individual can adopt whatever consumption bundle he chooses, subject only to the overall budget constraint that the externality is completely consumed. In this case, it is quite clear that, if pricing is possible, the 'depletable externality' is no different from a private good.

However, it is quite possible to construct examples where this is not the case. Consider, for example, the case of a road used by both cars and trucks. The trucks occasionally spill their loads, thereby blocking the road, which must be cleared by the next driver to pass. For simplicity, we may consider only the cases when this driver is in a car. The externality generated by the trucks is clearly fully depletable; however, individuals' consumption levels are determined by the number of road trips they consume. The problems raised are now as severe as for the cases discussed above. Suppose, for example, that the provision of trips to motorists is costless. Then the optimal price for consumption efficiency is zero but, in this case, a firm owning the road would have no incentive to curb the activities of trucks in any way. Alternatively, we may suppose that the price of an uninterrupted trip is 'competitively'

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11 Strictly speaking, this constraint may be slack for a positive externality which is subject to satiation.
determined at \( P^* \), and that the cost of an interruption is higher for inframarginal than for marginal users. For a given number of trucks, the probability of a given driver encountering a blockage declines as the number of drivers increases. Thus, the price charged to car drivers will be determined by a condition analogous to (2.3.8), with the number of drivers being less than the socially optimal level.

If trucks (which are assumed to be unaffected by road blockages) are also charged a competitively determined price, then the number of trucks will be restricted to take account of their adverse effect on revenue from cars. However, no account will be taken of their effects on the consumer surplus received by inframarginal users. Thus, there will in general be too many trucks using the road under private ownership, and this will adversely affect the welfare of car users.

2.4 Private and Common Property Rights

The most important alternative to the externality framework has been the 'property rights' analysis stemming from the work of Coase (1960). Coase made a number of criticisms of the externality approach, including some related to the points discussed in previous sections. His fundamental critique, however, was based on what has come to be known as 'Coase's theorem'.

The Coase theorem states that externalities do not create any necessity for intervention on efficiency grounds provided that 'the market system worked smoothly'. Coase argued that a bilateral externality situation could be represented by an allocation of property rights. If rights are allocated to 'polluters' then they are free to do as they wish without hindrance. If they are allocated to 'victims' then they are free to put a stop to polluting activities.

The Coase theorem claims that provided there are no transactions costs, bargaining between the parties (including, if necessary, the payment of bribes), would lead to an efficient use of resources independent of the initial allocation of property rights. As Mishan (1971) points out, this claim is not strictly correct when income effects are taken into account; an initial allocation of rights to 'victims' is
likely to increase the demand for clean air. Nonetheless, Coase's insight has had a major impact on the way economists think about these problems.

While the Coase theorem has had a major theoretical impact, the most important aspect of Coase's work was his analysis of the situation where 'transactions costs' prevented bargaining between the parties from reaching an optimal solution. In this case, the final allocation of productive resources will be substantially affected by the initial allocation of property rights.

The traditional Pigovian framework suggested the view that an optimal allocation could be reached either by the imposition of a tax, or by the assignment of property rights to victims through a liability rule. Coase concerned himself mainly with the latter possibility, and did not consider the case of taxes without compensation to victims. He argued that a liability rule gave victims no incentive to undertake measures which reduced the damage they incurred. Thus, there were some adverse effects whether property rights were assigned to polluters or to victims.

As was pointed out in Section 2.2, claims of this kind are valid only if compensation to victims is determined within an externality-style direct interaction framework. Compensation based on the change in value of a common-property asset is effectively 'lump-sum', in that it does not affect the incentives to victims to adopt cost-minimising measures.

Coase argued that the allocation of property rights must be made so as to achieve the most productive use of resources, and that the common law decisions of the courts had, in fact, followed this criterion to a significant extent. Thus, he claimed, the existence of externalities did not, in general, provide a ground for legislative intervention in the economy.

The mechanism of 'zoning by court order' will be considered in more depth in the following section. The remainder of this section will be devoted to an analysis of the Coasian theoretical framework. A number of problems with this framework have been briefly referred to above.
The most important problem is that Coasian property rights normally refer to activities rather than assets. As Mohring and Boyd put it, they are 'typically characterised in terms of A's right to do something to, or to collect damages from, B'. Because Coase examines a series of once-off, two-person cases, he never considers the existence of more than one property right. In every case either A has a right and B none, or vice versa. In practice, however, rights to undertake a given activity will rarely be the property of a single individual. In most cases large numbers of people, possibly the entire population, will possess the relevant rights, and negotiation of unanimous consent for change in the set of permitted activities would be impractical.

This last point largely explains the general absence of 'Coasian' bargaining over property rights even in what appear to be small-numbers' or 'two-party' cases. Consider the example of a smoker and a person allergic to smoke, in a room containing a large number of people who are indifferent with respect to smoking. In order to effect a change of regime, say from 'smokers rights' to 'non-smokers rights' it is necessary to bribe, not only the smoker, but all the people in the room to give up their customary rights. Otherwise, any of these people would be free to begin smoking for the strategic purpose of extracting a bribe. Moreover, not only people actually present but also potential entrants, must give their consent. Thus, even when only two people are directly involved, an attempt to effect a change in common property rights through Coasian bargaining may involve all of the strategic problems of the large numbers case.

These difficulties are generally ascribed by the Coasian school to 'transactions costs' which prevent the parties from reaching an agreement. The concept of transaction costs is a deceptive one. Transaction costs are often treated as if they were technological givens like transport costs - see Stigler (1967) - when in fact they are almost entirely dependent on institutional arrangements (like the structure of property rights). This treatment leads naturally to the idea that transactions costs will be lowest when only two parties are directly involved, just as transport costs are lowest over short distances. Unfortunately, this analogy is highly misleading. In almost all cases of two-party bargaining, a large number of other parties are potentially
involved. For example, bribing one firm not to pollute the atmosphere will almost certainly attract the attention of others (or spur the creation of new ones). Conversely, an out-of-court settlement with one victim of pollution will almost certainly generate a rash of litigation.

Thus, transactions costs are essentially strategic rather than technological. They will typically increase with the size of the unappropriated rent involved and decrease with the cost of preventing the finalisation of an agreement. For example, if a readily available commodity of standard quality is to be auctioned, the available surplus is very small and transactions costs are low. The number of people participating in the auction is generally irrelevant.¹²

The case of Coasian bargaining provides a complete contrast. The surplus involved is frequently quite large, and a two-party agreement can typically be upset by a simple declaration that a third party intends to exercise the right to undertake some activity. Thus, the conclusion of an agreement is rarely possible, and the only relevant aspect of the Coasian analysis is the suggestion that property rights should be allocated so as to ensure the most valuable use of resources.

Like subsequent users of the property rights paradigm, Coase ignores the problem of stability in rights, which was discussed in Section 1.3. Security is crucial to a system of property rights. By contrast, the most important feature of a market economy is the fact that, as technology, tastes and population change, often in an unpredictable fashion, so does the optimal allocation of resources. A once-off allocation of 'activity' rights, even with the use of contingent rights to cover identifiable possibilities of change in the future, cannot solve the dynamic problem of resource use unless rights can be traded easily, that is, unless transactions costs are low.

Consider, for example, the establishment of a pollution-generating factory in an area where there is a good deal of free (or low-cost) land.

¹² Indeed, transactions costs will typically be significant only if the market is 'thin' i.e. very few people are involved.
If the benefits generated by the factory exceed the costs imposed on users of nearby land, then the property rights theory would recommend an allocation of 'polluters rights' to the factory owners (and hence to potential polluters as well). Suppose, however, that the population and the value of land increases. It may now be more economically efficient to restrict pollution. But in an 'activity rights' regime this can only be done by buying out all holders of rights to pollute, a task which will normally be impossible. Demsetz's comment on socialism seems appropriate here. The Coasian system 'resolves static problems of allocations rather neatly. But this is only because all the dynamic problems of production are ignored' (1969, p. 12).

This implication might be avoided, if it were supposed that only actual polluters held a right to pollute. In this case Coasian bargaining might be possible, since at least one group would be fixed in size. Unfortunately, this would create a positive incentive to pollute, since polluters would be rewarded by an allocation of property rights.

Coase's own analysis did not make clear which of these regimes he advocated, and this ambiguity is fundamental to the dispute between Mohring and Boyd (1971) and Gould (1975). Mohring and Boyd took the second interpretation and pointed out the inefficiency involved. Gould, who sought to refute their argument, used the first interpretation and upheld the theoretical validity of the Coase theorem in the absence of transactions costs. However, he did not consider the more relevant case when transactions costs are present.

2.5 Property Rights and the Law of Nuisance

Coase supported his analysis of bilateral externalities with a detailed discussion of a number of cases concerning the common law tort of (private) nuisance. At first sight, this area of the law would seem admirably suited to a (private) property rights analysis since it arises out of the duties owed by neighbouring owners or occupiers of land. 'Nuisances are interferences by owners or occupiers of property with the
use or enjoyment of neighbouring property' (Talbot, J. quoted in Heuston 1977). 13 14

In Coase's view, the law of nuisance determines what rights to undertake particular activities, or to prevent one's neighbour from undertaking such activities, arise out of private property rights in land. As we have seen, Coase's analysis suggests that

(a) in the absence of 'transactions costs', it does not matter how these rights are allocated;

(b) if transactions costs are high rights should be allocated so that land will achieve its most productive use.

Coase illustrates the first point by reference to the case of Sturges v Bridgman (1879). The parties were a confectioner who used machinery in connection with his business and a doctor occupying neighbouring premises. When the doctor built a consulting room adjoining the confectioner's kitchen, the noise and vibration from the machines made his work difficult. He therefore sought, and obtained, an injunction to prevent the confectioner from using his machinery. Coase (p.7) states

'The court's decision established that the doctor had the right to prevent the confectioner from using his machinery. But, of course, it would have been possible to modify the arrangements envisaged in the legal ruling by means of a bargain between the parties. The doctor would have been willing to waive his right and allow the machinery to continue in operation if the confectioner would have paid him a sum of money which was greater than the loss of income

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13 As I am mainly concerned with the economic implications of the law, rather than with specific questions of jurisprudence, I have worked mainly from secondary sources such as Salmond on Torts (R. Heuston ed.). These, rather than the law reports, will be given as citations.

14 The restriction of rights of action under nuisance to the legal holder of property rights is very strict. Thus in Malone v Lasky, (1907, described in Heuston 1977) the vibrations of an engine in an adjoining building led to an injury to the wife of the occupier of some premises, but it was held that, having no property right, she could not recover damages, at least for nuisance.
which he would suffer from having to move to a more costly or less convenient location or from having to curtail his activities at this location.'

In this, and a number of other examples, Coase lays great stress on the symmetry of the situation. He suggests that, had the court awarded the confectioner the right to operate the machine, the doctor could pay him not to. Thus, he argues, in the absence of transactions costs, the ultimate equilibrium will be independent of the initial allocation of rights.

However, this symmetry is largely illusory. If the confectioner pays the doctor to waive the rights of exclusion awarded by the court, he does not thereby acquire a right to operate machinery. This still constitutes a nuisance, and a subsequent owner, or any other neighbour who was inconvenienced by it, would have the right to seek an injunction against the confectioner. Even as between the original parties, such an agreement, technically termed a licence, has only a limited degree of force in law. For example, it is revocable at the will of licensor, in this case the doctor (Heuston, op. cit., p.74). Heuston (ibid, p.78) states that this is because 'it is against the policy of the law to create new proprietary interests'. The point is that the licensee is not paying for individual 'activity rights', but for rights in respect of a specific parcel of neighbouring land. A Coasian bargaining solution of even quite simple nuisance problems could involve an immensely complicated set of property rights in land.

The difficulties arising from a 'direct interaction' analysis of the kind put forward by Coase, may be remedied by considering the problem in terms of both private and common property. By virtue of acquiring private property rights in neighbouring blocks of land, individuals acquire rights in various common property assets. A very simple example is the boundary fence between suburban houses. This is, in effect, the common property of two neighbours, and each is under an obligation to contribute to the cost of reasonable repairs made by the other. In this case, since no other parties are even potentially involved, Coasian bargaining between the parties is quite possible, and appears to take place in practice. For example, individuals with a low demand for privacy and a
high demand for leisure can agree to leave a fence in a state of disrepair.

Other common property assets involve a larger group of owners and more complex obligations. The most important for cases of nuisance is the atmosphere, which carries such things as smoke, smells and noise. The number of co-owners here is not confined to immediately adjacent occupiers. Thus, Coasian bargaining is not likely to be practical in this case.

Because of his direct interaction framework, Coase does not observe this. Indeed, in one of the cases he quotes, the judge draws the relevant distinction, but Coase ignores it. In the case of Bass v. Gregory (1890), a public house had for some years brewed beer in a cellar, which was ventilated through a shaft which opened into a well in a neighbouring property. The owner of the property blocked the well, and the brewers sought an injunction to have it unstopped. In a previous case, that of Bryant v. Lefever, it had been held that there was no general right to vent smoke etc. onto neighbouring properties. Thus, (op. cit. p.11)

'The court had first to determine whether the owners of the public house could have a legal right to a current of air. If they were to have such a right, this case would have to be distinguished from Bryant v. Lefever. This, however, presented no difficulty. In this case, the current of air was confined to 'a strictly defined channel'. In the case of Bryant v. Lefever, what was involved was 'the general current of air common to all mankind'. The judge, therefore, held that the owners of the public house could have the right to a current of air, whereas the owner of the private house in Bryant v. Lefever could not.'

Coase comments 'an economist might be tempted to add 'but the air moved all the same'. He further adds that, in deciding the economically desirable allocation of rights such questions are 'about as relevant as

15 It is, however, finite, both because of physical limits on the propogation of, say, noise, and because very widespread nuisance, would be dealt with under the criminal law of public nuisance.
the colour of the judge's eyes'. Because of his 'activity rights' framework, Coase fails to see that rights over a particular current of air confined to two neighbouring properties are entirely different to rights over 'the general current of air common to all mankind', in both their economic and legal implications.

In the case of the individual air current, Coasian bargaining between the two affected parties will ensure an optimal allocation of resources. In the case of the atmosphere which is common to all, no such bargaining is possible, and the decisions of judges and legislators represent a final determination of use. Thus, like many other users of the concept of 'transaction costs', Coase fails to analyse the factors which make these costs small or prohibitively large. This would not matter, if, as he asserts, judges tend to make decisions which allocate land to its most productive use.

In order to support this claim, Coase refers to a number of cases which establish the doctrine of a 'local standard of comfort' i.e. that the level of personal discomfort which constitutes a nuisance depends on the general amenity of the neighbourhood. Since the lower the general level of amenity, the higher would be the cost of imposing a given standard, this form of 'court-ordered zoning' tends to favour the more economically productive uses of land.

However, Coase fails to observe that this principle is strictly limited to questions of personal discomfort. In cases where there is actual financial loss arising from a nuisance, no such considerations apply. Indeed, Heuston (op. cit. p.60) explicitly rejects Coase's main argument saying 'no consideration of public utility can be suffered to deprive an individual of his legal rights without compensation'.

The main problem with Coase's claim is that discussed in Section 1.3. A policy of allocating property rights so as to favour the form of land use which is currently most productive is inconsistent with the requirement for stability in the property rights structure. The problems of an excessively rigid structure of rights, implied by the rejection of any test of public utility, are met in two ways - the possibility of
41.

substituting damages for injunctions, and the power of the legislature to alter the allocation of rights.

As well as rejecting the defence of public utility for a nuisance, the case of Shelter v. The City of London Electric Lighting Co. (1895) laid down the principle that damages could be paid, in lieu of an injunction, where the plaintiff's loss was small and could be compensated by a money payment while an injunction would be 'oppressive' to the defendant. As noted above, Coase's analysis of the question of compensation was defective, and for this reason he paid little attention to the distinction between damages and injunctive remedies.

Coase recognises the possibility of government intervention to change the structure of rights, and, indeed, points out that this may have legalised many acts which would otherwise constitute a nuisance and have been widely regarded as examples of market failure, e.g. airports and the associated noise. As he points out, such intervention may improve the allocation of resources.

Indeed, where the numbers (potentially) involved are so large as to prevent a negotiated solution, and the costs and benefits of a proposed alterations in rights are both large, the decision (or lack of it) is inevitably one for government. This should not, however, prevent the payment of compensation to those whose rights are disturbed. As noted above, such compensation will assist both in the attainment of (static) efficiency in resource use, and in the maintenance of a stable system of rights.

In summary, the legal cases cited by Coase are not consistent with a pure 'activity rights' framework and are better interpreted as regulating the use of various forms of common property arising from the ownership of neighbouring blocks of land. Only in cases where the number of common owners (as distinct from the parties actually involved in a particular dispute) is small, will Coasian bargaining yield an optimal allocation regardless of the legal allocation of rights. Since the function of the courts is to uphold the stability of rights, substantial changes in the use of common property can only be brought about by legislative action. Such action may either lay down changes in the rights to use common
property, or it may allow a group of common owners to make such changes, replacing the common law unanimity rule with some form of majority vote.

2.6 The Knightian Approach

The debate over the economics of the environment has been dominated by the Pigovian and Coasian schools. Alternative views have been expressed, however, and one of the most important will be considered here. Mohring and Boyd (1971, hereafter MB) criticised both Coase and Pigou. They described the previous approaches as 'direct interaction' frameworks in contrast to the 'asset utilisation' framework they advocated. The present work owes a significant debt to MB, since the common property approach is also based on analysis of asset utilisation. The main point of divergence is that the MB analysis is based on (competitive) profit maximisation by a private owner, rather than on maximising the welfare of a group of users. This approach leads them into a number of errors and contradictions.

The main analysis put forward by MB focuses on two examples of pollution problems, a lake and a river. In the following discussion their analysis will be simplified to eliminate some non-essential features. In the first problem, they consider a lake which is used by a number of firms as both a repository for wastes (denoted $Z_i$) and as an input in the production process, with a value depending on water quality $Q_i$.\(^\text{16}\) In combination with variable inputs $X_i$ purchased in competitive markets at a wage $W_i$, this yields outputs $Y_i$ which are sold (in competitive markets) at a price $P_i$. As in the analysis of section 1.5, each firm's impact on water quality is assumed to be small, so that, in particular, $Q_i$ is treated as an exogenous parameter by firm $i$.

MB then suggest that 'a reasonable social goal would be to maximise the difference between the value of output, $\sum P_i Y_i$ and the cost of $X$ inputs, $\sum W_i X_i$, for the $n$ firms'. From a common property viewpoint this suggestion is unexceptionable, except for the possibility of

\(^{16}\) MB allow the quality to be different for each user, since this is necessary in their next problem. This possibility may be incorporated in the analysis of section 1.5 by allowing $Q$ to be an $n$-dimensional vector.
potential users who are deterred completely by the present level of pollution. However, MB do not stop to consider whether this social goal is equivalent to profit maximisation by a competitive owner. As has been observed, this is a very thorny question.

The following marginal conditions are derived for $i=1,2,...,n$:

\[
(2.6.1) \quad P_i \frac{\partial Y_i}{\partial X_i} - w_i = 0
\]

and

\[
(2.6.2) \quad P_i \frac{\partial Y_i}{\partial Z_i} + \sum_j P_j \frac{\partial Y_j}{\partial Q_j} \frac{\partial Q_j}{\partial Z_i} = 0.
\]

MB go on to recommend a charge equal to the second term in (2.6.2) per unit of waste disposed of by firm $i$. This is essentially what would be obtained from a Pigovian analysis.

The second example concerns a river, and is distinguished by the fact that the water quality available to firm $i$ depends only on the emissions of firms located upstream. For simplicity the firms may be ordered, so that firm 1 is furthest upstream, and firm $n$ is at the mouth of the river where its waste is of no concern. Then, as MB point out, (2.6.2) may be specialised so that the summation in the second term is taken over $j > i$. In particular, they point out that no charge should be levied on firm $n$.

So far, so good. The problems arise when MB consider the establishment of a (non-polluting) bathing beach, which may be placed either at site 0, immediately upstream of firm 1 or at site $(n+1)$, immediately downstream of firm $n$. Now, they argue from (2.6.2), the first choice would involve no additional charges on the existing firms, whereas the second would add a term of the form

\[
(2.6.3) \quad P_{n+1} \left( \frac{\partial Y_{n+1}}{\partial Q_{n+1}} \right) \left( \frac{\partial Q_{n+1}}{\partial Z_i} \right)
\]

to the charges levied on firm $i$, and the imposition of this levy would reduce the net output of these firms. MB continue:
"In brief, under this set of operating rules, choice of site 0 for the beach would not change the contributions of firms 1,...,n to 'social welfare'; choice of site (n+1) would lead to a reduction in this contribution. Maximising welfare would require that this fact be taken into account in the bathing-beach entrepreneur's locational decision. This could be done by making it known that use of site (n+1) for a bathing beach would result in the imposition of a franchise tax equal to the difference between the socially optimum values of \( \sum_i (P_i Y_i - W_i X_i) \) with and without the beach.'

Unfortunately, this suggestion is completely inconsistent with all the analysis that has preceded it. It contradicts the suggestion that river firm n should pay no charges, since the levies on firms 1 to (n-1) for damage to n reduce their output. A particularly telling example of this is the case where firms 1 and n operate bathing beaches, and we are considering which of them should close down. This is the precise obverse of the problem considered above, but the MB solution does not involve a levy on firm n.

More generally, any of the firms in the lake example are free to reduce the amount of pollution damage they incur, either by changing their input mix or by shutting down altogether. This action would reduce the charges on other firms and increase their net output. Thus, MB's analysis of the bathing-beach problem would imply that all firms should pay charges in their capacity as victim, as well as in their capacity as polluters. This, of course, would be inconsistent with the maximisation conditions (2.6.2).

From a common-property perspective, it is fairly easy to detect the error in MB's analysis. The appropriate charge on firms 1 to n should represent the loss of asset value to the bathing beach firm, and the same charge should be levied regardless of the firm's siting decision. If, at the base level of pollution activity site 0 is preferred, it will always be adopted and no charge should be imposed. If site (n+1) is preferred at the base level, a pollution charge should always be imposed. Two possibilities arise. First, the polluting activities of firms 1 to n may induce the bathing beach to relocate at 0. In this case the appropriate charge is the difference in value between sites 0 and (n+1).
Alternatively, the bathing beach may remain at \((n+1)\) and suffer pollution damage. In this case, the firms must be charged in accordance with the reduction in value of the bathing beach, as compared with the base situation. This charge will, of course, be less than the difference in value between 0 and \((n+1)\) since otherwise the beach would have been relocated to 0.

The 'profit-maximising' framework adopted by MB predisposes them to errors of this kind. As has been observed above, no profit-maximising asset owner will consider the interests of asset users who are not subject to any charge. Thus, it is not surprising that, when MB attempt to formulate criteria which do take account of such users, their analytical framework does not give them much assistance.

2.7 The Theory of Clubs

Like the Mohring-Boyd asset-utilisation framework, the theory of clubs can be traced back to the work of Knight (1924). However, in its development by Buchanan (1965) and subsequent writers, the theory of clubs has diverged significantly from the Mohring-Boyd approach. Thus, it has a different focus from the theories discussed previously, and is generally associated with public good problems rather than 'externalities'.

In many ways, the common property analysis stands midway between the Mohring-Boyd analysis and the theory of clubs. In particular, like club theory, its dominant concern is with the group of users of an asset. However, there are significant differences between the two approaches, reflecting the rather different problems with which they are concerned. A debate within the theory of clubs itself serves to illustrate some of these distinctions.

Buchanan (1965) considered the formation of a club, made up of identical individuals, who would collectively purchase and use an 'impure' public good, from which non-members were excluded. The utility of the public good to each club member declined as the number of members increased, and ultimately this crowding effect outweighed the benefits of further cost-sharing. Buchanan derived conditions for the membership
level which would maximise the utility of the representative club member. Ng (1973) criticised this view. He argued that Buchanan's solution represented a market equilibrium, since at this point the club would not accept new members, but did not represent a Pareto-optimum, since the interests of non-members were not taken into account. Helpman and Hillman (1977) resolved this conflict, pointing out that Ng and Buchanan were examining different problems. Buchanan's analysis implicitly assumes that a large number of clubs may be formed to consume identical goods, whereas Ng's analysis assumes one club per good. Since the theory of clubs is typically concerned with produced public goods, Buchanan's approach is more appropriate and it is followed by the mainstream of the literature on clubs. However, the common property analysis, is mainly concerned with unique fixed assets, such as lakes and air-basins, and is therefore closer to Ng on this point.

This is not to say that a common property approach cannot be applied to problems involving produced goods. This can be done by including activities which improve asset quality and are therefore 'productive'. By making the number of productive activities sufficiently large, and the 'quality' vector sufficiently complex, it would even be possible to produce a model of the Buchanan type in which many groups of users consume essentially similar goods. Indeed, Ng (1977) suggests this possibility in an attempt to refute Helpman and Hillman's description of his approach as a 'one-club model'. However, this added complexity would make the model very unwieldy, without giving any improvement in explanatory power over the simple Buchanan model.

A related problem raised in this debate, and elsewhere in the club literature is that of discreteness. The basic club theory analysis is essentially discrete; an individual is either in the club or out of it. This naturally creates problems in the use of calculus, and particularly in marginal analysis i.e. considering decisions on whether marginal individuals should join the club. These problems do not usually arise in the common property analysis, because the group under consideration includes all potential users of the asset. Individuals' usage levels are normally assumed to vary continuously in response to changing circumstances. Of course, discreteness can be introduced by restricting the activity sets $A_i$ to two points, representing membership and
non-membership. Discreteness of a different kind may be introduced by the use of a two-part tariff to control usage levels. In problems of this kind, common property analysis and the theory of clubs may reach similar conclusions from different starting-points. Generally, though, the common property approach is concerned with continuous variables representing asset usage and quality rather than with discrete variables such as club membership.

To illustrate the relationship between the common property approach and the theory of clubs, it is useful to consider the example of road usage, first debated by Knight and Pigou. We may first consider the case of a single road, with no economical possibilities for upgrading. In terms of the theory of clubs, this corresponds to the Ng model, rather than that of Buchanan. Comparison with the existing literature will be facilitated by assuming each (potential) road user to have only two discrete options, using the road or not using it. This assumption means that the calculus approach used to obtain (1.7.8) is no longer applicable. Instead, let us order the asset users in terms of the benefit they obtain from using the asset, so that individual 1 obtains the greatest benefit and individual n the least. (Assume, for simplicity, that this ordering is unaffected by changes in asset quality). The optimal usage pattern may be determined recursively, beginning from a situation where individual 1 is the sole asset user. Whether individual j should be added to the set of asset users depends on whether or not

\[ v_j(1,q(j)) \geq \sum_{i<j} 3v_i/3q 3q/3a \]

where 0 and 1 correspond to using the asset or not using it respectively, the asset usage level a is set equal to the number of users, and it is assumed that

\[ V_i(0,q) = 0 \quad \text{for all } i,q. \]

A similar formula is derived by Ng.

The Buchanan approach would apply if the road could be duplicated as many times as necessary, and the carrying capacity increased linearly with the number of lanes. If all individuals were equally sensitive to
congestion, then there will be a fixed optimal number of users determined when congestion effects outweigh the benefits derived from spreading the costs of construction. If the sensitivity to congestion differs between individuals, the Buchanan approach would yield a 'discriminating' solution. 'Sensitive' users would choose low density, high cost per user roads (e.g. toll expressways), while others would use cheaper, more crowded roads. This last case is related to that examined by Tiebout (1956), in the context of local government.

In general, the assumption of a linear increase in carrying capacity is unrealistic. Because of opportunities for overtaking, the capacity of a road will normally increase more rapidly than the number of lanes. It is largely for this reason that discriminating systems of the type described above are rarely seen in practice, except where the high and low cost roads follow different routes for technical reasons e.g. where advances in technology make the construction of a more direct road feasible.

As was noted above, the latter situation may be handled within the common property approach by allowing two activities, road use and road construction. The optimal level of road usage will once again be determined by (2.7.1). If we denote the level of construction activity by $a_2$ and the cost of construction by $C(a_2)$, the optimal level of construction activity is given by

$$\frac{\partial q}{\partial a_2} = \frac{\partial C}{\partial a_2}$$

That is, the marginal cost of additional road construction must equal the marginal increase in the value of the asset to existing and potential road users.

This analysis also applies to the case where the number of lanes is fixed, but road quality can be altered by 'upgrading' expenditure of various kinds.

Thus, for most road problems, where the number of separate roads to be considered is small, a common property analysis would appear preferable to that yielded by the mainstream club theory approach.
Chapter 3

PRICING, ASSET USAGE AND INSTITUTIONAL FRAMEWORKS

3.1 Introduction

As can be seen from the previous two chapters, the question of pricing systems is central to the 'externalities' debate. This question may be broken down into two parts - the determination of an 'optimal' pricing scheme (if one exists), and the analysis and assessment of the pricing structures arising from different possible institutional arrangements.

According to Demsetz' (1969) 'comparative institutions' approach, only the second part of this analytic effort is useful. Demsetz strongly criticises what he calls the 'nirvana' approach - analysis which describes institutions as 'inefficient' if they do not yield an optimal allocation of resources. His main concern is with the case when market institutions are found to be inefficient and government intervention is suggested to correct this.

While Demsetz is correct in saying that inefficiencies in market institutions do not automatically justify government intervention, his methodological case for rejecting absolute efficiency criteria is unsound. It is useful to consider an analogy with engineering, where the efficiency with which an engine converts input energy into useful work is a question of major importance. The appropriate analogue of Demsetz' approach would be one in which any consideration of the theoretical limits on engine performance is set aside, and analysis is confined to comparing the actual performance of different engines. Such an approach would be extremely unhelpful in the design of new engines, since there would be no way of determining where there was room for improvement in current designs, and where they were already performing at or near the theoretical limit.

Similarly, the power of economic analysis would be greatly weakened if absolute yardsticks of efficiency and optimality were discarded in favour of purely relative comparisons between institutions. Consider the
example, raised by Demsetz himself, of free trade and protection. Suppose that we adopt a 'conservative' objective of maximising national income, subject to the requirement that any change from the existing position be a Pareto-improvement. Under the usual neoclassical assumptions, economic analysis can demonstrate that this is impossible under free trade, but that it may be possible under protection since the latter policy is 'inefficient' i.e. there exists a set of prices and initial asset endowment which would be Pareto-superior. However, it is extremely difficult to exhibit a feasible set of institutions which will yield such a Pareto-improvement from an initial situation of protection. Free trade will almost always involve some windfall losses, and 'lump-sum' compensation will have to be financed by distorting taxes.

Until such an institution can be presented, a user of the comparative institutions approach cannot draw any distinction between the two initial situations of free trade and protection. By contrast a user of the 'nirvana' approach can say that free trade is absolutely efficient (i.e. has attained nirvana), since no alternative policy can achieve an improvement under the conservative criterion described above. Protection is not efficient in this sense, and this justifies the consideration of alternative policies.

In this chapter, a 'nirvana' approach will be adopted. Consideration will first be given to determining the conditions for schemes of pricing (and alternatives such as regulation) which yield an optimal pattern of asset usage, and then to the likely performance of a range of possible institutions.

3.2 Damage Schedules and Pigouvian Taxes

A number of difficulties with the Pigouvian 'externality' analysis were discussed in the previous chapter. Many of these difficulties arose from a tendency to measure external costs on the assumption of an unchanged activity level by victims of pollution. This analytical error does not, of itself, invalidate the Pigouvian policy recommendation that polluters should be levied at a rate equal to the marginal external costs they generate, but it makes evaluation of the recommendation more difficult.
The analytical framework set out in sections 1.6 and 1.7 makes it possible to determine marginal and total damage schedules for the effects of polluters' activities, without necessarily assuming that victims cannot adjust their activities. This framework therefore permits a more rigorous evaluation of the Pigouvian policy recommendation.

The simplest case is that of a single polluter, with a number of victims whose activities do not impinge on the polluter. In the special case of 'passive' victims who are constrained to adopt the base activity, equation (1.5.7) gives a total damage level of

\[ (3.2.1) \quad C = - \sum_{j \neq i} v_j (a_j^0, q) \]

for pollution by individual i. This yields the marginal damage schedule

\[ (3.2.2) \quad c = \frac{\partial C}{\partial a_i^0} = - \sum_{j \neq i} \frac{\partial v_j}{\partial q} \frac{\partial q}{\partial a_i} \]

In this case, it is easy to see the rationale for the familiar Pigouvian recommendation that the (marginal) charge for pollution should be equal to the marginal external cost. However (3.2.1) indicates that, if global optimisation is to be guaranteed, the total damage level will not normally be equal to the revenue generated by a Pigouvian tax on the relevant activity levied at the marginal rate. This will only occur if the 'total damage function' C is linear, so that c is a constant.

The consequences of this may be observed more easily if the polluter is assumed to be a firm, \( a_i^1 \) its production level, and the base level \( a_i^0 \) to be zero. If C is convex in \( a_i^1 \), a flat-rate Pigouvian tax on activity will 'overcharge' the firm and may lead to production being abandoned when it should go ahead. Conversely, if C is concave, an undesirable activity may proceed. The most extreme case is where the marginal damage becomes zero after a certain point. This is the 'inframarginal externality' of Buchanan and Stubblebine (1962).

Note that nothing except income distribution is affected if the base level is altered. If the polluter operates below the base level, the LHS of (3.2.1) becomes negative i.e. the polluter receives compensation similar to Coasian 'bribes'. This point is essentially equivalent to the Coase's well-known theorem.
The passivity assumption may be relaxed and the group of victims allowed to adjust. On the assumption that the base level of usage represents an initial optimum (i.e. an optimum in the zero pollution situation) the total damage schedule yielded by (1.5.15) is

\[(3.2.3) \quad C = \min (- \bar{V}_i (a_2, \ldots, a_n)) \]

In the case where none of the victims' activities affect asset quality, (3.2.3) yields

\[(3.2.4) \quad C = - \sum_{j \neq i} V_j (q) \]

and

\[(3.2.5) \quad \frac{\partial C}{\partial a_i} = - \sum_{j \neq i} \frac{\partial V_j}{\partial q} \frac{\partial q}{\partial a_i}. \]

These conditions differ from (3.2.1) and (3.2.2) in that, the asset value at the base level of activity \( a_j^0 \), is replaced by the maximum asset value \( V_j \). This does not invalidate the Pigouvian recommendation of a tax equal to marginal damage, since at the optimum activity level \( a^*(q) \) we have

\[(3.2.6) \quad \frac{\partial V_j}{\partial a^*_j} = 0 , \]

and hence

\[(3.2.7) \quad \frac{\partial V_j}{\partial q} = \frac{\partial}{\partial q} V_j (a^*, q). \]

The fact that \( a^* \) varies with \( q \) does, however create some additional problems for analysis using the Pigouvian approach. It means that the total damage schedule (3.2.4) cannot be obtained simply by integrating (3.2.7) with respect to \( q \). Thus, a flat-rate tax may be inappropriate even if (3.2.7) is a linear function. Consider, for example, the problem of beach pollution, referred to above. If pollution is so bad as to reduce usage to zero, then the marginal damage given by (3.2.7) will be identically zero but this will not give any information about the total damage level.
Further problems arise when there is more than one polluter. In this case, not only must victims adjust their non-polluting activities to reduce the damage they incur individually but an increase in polluting activity by one individual will alter the optimal level of polluting activity for the others. These effects may be illustrated most easily for a two-polluter case, where individuals 1 and 2 are polluters and \( a_1 \) represents the level of polluting activity as before, so that

\[
(3.2.8) \quad a = a_1 + a_2.
\]

The marginal damage schedule for pollution by individual 1 is given by

\[
(3.2.9) \quad \frac{\partial C_1}{\partial a_1} = \sum_{j>3} \frac{\partial q_j}{\partial q} \frac{\partial q_j}{\partial a_1} \frac{\partial q_j}{\partial a} - \frac{\partial q_2}{\partial a_2} (1 - a/a_1).
\]

This marginal damage schedule may be integrated with respect to \( a_1 \) to yield a total damage schedule for individual 1, and a similar process may be undertaken for individual 2. It would seem natural to add these schedules together, to produce a schedule of total damage for the two polluters combined. Unfortunately, this cannot, in general, be done. Consider once again the case of an 'inframarginal' externality, in which the marginal damage to all victims is zero after a certain point, and suppose that the optimal quality level is beyond this point in all cases. That is, for both of the groups consisting of only one polluter and all the victims (i.e. groups (1, 3,..., n) and 2,..., n), the quality level at which total asset value is maximised is beyond the critical level \( \bar{q} \). Then the total and marginal damage schedule for each polluter, considered singly, are identically equal to zero. However, the two polluters, considered together, do impose positive damage on the remaining users. It may be noted that the assumptions of the case mean that a zero polluter charge will yield a value-maximising use of the resource. However, as (3.2.9) shows, it is necessary to have information about the profitability of the 'polluters', as well as the marginal damage schedule for 'victims' alone in order to arrive at this result. This issue will be considered in more detail in the following section.

The major issue of interest in this section is the relationship between the individuals polluters' damage schedules and the collective damage schedule for the polluters as a group. For the sake of simplicity,
a two-polluter case will be considered. The collective damage schedule for individuals 1 and 2 may be written $C_{12}(a)$, or more explicitly, $C_{12}(a_1+a_2)$. The marginal schedule is simply

$\frac{C_{12}}{\partial a} = - \sum_{j>3} \frac{\partial V_j}{\partial q} \frac{\partial q}{\partial a}$

(3.2.10)

It is fairly easy to see that equality between $C_1+C_2$ and $C_{12}$ will hold if the marginal damage schedule (3.2.10) is constant. In this case, the optimal activity level for each polluter is independent of asset quality and hence of the activities of the other polluter. Thus, the second term in the RHS of (3.2.9) is zero for both individuals, and the constancy of $\frac{\partial V_j}{\partial q}$ yields the desired result. More generally, $C_{12}$ will be less than $C_1+C_2$ if $V$ is convex in $q$, and greater if $V$ is concave. This result will not be proved here, but the basic reasoning is as follows.

If $V$ is convex, then each polluter will impose external costs upon the other, by increasing the cost of asset usage and reducing the optimal level of activity. Conversely, if $V$ is concave, the polluters will generate external economies for each other. The latter case is reminiscent of the case of external size economies.

A limiting case of significant interest arises, when there are many polluters, each of whom has only a 'small' effect on asset quality. In many cases of this kind, such as congestion problems, the distinction between 'polluters' and 'victims' breaks down. Since each individual's contribution is small, the sensitivity of other individuals to changes in asset quality will be almost independent of the activity level of individual $i$. Hence, the marginal damage schedule for individual $i$ will be constant. Moreover, it will be possible to combine the damage schedules for groups of polluters, provided their total impact is still small. For larger groups, the questions of concavity and convexity will apply as before.

Thus, examination of the marginal and total damage schedules yielded by a common property analysis reveals significant difficulties for the Pigouvian tax policy. In the following section, alternative pricing policies are considered.
3.3 Pricing, Information and Resource Allocation

The analytical framework associated with the common property approach has been used above to determine optimal usage conditions for a common property assets. One method of achieving optimal resource use would be to assign compulsory usage levels in accordance with these optimal conditions. This method was used quite successfully by many traditional common property institutions, such as the open field system discussed below. However, it generally requires relatively static technology and tastes, and a well-informed assigning authority. These were features of many traditional common property institutions, but are less applicable to modern pollution problems. For this reason, it is desirable to examine price mechanisms, which can respond flexibly to changing situations.

Price systems may be viewed in a number of ways. In economic analysis the most common concern is with their function as signals, determining the allocation of resources while minimising the information requirements of decision-makers. Businessmen, on the other hand, are more typically concerned with the degree to which the price they charge will 'cover costs'.

Three important issues may be distinguished here. They are:

(i) how close is the use of resources yielded by a particular pricing system to the optimal or 'nirvana' allocation?

(ii) how much information is required to set the prices?

(iii) to what extent does the price charged to each individual or group of individuals reflect the costs they impose on other asset users?

These issues are fairly simple in the one polluter case. Let \( a_1^* \) be the optimal level of polluting activity as determined by (1.7.13), and let \( C(a_1) \) be the damage schedule of (3.2.1). Then it is reasonable to suppose

\[
\frac{\partial v_1}{\partial a_1} > \frac{\partial C}{\partial a_1} \quad \text{for} \quad a_1 < a_1^* \\
\frac{\partial v_1}{\partial a_1} < \frac{\partial C}{\partial a_1} \quad \text{for} \quad a_1 > a_1^*,
\]

at least in a neighbourhood of \( a_1^* \).
As has been noted above, efficiency will normally require a schedule of charges rather than a single fixed price. We may write the total price charged for activity level \(a_1\) as \(P(a_1)\) and the marginal rate as \(p(a_1)\). Then a sufficient condition that the level of pollution will not be too great is

\[
(3.3.2) \quad p(a_1) > \frac{\partial C}{\partial a_1} \quad \text{for all } a_1,
\]

since, by (3.3.1), this means that

\[
(3.3.3) \quad p(a_1) > \frac{\partial v_1}{\partial a_1} \quad \text{for } a_1 < a_1^*.
\]

A sufficient condition for the level of pollution not to be smaller than the optimal level \(a_1^*\) is given by the converse of (3.3.3),

\[
(3.3.4) \quad p(a_1) < \frac{\partial v_1}{\partial a_1} \quad \text{for } a_1 < a_1^*.
\]

There are a range of possible pricing schemes which will satisfy both (3.3.2) and (3.3.4), and hence will yield the optimal allocation of resources. The lowest such charge is given by:

**TOTAL DAMAGE RULE:** Charge the polluter an amount equal to the total social damage i.e. the loss in asset value to all other users associated with his/her move away from the base level of activity.

This rule equates \(P(a_1)\) with \(C(a_1)\) and replaces the inequality in (3.3.2) with an equality. If, instead, equality is imposed in (3.3.4), we obtain:

**TOTAL SURPLUS RULE:** Charge the polluter at a marginal rate equal to the greater of the marginal private benefit and the marginal social cost.

This rule yields a total charge given by

\[
(3.3.5) \quad P(a_1) = \begin{cases} 
  v_1(a_1) & \text{for } a_1 < a_1^* \\
  v_1(a_1^*) + C(a_1) - C(a_1^*) & \text{for } a_1 > a_1^*
\end{cases}
\]
Any pricing schedule lying between the two just described will also yield the optimal allocation $a^*$. It is also apparent that any such schedule will satisfy the 'cost-covering' requirement, since the total damage rule does so.

The minimal information required by all the rules described above is the victim's marginal damage schedule. The total damage rule uses this information only, while all other rules require information on private benefits to the polluter. Thus, the total damage rule best fulfils the criteria set out above, although other rules may still be preferred, perhaps on distributional grounds.

As was pointed out in section 3.2, the Pigouvian policy of setting a tax equal to the marginal damage level at the optimum may not yield an efficient allocation of resources. If the damage schedule is convex, the Pigouvian tax may exceed the total surplus so that the polluting activity is not undertaken even though there are positive net benefits. If the schedule is concave, the Pigouvian tax will be less than the total damage, and undesirable activities may proceed.

The Pigouvian tax approach also faces significant information difficulties. The optimal pollution level can only be determined in advance if information is possessed on both the surplus accruing to polluters, and the damage suffered by victims. Attempts to avoid this difficulty by altering charges on an iterative basis seem to create as many difficulties as they resolve (Baumol and Oates 1975, pp. 78-79).

The formal analysis above carries over quite straightforwardly to the multiple polluter case. The inequalities (3.3.1-4) hold for each polluter $i$, and the total damage and total surplus rules once again bound the set of pricing schedules which guarantee an optimum pattern of asset usage. However, the analysis of information requirements and cost-covering must be modified to a significant extent. For example, determining $C(a_i)$ for a polluter $i$ requires knowledge of the reduction in asset value to the other users considered as a group. However, this group includes not only 'victims' but other polluters who must reduce their own levels of polluting activity in response to that of individual $i$. Thus, determination of an efficient pricing system requires information on the
cost/benefit functions of all asset users, polluters and victims alike.\textsuperscript{18}

As was shown in the previous section, the fact that a pricing schedule covers the costs imposed by a single polluter does not mean that it will cover the costs generated collectively by two or more polluters. In fact, we may observe that application of the total damage rule to each individual polluter will cover the collective costs of pollution only if the relevant damage schedules are linear or convex. On the other hand, use of the total surplus rule will always cover all costs. This is because, in order for more than zero pollution to be optimal, the total surplus accruing to the polluters must exceed the costs they impose on other asset users.

3.4 Private Ownership and Competitive Pricing

The establishment of private ownership rights has been the main policy proposal associated with standard economic analyses of so-called 'common property' problems. In the more general debate over 'externalities', the question of when private ownership provides an appropriate institutional framework has been argued at length without a satisfactory resolution. In particular, the distinction between depletable and undepletable externalities, put forward by Baumol and Oates (1975) has been shown to provide an inadequate basis for determining this issue.

Two forms of private ownership rights were discussed in the previous chapter - the 'Coasian' rights to engage in a particular activity, and the 'Knightian' rights associated with particular assets. As has been argued above, when Coasian rights do exist, they are normally associated with a common property asset and are better discussed in terms of that asset. For this reason, the present section will deal only with the Knightian recommendation of private ownership and control over the asset in question. This recommendation has been repeated in general by writers

\textsuperscript{18} This is not strictly correct. If information is available for all but one polluter, it would be possible to apply the Total Damage Rule to that one and the Total Surplus Rule to all the others.
such as Mohring and Boyd (1974), and in specific cases by Scott (1955) and others.

In order to develop a discussion of the conditions under which private ownership will achieve optimal asset usage, it will be useful to review some of the examples (and counter-examples) presented in section 2.3. The fisheries example, taken from Baumol and Oates, is easy to explain in the light of the results of section 3.2. In this example all of the surplus arising from the existence of the asset accrues to the owner. By charging profit-maximising prices, the owner is, in effect, implementing the total surplus rule described in the previous section. The question of depletability may fairly be described as a red herring.

A question of rather more interest is: why does the total surplus accrue to the asset owner? The reason is that both the inputs (fisherman's labour) and the outputs (fish) associated with the asset-using activity are available, in perfectly elastic supply, at competitively determined prices. Hence, the benefits and opportunity costs associated with using the lake are the same for each fisherman, and will be equilibrated to the price charged by the owner. Reasoning similar to this underlies the Knightian argument elaborated by Mohring and Boyd. The crucial assumption is that the benefit yielded by the asset is the same for all individuals undertaking the activity.

In the second Baumol-Oates example, that of the flower gardens, benefits of using the asset vary between individuals. If, by chance, the benefit of viewing a particular garden was the same for all individuals, then a charge equal to this benefit would maximise profits and satisfy the total surplus rule. This charge would yield efficiency in both production and consumption, since there would be an adequate incentive to supply enough gardens to meet the viewing demand.

The above framework of analysis may be related to the analysis of the private supply of public goods put forward by Demsetz (1970) and Oakland (1974), among others. The work of these writers may be viewed as an attempt to discover ways in which the consumer surplus associated with public goods may be appropriated by the producers of those goods. After examining a case of identical demand similar to that which has just been
discussed, Demsetz pointed out that this result could be generalised if the supplier was able to practice price discrimination between consumers. Unfortunately, as noted in section 3.2, the information requirements of this solution are very stringent, as are the difficulties of preventing 'resale' transactions between users. For this reason, price discrimination is not very common in practice.

Oakland presents a model in which firms charge different prices for similar goods, securing some of the consumer surplus associated with public goods without substantial information requirements. However, since some consumers are excluded from goods they could costlessly use, Oakland's solution does involve significant departures from efficiency in consumption as well as in production.

All of the counter-examples presented in section 2.3 involve the problem of unappropriated consumer surplus. However, the existence of such a surplus does not, in itself, mean that private ownership will be inefficient. What is important is whether the surplus accruing to the owner is substantially affected by changes in asset quality. A private owner will be indifferent to these effects, and, if they are significant, asset quality will normally be suboptimal and usage excessive.

As the fishing example showed, however, this effect may be countered by monopoly effects which tend to limit usage and increase asset quality. As was pointed out in the previous section, these monopoly effects will be unimportant provided the asset-owner faces a horizontal demand curve at the margin. Thus, it is possible to derive two conditions which together are sufficient for private ownership to yield an efficient pattern of asset usage.

**Competitive pricing condition:** In a neighbourhood of the private ownership usage pattern \((a_1, a_2 \ldots a_n)\) the marginal value of asset usage, \(\partial v_i \partial a_i\) is a constant, independent of \(i\).

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19 For a converse to this effect, see the analysis of Thompson (1968) in which monopsony effects lead to an overproduction of public goods.
**Linear damage condition:** For each level of asset quality \( q \), the loss of asset value compared to the base quality level is represented by a linear function on the set of activities which is the same for all individuals.

The linear damage condition means that each of the individual asset value functions takes the form:

\[
(3.4.1) \quad v_i(a_i, q) = v_i(a_i, q^0) - k(q) a_i .
\]

If the competitive pricing condition also holds, then in a neighbourhood of \( a_i \), we may write:

\[
(3.4.2) \quad v_i(a_i, q) = z_i + (c - k(a)) a_i ,
\]

where \( c \) and \( z_i \) are constants.

The total value of the asset is:

\[
(3.4.3) \quad \sum_i v_i(a_i, q) = \sum_i v_i(a_i, q^0) - k(q) a = \sum_i z_i + (c - k(q)) a .
\]

The optimisation conditions, which may be derived directly or from (1.5.8) are:

\[
(3.4.4) \quad c - k(q) = k'(q) \partial q/\partial a .
\]

The price a private owner can charge any asset user is determined by (3.4.2) as \( c - k(q) \) so that total revenue is \( (c - k(q))a \), and maximising this yields (3.4.4). The surplus left to each asset user is a constant \( z_i \), which is independent of asset quality and hence unaffected by the pricing decisions of the asset owner.

Some further comment is desirable on the relationship between the 'competitive pricing condition' described above, and the Knightian assumption that the asset produces a good which can be sold in a perfectly competitive market. The Knightian assumption, which implies
that all $z_i = 0$, means that private ownership will be efficient, whereas the 'competitive pricing condition' does not. The crucial difference arises from the assumption in the textbook definition of perfect competition, that all consumers are completely indifferent between suppliers of the good in question. For the competitive pricing condition to hold, indifference is required only at the margin, i.e. for marginal consumers and/or units of consumption. If this weaker condition holds, the firm will still behave precisely as would a textbook competitive firm, since the existence and level of the unappropriated consumer surpluses is entirely irrelevant to it.

This problem illustrates a significant difficulty with the well-known 'instrumentalist' methodology of Friedman (1953). Friedman argues that the accuracy of predictions (in the area of interest), rather than the realism of assumptions should be the crucial test of an economic theory. In this case, the existence of 'inframarginal' consumer surpluses will have no effect on the accuracy of predictions as to pricing, firm size, industry structure, etc. However, the seemingly innocent assumption that there are no such surpluses can play a vital role in determining the validity of policy recommendations derived from the competitive model. In this case, at least, assumptions do matter.

Since 'inframarginal' surpluses of the kind discussed above do not affect the market behaviour of firms, they are likely to be revealed through 'political' processes of one kind or another. Asset users will seek either to modify decisions of asset owners which affect them adversely, or to remove the asset from private ownership. By contrast, in a perfectly competitive model, disgruntled asset users would simply take their custom elsewhere.

On the basis of the discussion above, it is possible to make some predictions as to the areas in which private ownership is likely to yield inefficient results. First, it is necessary that the asset in question should be unique or rare in some way, for example, with respect to geographical location. Second, inefficiency is more likely to arise in the case of consumption activities. Inefficiency with respect to productive activities is less likely, but is possible if there are factors of production which are specific to the asset in question. In the
fisheries case, for example, fishermen might have specific 'local knowledge' of a particular lake, or they might be geographically immobile.

These predictions would appear to be borne out in practice. The main areas of political concern over 'externalities' have involved unique assets such as air basins and rivers, and it has been those involved in 'consumption' activities (breathing, drinking, recreation, etc) who have found market solutions unsatisfactory.  

3.5 Pricing Decisions in Common Property Institutions

Economic analysis of decision-making has focused mainly on the decisions of individuals and entrepreneur-controlled firms. There is, however, a significant, though generally rather abstract, literature relating to collective decision-making procedures. Perhaps the most notable result in this area is Arrow's (1952) 'impossibility theorem'. Arrow's theorem showed that no 'well-behaved' collective decision-making procedure could work, unless the set of possible preference rankings of the individuals involved was restricted in some way.

A number of possible restrictions have been proposed. The most important for our purpose is the requirement, put forward by Sen (1966), that preferences be 'unimodal' or 'single-peaked'. Roughly speaking, this means that the available alternatives can be ordered on a one-dimensional scale, say from 'right' to 'left', in a way which is agreed by all voters. Each voter has a most preferred position on this scale and rates other alternatives according to how 'close' they are to this optimal position. Preferences of this kind make a consistent majority voting procedure possible. An example is the meeting procedure commonly adopted when there are a number of alternatives which can be ordered from 'left' to 'right'. This is to begin with one of the 'extreme' proposals and to proceed across the scale, until a proposal is found which obtains majority support as against the proposal next along the scale.

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20 In some of these cases, private ownership is unsatisfactory because of monopoly effects. The larger is the unappropriated user surplus, the more likely it is that the competitive pricing equilibrium will be dominated by an 'inframarginal' monopoly equilibrium.
In this section, consideration will be given to the question of a collective decision to determine an access price for use of a common property asset. In most circumstances this decision will satisfy Sen's unimodality requirement. An individual whose preferred price \( p^* \) is lower than the price \( p_0 \), may be expected to support a move from \( p_0 \) to any 'intermediate' price \( p \), \( p_0 < p < p^* \). Given this condition, majority voting will lead to the adopted price being that preferred by the median voter.

The situation is more complex where there are multiple uses for the asset, and hence more than one price to be set. In this case, it is quite possible for intransitivities of the kind considered by Arrow to arise. Consider, for example, a forest which may be either (A) cleared for farming, (B) selectively logged for forestry or (C) left untouched for recreational purposes. Clearly, both conservationists and foresters might prefer B to A, while both farmers and loggers would prefer A to C. However, if farmers are inconvenienced by logging operations, they might well join with conservationists in preferring C to B, so that majority votes could 'cycle' endlessly.

There are a number of possible solutions to this problem. First, it may be observed that, in practice, a uniform scaling of alternatives from 'heavy use, high pollution' to 'low use, low pollution' works fairly well to describe most debates over the use of environmental assets. Second, there are possibilities of arriving at a firm decision through 'logrolling' between different groups. These issues will not be considered further here. Instead, it will be assumed that the pricing preferences of the median voter prevails, and the efficiency of the resulting decisions will be assessed.

Consider the case of an asset used for a single activity. A usage charge is decided by majority vote, and the proceeds are divided equally among the group of asset owners. Thus, each voter must weigh the cost they will bear in usage charges against the benefits in improved asset quality and their share of the proceeds of the usage charge. It may be shown that majority voting will yield an optimal result provided the median voter is 'representative' i.e. provided the median levels of the relevant variables are equal to their means.
Consider the decision problem of an individual voter, seeking to set a price which will maximise his/her benefit from the asset. Three factors must be taken into consideration:

(i) the cost of usage charges to the voter;
(ii) the share of revenue received by the voter (it is assumed that revenue is divided equally between voters); and
(iii) the effect on asset quality.

The voter must choose a price $p$, and an activity level $a_i$ to solve the problem:

$$\text{(3.5.1) } \max_{a_i, p} \left( V_i(a_i, q) - pa_i + (pa)/n \right).$$

The first order conditions are:

$$\text{(3.5.2) } \frac{\partial V_i}{\partial a_i} = p,$$

and

$$\text{(3.5.3) } \frac{\partial V_i}{\partial q} \frac{\partial q}{\partial a} \frac{\partial a}{\partial p} - a_i + a/n + p/n \frac{\partial a}{\partial p} = 0.$$

The first condition simply determines the individual's usage level for given $p$. The second condition may be simplified for a 'representative' voter for whom $a_i$ is equal to $a/n$, yielding

$$\text{(3.5.4) } p = -n \frac{\partial V_i}{\partial q} \frac{\partial q}{\partial a}.$$

Again, for a 'representative' voter, the term in $n$ may be replaced by a summation over all individuals to yield

$$\text{(3.5.5) } p = -(\sum V_j/\partial q) \frac{\partial q}{\partial a}.$$

As is shown in section (3.2), this is the efficient uniform price, if one exists. Thus, as long as the median voter is 'representative' a majority voting system will yield an efficient pricing decision.
A sufficient condition for the median of a random variable to equal the mean is that the distribution should be symmetric e.g. normal or uniform. This would appear to be a reasonable assumption, at least as a first approximation, where the variable of interest is determined by personal sensitivity to changes in asset quality. 'Psychological' variables of this kind are commonly represented by normal distributions.

Conversely, skewness in the distribution implies that the median will differ from the mean. A number of possible cases may be considered. First, the distribution of 'sensitivity' variables may be truncated at zero (i.e. an individual indifferent to changes in asset quality), and, as a result, skewed somewhat to the left. In this case the distribution would contain a 'tail', consisting of highly sensitive individuals whose wishes will not be adequately taken into account.

The opposite possibility arises when there are a small number of 'polluters' and a large number of victims. Because the voters will take into account the effects of pricing decisions on the total revenue from charges, they will act collectively in a manner similar to that of an individual monopolist (assuming, of course, that such a monopolist could appropriate the total surplus accruing to 'victims'). This problem could be remedied if the asset owners possessed sufficient information to apply the Total Surplus Rule to polluters (a discriminating monopoly solution). An alternative solution would arise if the relationship between price level and usage is determined in an 'almost competitive' fashion (compare 2.3.8).

Thus, majority voting may lead to inefficient results unless the decisive median voter is 'typical'. In other cases, where a small number of individuals have a vital interest in the asset, while others are roughly indifferent, alternative possibilities must be considered.

Two main alternatives will be considered here. The first is to allow unequal weighting of votes, so that those individuals with a greater interest will have a larger say. In this way, the decisive voter will be close to the mean of the relevant distributions, and the analysis above will follow through. The second approach is to permit trading of votes. In the absence of transactions costs, a Coase-theorem analysis will
apply, and the most concerned individuals will buy the votes of the others. Clearly, this will imply a final situation of unequal voting power even if the initial allocation is equal. In the Coasian 'no transactions costs' case, the initial allocation is relevant only on distributional grounds.

In practice, the two changes go together. While an unequal allocation of votes does not imply alienability of voting rights, the two are closely linked. For example, the widening of the electoral franchise in the nineteenth century went hand in hand with measures, such as secret ballots, aimed at preventing the sale of votes. One explanation for this is that unequal votes generally reflect allocations of other property rights, rather than inherent differences between individuals. Since property rights are normally tradeable, so are the privileges which attend them.

Since the median voter will never be exactly typical, it could be argued that votes should always be tradeable. On the whole, economists have been opposed to limitations on alienability (see e.g. Posner 1972). Inalienability rules have the obvious disadvantage of preventing mutually beneficial trades between consenting parties. However, in a collective choice framework, bargaining between voters involves substantial difficulties. Allowing the sale of voting rights increases the potential for rent-seeking activities aimed at creating a majority coalition. Such a coalition may adopt policies which confer benefits on its members, but impose heavy costs on those outside it. This, in turn, creates incentives to split the coalition and the potential for considerable costs arising from the decision-making process, as well as from the adoption of inefficient decisions.

This discussion may be put in the context of Arrow's 'impossibility' theorem. Permitting parties to make side payments greatly increases the range of possible outcomes from the voting process. This is likely to break down stability conditions, such as 'single-peakedness', which depend on restrictions on the set of outcomes.

Thus, the assumption that the median voter is representative need not be fulfilled exactly for simple majority voting to be preferable to
alternative systems allowing transferable votes. Of course, if the assumption is not satisfied, majority voting will not yield an optimal allocation of resources. It may, however, come closer than any of the available alternatives, such as systems based on transferable votes or on sole private ownership.
Chapter 4

APPLICATIONS OF THE COMMON PROPERTY APPROACH

4.1 Introduction

Previous chapters have developed the concept of common property, both as an institutional framework and as a tool of analysis, and have contrasted it with competing paradigms. Applications of the theory have been dealt with in a somewhat piecemeal fashion, being used as illustrations of theoretical points rather than as problems of interest in their own right.

In this chapter, the focus is shifted onto a number of specific applications. First, the analysis of common property as an institutional framework is used as the basis for a discussion of recent work on an important common property institution - the medieval open field system. In the following two sections, aspects of the salinity problems facing Australian agriculture are discussed, and some possible common property solutions are examined. Finally, the concept of common property is considered as a tool for the analysis of problems in relation to inventions, patenting and Plant Variety Rights.

Numerous other applications could be envisaged. A particularly interesting example would be the interaction of common and private property rights in the modern corporation. Another important area which has not been examined explicitly is that of multiple-use resources. The common property approach appears to offer significant advantages in analytic power in this area, as was shown in some of the examples in section 2.3. However, real-world applications will inevitably be complex, and require substantial empirical information on the shapes of damage schedules and other factors. It is hoped that the range of relatively simple applications contained in this chapter will give some measure of the scope and power of the concept of common property in economic analysis.
4.2 The Open Field System - a Historical Example

Many of the widely held images of common property are derived from agriculture, and especially from the medieval open field system. This system was examined by Dahlman (1980), in what he claims to be 'the first truly intensive study of a particular economic institution from a property rights perspective' (op.cit., p.15). Dahlman finds it necessary to modify the standard property rights framework quite considerably before it can be applied to the problem.

He first confirms the point made by Ciriacy-Wantrup and Bishop (1975), that common property did not imply the absence of exclusion rights, noting that:

'Because of their basic belief in the inefficiency of collectively owned resources, it is economists who make themselves guilty of often assuming that the commons were open to everyone, and that any newcomer to an open field village could partake in grazing and tilling. Historians do not go wrong here.' (op cit., p.100)

In order to make analysis possible, some abstractions must be made from the wide range of variations which characterised the long history of the open field system. Dahlman adopts the device of a 'representative village' with the following features:

(i) the village consisted of a certain amount of land, divided into commons and arable

(ii) the arable, while in use for cropping, was privately owned and controlled

(iii) the non-arable land was owned collectively by the entire community

(iv) land reverted from arable to common, and back to arable, in a well-defined cycle.

The collective control over the common land included decisions on where the (privately-owned) cattle should be grazed, and the timing of rotation decisions. Often, it also included the hiring of a herdsman to
take the cattle to and from the pastures. Most important of all, it included power to control the number of cattle each individual could graze, and enforced these decisions to prevent overgrazing. If this had not been done, the system could not have survived a thousand years, as it did in much of Northern Europe.

The structure by which these decisions were made is not very well-documented. Presumably custom played a significant role, but this should not be overstressed. The system required the capacity to adjudicate disputes, and to adapt to technological change (see below). It would appear that this was performed either through village meetings or through the manorial courts. The main legally determined requirement arose in connection with a decision to alienate the commons through enclosure. This initially required unanimous consent of the owners or 'commoners'. Later this was changed by statute to a four-fifths majority, and then to three-quarters (op. cit., pp.183-84). This is a compromise between the problems of holdouts and the dangers of a 'rent-seeking' majority coalition. The other main problems with voting systems, discussed in Section 3.5, arose in the case of the feudal system, where the lord of the manor usually owned a very large holding, while many villagers had holdings too small to support them, and worked as hired labour. In view of the discussion of Section 3.5, and the absence of any egalitarian social welfare function in the feudal and early capitalist eras, it is not surprising to learn that voting was on a basis of land area or value, rather than equal individual votes. In a system of this kind, the number of villagers would not be particularly important, though it would be desirable that they could all meet together, rather than have recourse to representatives.

As was noted in Section 1.2, Dahlman refutes the idea that common property institutions imply open access and overuse of resources. Nevertheless, this is not sufficient to show why these institutions were preferred to available alternatives, such as enclosure, over a period of centuries. Dahlman demonstrates that, given increasing returns to scale in grazing, associated with factors such as the hiring of a common herdsman, common ownership will be superior to a system where the land is divided between a number of private owners (op.cit., pp.115-120).
In similar situations, writers in the property rights tradition have frequently advocated 'internalising the externality' through a single private owner (Scott 1955). This would work well enough in a pure livestock enterprise. However, as Dahlman points out, the cropping and grazing aspects of the open field system were closely integrated. Livestock grazed both the fallow land, and the stubble left after harvesting. In turn, their dung was used to fertilise the fields. Sole private ownership of a combined grazing-cropping enterprise would require the replacement of peasant cultivators by hired labourers, with all the attendant problems of shirking, monitoring costs etc. (see Alchian and Demsetz 1972 on these issues).

One puzzle, which has not been fully resolved, relates to the division of arable land into many strips, and the 'scattering' of individual holdings. Some scattering was required by the three field system of crop rotation, in order to ensure that each farmer's cropping area remained roughly constant over the cycle. However, the scattering of strips within a single field would seem to involve needless costs.

A number of hypotheses have been put forward. McCloskey (1976) suggests that scattering was adopted as a form of risk-reduction. Dahlman prefers the hypothesis that it was used to prevent individuals from extorting rents from the community by threatening to enclose their own land (op.cit. pp.121-130). I do not find this very convincing. If the village courts had the power to enforce scattering, why should it be unable to prevent a villager from unilaterally withdrawing his land from the common?

I would argue for an alternative hypothesis consistent with Dahlman's general theme - that the open field system combined as far as possible the benefits of size economies with those of individual proprietorship. Dahlman notes that cropping activities with substantial size economies, such as ploughing, were performed collectively, while tasks such as weeding, where monitoring costs are more important, were left to the individual proprietors. However, there must have been an intermediate range of tasks where mutual assistance between neighbours would have been valuable. The performance of such tasks on an ad hoc basis would be facilitated by the existence of relatively small contiguous strips. Such
an interpretation is supported by the observation (op.cit. p.144) that individuals often had the same neighbours on each of their strips. This would aid the formation of small 'teams'.

Having shown that the open field system was not the inefficient monstrosity so frequently portrayed, it is necessary to explain its gradual disappearance through the process of enclosure. Apart from the idea that the system was replaced because it was inherently inefficient (either from a broad social viewpoint, or, in Marxian terms, with respect to the extraction of surplus value), the most popular idea among economists has been that the system was too inflexible to adapt to new technology. Dahlman refutes this view, pointing out the adoption of complex new technologies, such as water meadows and up-and-down husbandry (op cit. p.166). He argues that the growth of markets, and improvements in transport led to a gradual process, in which specialised monocultural cash crops replaced the multi-activity subsistence farming, on which the open field system was based. We have already noted the efficiency of sole private ownership in the case of a pure grazing enterprise — this was reflected in the Tudor enclosures for wool production, when 'sheep ate men', and in the Highland clearances. In pure cropping enterprises, the case is less clear cut. Dahlman argues that, whereas a collectively agreed rotation scheme was essential for the integrated system, production for markets put a premium on individual flexibility.

While Dahlman's analysis is quite convincing, he tends to underplay the conflict inherent in this process (pp.178-84). Enclosure affected not only the level of income derived from a given area of land, but also its distribution. As was noted above, the existence of tradeable shares enhances the formation of rent-seeking majority coalitions. This would be particularly true in the case of enclosure, where the lord of the manor possessed not only a large holding, but control over transfers between landholders. This would facilitate the use of 'divide-and-conquer'

21 Up-and-down husbandry was a rotation scheme in which a year or two of cropping was followed by several years of grazing. Water meadows improved positive growth in winter by covering the meadow with an inch or two of flowing water, thereby preventing freezing.
tactics, aimed at securing a low price for the common property rights which were alienated through enclosure.  

Thus, Dahlman's analysis differs in some details from that which would follow from the theoretical approach outlined in this study. Nevertheless, the general agreement is very close. In particular, Dahlman conclusively refutes the ideas that common property implies that property rights are either non-existent or ill-defined, and that common property institutions are inherently inefficient and imply over-exploitation of resources.

4.3 Salinity in Australian Agriculture - The Case of Dryland Salting

Salinity has been a major problem in Australian agriculture for many years. Until recently, salinity associated with irrigation has been the main area of concern. Economic analysis of the problem has been caught up in the broader debate over issues such as dam construction and water pricing. Over the last ten years, a new area of concern has emerged, that of 'dryland' salting or saline seepage. The latter term is more precise, since the problem involves a buildup of salt in the catchment area of a given stream, and an increase in the salinity of the stream itself. The increase in dryland salting has been attributed mainly to the removal of deep-rooted tree species, and their replacement by shallow-rooted crop and pasture species (Greig and Devonshire, 1981).

Some of the costs of increased salinity due to tree clearance on a particular farm are internal to that farm, while others are borne by neighbours and downstream users. The proportion of costs which is borne privately varies widely, depending on factors such as location, and the sensitivity of different enterprises to salinity.

22 Work published since this chapter was written supports this contention. Allen (1982) uses econometric evidence to argue that the increases in rent following enclosures were wholly due to the redistribution of existing agricultural incomes from farmers to landlords. He also notes that the positive value of common grazing rights refutes those who have 'loosely argued that commons were common property resources and (hence) overgrazed to the extent that all rent was dissipated.
In both cases, arguments derived from an externality framework have led to, or at least accompanied, various forms of government intervention. Also in both cases, private property rights solutions have been advocated as an alternative to intervention. The purpose of this section is to consider a third alternative: the adoption of common property institutions of the kind discussed in preceding chapters.

The case of dryland salting will be considered in the current section. As noted above, the main activity which affects salinity levels is the removal of tree cover. Greig and Devonshire use regression analysis to estimate this effect, and argue for a Pigouvian tax, which they estimate at $88 per hectare cleared. This estimate includes only the costs of treatment to reduce stream salinity, and not the effects of dryland salting.

Lumley (1982) considers both of these effects in a cost-benefit analysis of reafforestation in the catchment area of MacCallum's creek. Salinity damage here includes both dryland salting effects on farmland, and costs, such as damage to water-using appliances, borne by residents of the downstream town of Maryborough. Lumley shows that, if a discount rate of 7.5 per cent is used, reafforestation would yield net benefits to farmers as a group. At a discount rate of 10 per cent, farmers would lose, but the benefits to farmers and residents combined would still be positive. At a discount rate of 12.5 per cent, the total present value of the reafforestation project becomes negative.

The costs of dryland salting have been recognised by governments. However, the only action so far has been regulatory in form. For example, the Western Australian government has imposed a freeze on tree clearance in badly affected areas. It has also promised to compensate any farmers who are financially disadvantaged by its actions. This approach has been criticised, from a private property rights standpoint, by Hodge (1982). He points out the well-known difficulties with intervention of this kind — in particular the fact that there is no mechanism to equate the marginal costs of preserving tree cover in different parts of the same catchment. In addition, Hodge argues that a freeze is inequitable, since it benefits those farmers who have already cleared a good deal of land.
Hodge proposes a system of transferable clearance rights. The optimal proportion of tree cover would be determined by government on scientific and economic grounds. Each landholder would then be allotted clearance rights for the remaining proportion of the land. If they desired to retain a larger cleared area, they would have to buy clearance rights from their neighbours. The resulting market in rights would ensure that cleared land was allocated to its most valuable use.

There are a number of difficulties with Hodge's proposal. The first, while in some sense semantic, may have a significant effect on the political viability of the scheme. This is the fact that it takes the form of an attenuation of property rights in land, and that these rights can only be restored in full by potentially costly purchases of new rights. As Hodge points out, 'occupiers would be likely to resent the need to buy something which was (already) theirs.'

There are also efficiency difficulties connected with the concept of attenuation. As was discussed in Section 1.3, these are particularly severe in relation to changes in the optimal structure of property rights. In this case, the rights structure depends upon the optimal cleared area, and this cannot be known with any certainty when the property rights scheme is introduced. If the initial limit is too stringent, and is relaxed, individuals will have paid for rights some of which, in the upshot, are valueless. On the other hand, if it turns out that efficiency requires a further reduction in the cleared area, existing rights must either be attenuated or bought up by the State. Either of these solutions involves significant difficulties.

Further difficulties relate to information requirements. For example, it was observed above, that the viability of reafforestation depends crucially on the real discount rate used. The range from 7.5 per cent to 12.5 per cent, used by Lumley, is widespread in public sector project analysis. However in this case most of the costs and benefits will accrue to farmers. In the case of farm investments, it has been argued (Quiggin 1981) that a range of real discount rates around 5 per cent is appropriate. Whether or not this argument is correct, it illustrates the fact that there is a great deal of disagreement about this topic. It seems reasonable to suppose that farmers themselves would be better
judges of the appropriate private discount rate than would a government authority.\textsuperscript{23}

This argument is not quite so clear-cut with scientific aspects of the problem. It could be argued that farmers are not aware of the dangers posed by salinity. However, problems of this kind are normally supposed to justify extension and other forms of education, rather than paternalistic government intervention.

The common property approach provides an alternative both to the taxes and/or regulations suggested by an externality analysis, and to private 'activity' rights, such as those proposed by Hodge. In the case of saline seepage, the catchment system may be treated as an asset over which no effective property rights exist, and for which common property rights may be created, and enforced by the State. The common owners, in this case the group of farmers owning land in the catchment system, could be empowered by government to levy charges on activities, such as the maintenance of cleared land areas, which contribute to saline seepage and thereby degrade the value of the common asset. Since the proceeds of these levies would be distributed among the owners, the welfare of farmers as a group would be increased by an appropriate levy.\textsuperscript{24} As with the enforcement of other property rights, the collection of this levy would, ultimately, depend upon the coercive power of the state. The crucial question here is whether the size of the levy should be determined by government or by a group of common owners.

The creation of common property rights does, of course, imply some attenuation of pre-existing private rights. However, it makes explicit the reciprocity of these limitations, in a way in which a legally imposed redefinition of 'activity' rights does not. It would also permit a more flexible adaptation to changes in the state of technical knowledge about

\textsuperscript{23} There may, of course, by a divergence between private and social discount rates. If this is the case, however, a Pigouvian tax is not the appropriate remedy.

\textsuperscript{24} However, this will not necessarily be a Pareto-improvement. Farmers with a higher than average preference for cleared land, due to factors such as differences in enterprise mix, may lose as a result of the enforcement of common property rights.
the causes and extent of salinity than would the definition of rights to undertake a particular activity, such as tree clearance.

It might be argued that the common property solution is, in effect, the same as that which would be yielded by a Pigovian externality analysis. It is certainly true that, if information difficulties could be overcome, the optimal Pigovian tax would be equal to the optimal levy imposed by a group of common owners. However, the Pigovian theory suggests the imposition of a tax without compensation. As was noted in Section 2.2, this would improve the efficiency of resource use while making all of those affected worse off. Even if such a proposal were acceptable on equity grounds, it would certainly be unlikely to achieve political acceptance.25

A Pigovian remedy would be more appropriate in the case of the unilateral externality imposed by farmers on downstream water users. While this could, in principle, be dealt with by an expanded common property system, there would be some significant difficulties with any voting system, as discussed in Chapter 3. In this case, it would seem simpler to apply a tax-subsidy arrangement to salinity levels generated by the common owners of the catchment. A subsidy may be preferred so as to generate an overall Pareto-improvement. It may be noted that the argument against subsidies for pollution reductions, put forward by Baumol and Oates (1975, Ch. 12) does not apply here. The argument assumes that new firms will be established to take advantage of the subsidy. By contrast, in the common property case, the subsidy is made available to a given group, and its size will not be affected by changes in the membership of that group.

It is apparent that the costs imposed on individual landowners, whether through charges or through reafforestation and the maintenance of tree cover, will be essentially proportional to the area owned in the catchment. In the absence of compelling distributional arguments, this would appear also to be the most desirable basis for distributing the

25 The proceeds of a government-imposed tax could, of course, be redistributed along the lines suggested by a common property analysis. This reflects the difference between common property as a tool of analysis and as an institutional framework.
proceeds of charges levied by the common owners. If the size of landholdings were roughly equal, the analysis of Section 3.5 would suggest that a majority voting system might be preferable. However, since even an initially equal distribution could be skewed by subsequent sales and purchases of land, it would probably be preferable to base the voting system, like the charges, on land area. The dangers of rent-seeking could be minimised by requiring regulatory approval for decisions involving an effective alienation of rights - e.g. a change in the basis of the charging system, as distinct from the rates at which charges are levied.

4.4 Salinity in Irrigation Systems

The problems of salinity in irrigation systems are bound up with the complex economic problems of water supply. Nevertheless, many of the points made in the analysis of dryland salting remain valid.

As in the dryland case, economic analysis of irrigation has followed two main lines of thought. The first has been based on the existence of a public authority with control over the construction of dams, and the allocation and pricing of access to water. This solution has been most widely adopted in practice, generally accompanied by pricing policies which cover little more than operating costs. Watson and Rose (1980) argue that this pricing pattern is characteristic of a system in a 'development phase', and that with the completion of this phase, issues of equity and efficiency in pricing will become more important. A great deal of analysis has been devoted to the problem of determining appropriate pricing policies in this and related cases, taking into account problems such as size economies and peak-load pricing. (See, for example, Baumol and Bradford 1970 and Starrett 1978. These issues are related to the problems discussed further here). Very few of the writers in this area have explicitly incorporated salinity problems into their analysis, though it is frequently mentioned in discussion of the problem. The general approach taken is, however, consistant with the imposition of Pigouvian taxes to deal with salinity.

An alternative approach, based on private property rights in water, has been advocated by writers such as Milliman (1959), Hartman and Seastone (1965) and Phelps et al. (1978). In our analysis, attention will
focus on the work of Randall (1981), who provides an extensive review of the literature, and puts forward property-rights proposals in an Australian context.

Randall criticises attempts to introduce an 'efficient' pricing structure on two grounds. The first is the information load imposed upon the authorities, which was noted in the previous section. The second is that an (unanticipated) change in pricing structures implies windfall capital losses for existing water-users, whereas Randall proposes to consider only Pareto-improvements.26

Randall proposes that, instead of setting prices for water based on estimates of opportunity costs, the authorities should create marketable rights to water. These would be entitlements to have water delivered at a specified time and place and at a predetermined charge. Initially, these rights would be distributed freely, on the basis of historical usage levels, so that existing water users would have their de facto property rights formalised. In the case of new water developments, the authorities would be required to earn sufficient revenue from the sale of entitlements and from charges for water to cover their additional costs. Transfers and sales of entitlements would be unrestricted, except that transfers involving significant alteration in the time or place of delivery would require the approval of the authority.

Randall also suggests that downstream water users, including 'organised groups of conservationists', could buy rights from irrigators. There are, of course, significant free-rider problems here. Another, more fundamental, issue arises from the fact that the river is of value to downstream users regardless of whether dams are constructed. This opportunity cost is not taken into account in the financing rule imposed on the irrigation authority. Indeed, Niskanen's (1974) model of a budget-maximising bureaucracy suggests an alternative possibility. The authority might use funds from the sale of downstream water flows to

26 Randall bases his requirement for Pareto improvements on Buchanan's (1975) contract theory. However, it is not necessary to accept this theory in order to see the attractions of policy schemes which will lead to Pareto-improvements.
subsidise the construction of additional dams. A similar subsidy could be obtained from the surplus revenue yielded by infra-marginal projects.

Problems of this kind are particularly severe in relation to Randall's discussion of salinity. This is considered in the context of a discussion of the pricing of tailwater flows from one individual to another. Thus, the problem is considered in a 'direct interaction' framework, with all its attendant complexity. The property rights solution would require Coasian bargaining between each contiguous pair of water users to agree on a payment for the acceptance of saline water flows. Not surprisingly, Randall comes to the conclusion that 'a system of effluent charges may be somewhat unwieldy in operation' (op. cit. p.215). He suggests that the only possible solution may be ameliorative action by the authorities such as drainage and tube-well pumping.

There is no discussion of the incentive structure or the information load on the authorities here. Following on the analysis above, it may be noted that an expansionist Niskanen-type authority would be likely to ignore some aspects of the problem, such as salinity costs imposed on existing users by new dam constructions. Indeed, as was shown in Section 3.4, even a profit-maximising authority would not take adequate account of the cost imposed on sensitive infra-marginal water users. Further problems of this kind arise from Randall's proposal to maintain 'historically acquired' rights to receive water at less than marginal costs. This gives the authority a clear incentive to downgrade the quality of water which is supplied, or at least to take no action to prevent such degradation.

The discussion above reveals two main problems in Randall's analysis. First, while individual rights to use the water flowing through the rivers system are defined, property rights to the underlying asset itself remain nebulous. The rights are not explicitly allocated to the water authority, but they can be captured by the construction of dams or other irrigation works. The second problem, arising particularly in connection with salinity, is that there is no mechanism to ensure that the authority uses such rights as it does possess in a manner which will maximise the value of the asset.
These problems could be met in a common property institutional framework. Existing irrigators may be regarded as having acquired a common property right to the benefit of some portion of the river flow, as well as to value added by government construction of dams and other works. The first requirement is that the rights in the river flow be clearly partitioned between irrigators and downstream users. This implies a collective obligation on irrigators to leave a downstream flow which is adequate in quantity and quality. As in the case of dryland salinity, this could be done via a tax-subsidy arrangement.

The second, and more fundamental, implication is that irrigators themselves would exercise rights of control over the portion of the river flow to which they were entitled. One way of doing this would be to convert water authorities into corporations and allocate shares in the place of, or along with, water rights for traditional users. The corporation would be empowered to make decisions on pricing and supply levels, subject to a tax-subsidy designed to maintain downstream water flows.

The crucial question here is whether shares should be separable from the associated right to receive water deliveries. Allowing separability would make the transfer of property rights complete and explicit. Indeed, the transfer might be so explicit as to reduce its political viability (compare Sieper's 1982 proposal for 'butter bonds'). The main disadvantage would arise if ownership of the common property asset became effectively separated from the group of users. In this case, many of the problems discussed above would apply. However, it may be noted that the larger are these potential costs, the greater are the incentives for asset users to retain their shares.

4.5 Inventions, Patents and Plant Variety Rights

The area of inventions and patenting has been the subject of a good deal of economic analysis. One notable example is the methodological debate between Arrow (1962, 1969) and Demsetz (1970), referred to in Section 3.1, which arose out of Arrow's analysis of the factors determining the rate and direction of economic activity. While the costs and benefits of the patenting system have been the subject of a good deal
of debate, there would appear to be a general consensus that there are net benefits. Recently, however, there has been vigorous debate over the desirability of extending patenting systems to new areas, and particularly over proposals for Plant Variety Rights (PVR).

The literature on inventions will not be reviewed in detail here. (See, for example, Usher (1964), Dasgupta and Stiglitz (1980) or Tisdell 1981). Rather, some of the main problems raised by the literature will be noted, and reviewed in the context of the common property approach. A system where the allocation of resources to invention is determined by the incentives of a patent system has been seen to depart from a socially optimal allocation of resources in three main ways.

First, the grant of a patent implies the creation of a monopoly. Indeed, in a historical sense, the term 'patent' refers to monopolies granted by governments for a variety of reasons. Patents have been used as a reward, not only for inventions, but for the development of new trade routes, or simply as a revenue-raising device. The deadweight monopoly loss associated with patents depends on whether the invention is supposed to be a new good or an improved method of producing an old one, and on the elasticity of demand (Tisdell 1981).

The second problem is that the inventor does not capture the full social benefit of the invention. This is partly because of the limited life of the patent, which reflects a trade-off between the desire to provide an adequate incentive for invention, and the desire to reduce monopoly cost. Patents are also limited in scope - while it may be possible to prevent the copying of products, it is very difficult to control the use of ideas. The more extensive the scope of the patent, the greater will be the costs of enforcement. In addition to direct costs such as litigation expenses, these include restrictions on independent research and development.

The third problem arises from the fact that a patent is granted exclusively to the first person to develop a particular invention. In a situation where the possibility of making an invention is clear, the marginal contribution of the person who actually succeeds is merely to bring the date of the invention forward somewhat. It might appear that
this problem, which tends to imply that private returns from patents may be higher than the social benefits of investment, would tend to offset the other problems noted above. However, as will be argued below, this need not be the case.

This point may be developed in a common property context, which will permit the analysis of both the rate and direction of inventive activity. This contrasts with much previous partial-equilibrium analysis, which has analysed individual inventions, and hence has had little to say about the direction of inventive activity.

The basis of the common property approach is the treatment of the body of scientific and technical knowledge as a common property asset. This asset may be used without significant congestion effects, but exclusion from at least some consumption activities is possible. Asset quality may be improved by a wide range of 'inventive' activities, including fundamental research as well as the development of new technologies.

In the absence of what may be loosely called 'transactions costs', the first-best solution is for the common property owners to hire resources for inventive activity (hereafter called 'inventors') and make the resulting knowledge freely available. This corresponds essentially to government-funded research, which plays a major role especially in areas of 'basic' research. Indeed, if inventors' work yielded results which were easily predicted and monitored, this would be a first-best solution. However, research work is notoriously difficult to monitor, while the very nature of invention is that it is unpredictable. An important illustration of this is given by 'backyard' inventors. Many of them are simply cranks, but others have produced valuable ideas. It would be virtually impossible to screen them in advance, and hire only those of 'genuine' merit. Even second-best solutions, such as paying a lump-sum for completed inventions, would involve major difficulties of this kind.

Patenting is an attempt to solve these problems by allowing inventors to appropriate part of the benefits of invention, by converting part of the common asset to private ownership. In appropriate cases, this will offer a closer relationship between the social and private benefits of
invention than would a system of direct payments. From the previous discussion it is clear that this relationship is not exact, and that there are likely to be costs associated with monopoly pricing.

Of rather more interest, in the common property analysis, is the problem of overinvestment in areas where a profitable patent may be secured. In this case successful inventors benefit not only from their own work, but from the potential for development already inherent in the pool of knowledge. The invention does not come 'out of thin air' but is dependent on previous, more fundamental research. The grant of a patent allows the inventor to appropriate the benefits of this previous research as well as his/her own work, and means that others can no longer draw upon it freely. This is a classic problem of an open-access resource, which may be analysed in a manner analogous to that of the fishing example.

A simple analysis of this kind tends to suggest that an incentive to over-invest in invention would counteract the problems noted above. This would be correct if only a single form of inventive activity were available. The picture changes, however, when a wide range of inventive activities are possible. It is apparent that, where patents supply the only incentive, resources will be invested in different activities up to the point where the expected private marginal returns are equal to the marginal cost. Over-investment in areas of obvious potential will raise the marginal cost of inventive resources in other areas, and hence tend to reduce the level of activity there. Since inventors are being allocated in an inefficient fashion, this effect will tend to reduce rather than increase the overall rate of invention. If the total supply of inventors is inelastic, this effect will tend to outweigh any tendency to attract new resources to invention.

This point may be treated in the context of open-access resources generally. The argument may be put most simply by considering a resource, such as agricultural land, which is variable in quality. High-quality land is available in limited quantities, but marginal land is effectively a free good. Open access will imply over-intensive use of high-quality land. However, if the supply of resources for agriculture is inelastic, agricultural production may be below, rather than above, the optimal
level. A somewhat similar model is put forward by Gould (1972), who shows that inefficient factor combinations may yield a sub-optimal production level, even though 'excessive' factor inputs are used.

The proposed introduction of PVR provides a case study of the problems involved in converting common to private property by means of a procedure such as patenting. PVR has been the subject of vigorous debate, both in Australia and overseas. References are given by Ockwell (1982) and Godden (1982).

At present, plant breeding in Australia is dominated by publicly funded, freely disseminated research, such as that carried out by CSIRO. Private breeding is not protected by existing patent laws, since breeding a new plant variety is not considered to be an invention. There are, however, some other methods by which private breeders can seek to appropriate the benefits of their research. These include trade marks, and in the case of sterile hybrids, trade secrets with respect to parent lines.27

Many of the opponents of PVR have explicitly argued that the granting of PVR enables the private appropriation of common property in a way in which the patenting of inventions do not. Such arguments have been criticised as 'emotional', and based on an unreasonable distinction between living and non-living 'inventions'. As has been argued above, all forms of patent involve some private appropriation of what are effectively common property resources, and thus the costs and benefits of PVR will be similar in kind to those of patenting in general. However, the nature of the plant breeding activity is such as to make the common property aspects of the problem particularly significant, and hence to weaken the case for the use of private property rights.

Plant breeding consists, in essence, of the sorting and recombination of materials already existing in the gene pool. While this is a highly skilled activity, it is essentially 'routine' in nature, in the sense that its results are sufficiently easily predicted and monitored to make

27 Godden gives further details on this.
the hiring of inventive resources a practical method of organisation. The difficulties which bedevil the public provision of inventive activity are not nearly so prevalent in this case. The main scope for genuinely 'inventive' activity in plant breeding relates to the development of new techniques which can then be used to develop a range of new varieties. PVR would protect the varieties themselves, but the techniques, if not protected by existing patent legislation, could only be protected as trade secrets.

Thus, the replacement of publicly funded breeding with private breeding financed by PVR would be unlikely to yield substantial efficiency gains. On the other hand, because of the relatively predictable nature of the activity, the potential for misdirection of research resources in an attempt to secure rights in profitable areas is quite significant. This will depend on the nature of the particular PVR scheme which is introduced.

Perhaps the most important question is that of the requirements for a new variety to be registered. If all that is required is that the new variety should be different from those already registered, then the protection afforded by PVR is very limited. A breeder who develops a high yield, pest resistant variety will be faced with competition from others who breed in slight variations, say in colour, and register the results as new varieties. In effect, the breeder will be forced to rely on a combination of trade-mark and trade-secret protection, as at present. Similar difficulties would arise if the sale of unregistered varieties and seed mixes was permitted. It would be very difficult for a breeder to prove that his/her rights were being infringed by such sales. For these reasons, the European PVR system requires that new varieties for registration be submitted for 'merit testing' to demonstrate that they are in fact an improvement. Sales of unregistered varieties are prohibited.

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28 Some areas of invention already covered by patent rights may share this characteristic. For example, drug companies find it profitable to hire, and monitor the work of, large teams of researchers. In such cases, publicly funded research would appear to be superior to the use of a patent system.
These procedures make it possible for plant breeders to appropriate the benefits of their own work, but they also maximise the opportunities to appropriate previously common property and hence the incentive for over-investment in areas of obvious profitability. For, under this scheme, once a particular property of the pre-existing gene pool has been captured in a registered variety, nobody else may exploit it.\(^{29}\)

Other problems relate to enforcement costs. In Australia most seed for crops such as wheat is produced on-farm from the previous year's crop. The prohibition of this practice would involve substantial costs. However, if this method is used under PVR, substantial benefits could be captured only with very high initial prices for seed. This in turn would heighten the incentive for various forms of 'piracy'.

The PVR legislation under consideration at present does not involve merit testing, restrictions on unregistered seeds, or a prohibition of on-farm seed production. Hence, it is probable that Godden is correct in suggesting that 'The likely effects of PVR in Australia appear to have been overstated by both opponents and proponents of PVR (1982, p.88)'. However, once a limited form of PVR has been introduced, Godden notes the possibility that its effects may be amplified by regulatory changes such as those noted above. The lobbying effort devoted to the campaign for, and against, PVR suggests that this possibility is a very real one.

Ultimately, questions such as the desirable balance between common property and private property in invention and plant varieties must be resolved by an empirical examination of the costs and benefits. The common property approach provides a useful framework, within which these costs and benefits may be assessed.

\(^{29}\) Similar difficulties can, of course, arise in other areas of patenting. However, the fact that all plant varieties are drawn from a common gene pool renders these difficulties particularly 'acute'. The problem of determining whether or not an invention is 'genuinely novel' seem almost trivial in comparison.
CONCLUDING COMMENTS

The economic analysis of pollution and other environmental problems has been the subject of a vigorous and creative debate. It has given rise to a number of competing methodological programmes and analytical tools. Many of these, such as the property rights approach and the concept of externality, have had widespread implications for economic thought. Despite, or perhaps because of, this profusion of creative ideas, many fundamental problems within the area of environmental economics remain unresolved.

In this context, it may seem rash to introduce another competing paradigm. Nevertheless, I believe that the preceding work shows that the common property approach has much to offer. Its first contribution is a more realistic and tractable description of many actual property rights structures. As has been shown above, attempts to force all property rights into the mould of pure private rights have hampered economic analysis. These problems have been particularly severe when actual common property institutions have been analysed within a framework which treats 'common property' and 'open access' as synonyms. Confusion between private and common property rights has also been evident in many areas where 'transactions costs' have traditionally been ascribed a major role.

In addition to the examples discussed above, a framework using common property as well as private property concepts would be useful in the analysis of institutions such as the joint-stock corporation. Both the orthodox theory of the shareholder-controlled firm, and the competing 'managerialist' theories imply the existence of important common property elements in the institutional structure. Issues such as the role of voting systems are clearly of great practical importance here.

While the recognition of common property as an institutional framework is important, the central contribution of this thesis relates to the analysis of environmental problems. The development of the concept of common property as a basis for the analysis of 'externalities' and related problems almost invariably involve the use of an asset, which is at least potentially the subject of common property rights, and that the optimal usage of this asset may be determined with reference to a group
of common owners. This insight may be formalised, as in the model of section 1.7, or simply used as a heuristic basis for analysis. The common property analysis may be used to derive policy recommendations for government in cases where the establishment of common property institutions is not feasible.

The concept of common property allows an effective move from 'direct interaction' to 'asset utilisation' as the basis for analysis of economic problems. Both the Pigovian 'externality' approach and the Coasian 'activity rights' approach are based on direct interaction between individuals, and this is responsible for many of the difficulties associated with these approaches. Mohring and Boyd's attempt to introduce an 'asset utilisation' approach foundered, largely because of their use of private ownership and profit maximisation as the basis of their analysis. This obscured the fact that maximising the profits of a private owner is not necessarily equivalent to maximising the value of an asset.

None of the alternative paradigms mentioned above have yielded a resolution of the fundamental question - when will private ownership of an asset lead to an optimal pattern of usage? Perhaps the most popular solution has been based on Baumol and Oates' distinction between 'depletable' and 'undepletable' externalities. As has been shown, however, Baumol and Oates' approach is both internally inconsistent and analytically flawed. A common property analysis yields the linear damage condition put forward in Chapter 3 - the requirement that any consumer surplus should be independent of asset quality.

The analysis of the behaviour of common property institutions is a subject which requires a great deal more attention than has been afforded here. Such issues as voting systems, coalition formation and the behavior of custom-based institutions must all be considered in greater detail. It can be stated, however, that common property institutions have worked effectively in such diverse situations as the medieval village and the modern corporation, and that they may provide the best available solution to many environmental problems, especially those involving a high degree of reciprocity. The case of dryland salting, considered in Chapter 4, is an ideal example.
Finally, the analysis of inventions and patents, based on the concept of the pool of knowledge as a common property asset, gives some idea of the range of possible extensions of the common property approach. I hope that this thesis may prove to be a worthwhile addition to the common pool.
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APPENDIX - THE TAXONOMY OF COMMON PROPERTY

The object of this Appendix is to contrast common property, as defined in this thesis, with alternative institutional forms.

A sharp distinction has been drawn between 'open access' and common property resources. As pointed out by Ciriacy-Wantrup and Bishop, an 'open access' situation is one where no effective property rights exist. In the pure open access case, there are no controls over the range of uses of the asset or over the intensity of asset use. This situation may occur because the enforcement of property rights is prohibitively expensive, as in the case of 'fugitive' resources'. Alternatively, resources which are ultimately subject to public control may be left in a condition of open access for a variety of reasons. By contrast, a pure common property situation is one where "rights of use, alienation and exclusion are held by a group of co-equal owners, and the way in which these rights are exercised is determined by a decision rule which gives all individuals equal weight".

There are a range of possible intermediate institutional forms. One which has received some attention arises when the group of owners can exclude outsiders, and control the range of permissible activities, but cannot directly limit usage by group members. If the number of group members is large, this case is essentially equivalent to open access. If the number is small, game-theoretic considerations come into play.

Individual usage may also be outside the control of the group because usage rights are rigidly fixed by law or custom. It is frequently difficult to distinguish this situation from a true common property situation which has reached a stable equilibrium usage pattern. The two cases will be distinguished by the response to a change in technology or prices which makes the existing usage pattern suboptimal for all or most group members. In this case, true common property institutions will normally generate an adaptive change in usage patterns.

Alternatively, there are cases when controls over usage are applied but there is no exclusion, so that the group of owners is co-extensive with the entire community. This will generally involve state ownership, but the two are not logically identical. For example, the state may administer property even though the relevant group of users is quite limited. In some sense, this 'paternalist' approach is implicit in the use of regulation or Pigovian taxes to control local externalities. As a converse, it would be possible to conceive of general representative institutions, separate from the government proper, being established to manage particular common property assets. As noted in the thesis, the common property analysis may be used to develop management rules for publicly owned assets. However, space considerations preclude analysis of the associated institutional frameworks.