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Australia's natural resources: optimising present and future use

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Foreword

Australia's natural resources are the base for the continued growth of the economy and well-being of society. Natural resources provide both commercial development opportunities and a wide range of 'conservation services'. In recent years, there has been an increase in competition among demands for the alternative uses of these resources, and a corresponding increase in tension between development and conservation groups.

In this paper, the economic issues involved in the use of natural resources are examined. Some suggestions are made for changing the policy framework to more efficiently meet the range of demands for resource use. The emphasis is on provision of incentives designed to bring about the greatest long term net benefits to the Australian community as a whole.

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Executive Director

Australian Bureau of Agricultural
and Resource Economics

May 1991

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Summary

Natural resources are important sources of income . . .

Development and use of Australia's natural resource base has played a major role in the growth in national income and the well-being of the community over the past two hundred years. The commercial aspects of natural resource use are important to the Australian economy. In 1989-90, for example, the resource-based industries — farming, fishing, forestry and mining — contributed around 12 per cent of total gross domestic product and around 67 per cent of total exports of goods and services.

. . . and environmental benefits

Natural resources such as land, forests and waterways also provide a large number of environmental amenities. These range from the opportunity for recreational use of forest, beaches and national parks to the possibility of future commercial benefits from maintained genetic diversity, and the satisfaction which some people derive from knowing that particular species or ecosystems continue to exist.

Getting the most out of natural resources

A stock of wealth for current use . . .

Natural resources represent a stock of wealth. This wealth can be used in a number of ways to provide a flow of goods to the community. Some natural resources, such as forests and fish populations, can either be used up now or managed so as to produce benefits over time. Others, such as fossil fuels, are not renewable. In either case, the question arises of how to manage the development, conservation and use of the resources so that society gets the greatest benefit over time. The fact that resources are scarce relative to the competing demands for them requires that trade-offs be made both

between alternative current uses and between current and future use.

. . . and future use

Another question is how society wishes to transfer wealth between generations. For depletable natural resources the current generation has the option of using the resource now and consuming the proceeds, using it now and generating other kinds of wealth with the proceeds, or saving the resource in its natural state. In some cases, using the resources now in order to build up capital stock and technology may be a more effective way of passing on wealth to the next generation than leaving those resources intact.

Absence or incompleteness of markets

Markets difficult to establish . . .

For most goods produced and used in the Australian economy, production, distribution and consumption are managed through markets. However, in a significant number of cases, there are no effective markets. In some instances, particularly where environmental amenities are concerned, markets do not exist because their development is too difficult or expensive to justify the effort. Organising a market to buy and sell views over a mountain range, for example, may be very difficult. In other areas, the development of efficient markets has been precluded by the way ownership has been defined or by other governmental decisions. For example, a market for trading mineral rights has not been fully developed because of constraints imposed by government allocation of prospective areas.

. . . when non-payers cannot be excluded

Certain types of goods are instrinsically difficult to market. Such goods have one or both of two characteristics. The first is that it is impossible to exclude non-payers from the consumption of the good (non-excludability). The second is that consumption of the good by one person does not preclude consumption of the identical sample of the good by anyone else (non-rivalry). Goods which have these

characteristics may be difficult or impracticable to produce and distribute through markets, and will generally not be provided by markets at socially optimal levels.

'Off-site' environmental benefits and costs . . .

The primary area in which natural impediments to the development and functioning of markets are important in the use of natural resources is the conservation of environmental amenities, particularly in relation to benefits which arise 'off-site'. There may be no significant impediments to the development of markets for 'on-site' use of environmental features. Entry fees to national parks, for example, can be charged, although collection costs may make it not worthwhile to do so in some cases. In contrast, off-site benefits, including those which people draw from the knowledge that particular species and ecosystems are preserved, are generally both non-excludable and non-rival. Once a species or area is conserved, the off-site benefits are available to any number of people without increasing the cost of provision and there is no obvious way of identifying those who benefit and ensuring that they pay commensurately.

. . . make provision by markets difficult

Problems associated with natural impediments to the use of markets arise to some extent in most agricultural, mining, forestry and fishing industries. For example, native forests provide benefits by way of protection of water quality and conservation of genetic diversity, species and habitat; agricultural and grazing activities have adverse off-site effects related to soil erosion, salinity and downstream flooding, for which no market extracts a payment; mining has non-marketed effects on surrounding ecosystems associated with the siting, operation and extent of rehabilitation of mines; in open-access fisheries, no individual fishing operator can gain significantly by decreased fishing, even though there may be considerable gains for a fishery as a whole from limiting fishing effort.

Some private provision of environmental benefits

Such natural impediments to marketing do not necessarily mean that no environmental

amenities will be supplied without government intervention — only that there is no reason to expect the supply to be socially optimal. For example, in the United States the Nature Conservancy, a non-profit agency, manages a large number of reserves for specific habitat and conservation purposes and is financed by membership fees and corporate sponsorship. More broadly, people frequently donate funds to charities and to other private organisations involved in the supply of recreational and conservation facilities. What is important is that government activities be designed to supplement the private supply of such goods, rather than inhibit private efforts.

Important that government does not inhibit private provision

Taxes, industry assistance and regulation

Impediments to the development of efficient markets can result not only from natural causes but also from the decisions of governments. In particular, governments are often responsible for defining, assigning and enforcing ownership and use of resources. Clear definition of ownership of or access to resources is important to the successful operation of a market. Governments may also have a strong influence on the effectiveness of markets by way of taxation and industry assistance programs. For most Australian natural resource based industries there is limited or no direct assistance. However, support for other industries, particularly the vehicle manufacturing, textiles, clothing and footwear industries, can limit the development of resource industries by drawing resources toward the assisted industries. Regulation of side effects, and direct government provision of environmental amenities, are further areas of government influence in markets.

Sustainability and resource use

Concern about irreversible effects

In recent years there has been increasing concern about whether or not existing resource uses and consumption patterns can be sustained. Much of that concern has centred on the fact that some consequences of resource use decisions are

irreversible. Some examples of this are the depletion of fossil fuels and of gene pools, soil erosion and the influence of human activities on climate. More recently, it has been argued that economic, as well as ecological, systems should be sustainable — that resources should be used so as to minimise the stress imposed by environmental degradation on the economic system. For example, soil loss and salinity will constrain the ability of the Australian agricultural industry to respond efficiently to changes in world market conditions.

Using natural resources to increase skills and physical capital

An economic criterion for sustainable development centres on the view that an economy's capital stock is made up of both natural and manufactured capital, and that reduction of natural capital is offset by conversion of at least part of that wealth into other, manufactured, forms of capital. While there may well be legitimate arguments for preserving some natural assets, it must also be recognised that such preservation limits the scope for current income and for the development of human skills and physical capital for future generations.

Resource ownership and resource rent

Public and private ownership of resources

A second, related set of issues concerns the assignment of rights of ownership of or access to natural resources, and the returns to resource owners. The nature and degree of public and private ownership of resources varies considerably between resources and between the states. Most of Australia's urban and agricultural land is owned by private agents. On the other hand, rights to minerals, oil and gas, most fisheries and many forests have been retained or resumed by government.

Community benefits from private ownership

Where land ownership rights belongs to private agents, there is generally a strong incentive for the owners to maximise their long run returns from use of that land. In this case, the major public policy questions concern any

side-effects of the activities of the resource owners on other resource users or on consumers. Only if resource users bear the full consequences, both positive and negative, of their individual actions will they have the incentive to make choices which will be of maximum benefit to the community as a whole.

Sharing returns to publicly owned resources

For resources under explicit public ownership, a further question is how the returns from these resources should be shared between the resource users (such as mining companies) and the rest of the community. Particular attention has been paid in recent times to the design and efficient implementation of resource rent charges — that is, charges designed to return to the general public some of the value of the resource consumed by private users. Two areas of concern include the way investment may be distorted if the charges are set incorrectly, and the administrative costs of collecting the charges. A more general concern about publicly owned resources centres on the way that some rules of access may encourage wasteful lobbying or exploration activities. There is, for example, evidence that the work program system of assignment of mining rights may encourage excessive exploration. More widely, if there are significant returns to lobbying and other private efforts to gain access to publicly owned resources, entrepreneurial effort may be directed to those ends rather than to pursuits of more benefit to the society.

Misdirection of effort to gain private access to public resources

Policy alternatives

Four main approaches

A number of approaches could be taken to ensuring that the Australian community derives the greatest net benefit from use of its natural resources. The major approaches are: the free operation of markets; direct government management; the establishment of 'parallel' markets through public organisations; and reliance on regulation of activities of market participants.

Efficient markets require transferable property rights and information

Markets continue to be the dominant mechanism for successfully organising the production, distribution and use of a wide range of natural resource based goods, including most of the output from the mining, rural and processed forest products industries. Efficient markets require an ability to fully specify property rights, freedom to transfer those rights, and the availability of information. Property rights need to be specified so that owners of resources bear the full consequences of their actions, and thus have an incentive to take account of all the costs and benefits of those actions. Transferability of rights facilitates efficient resource use by allowing resources to be moved to those uses where they are most highly valued. The availability of information is important in that it enables the various options to be known and evaluated by alternative users.

Alternatives where markets do not work:

As has been explained above, for some resources there may be economic or other reasons for not depending totally on market systems. Where this is the case, there are two alternative approaches of particular importance. These are government management of resources, and the establishment of markets for rights to use environmental amenities. Regardless of whether either of these strategies is followed or whether some regulatory solution is adopted, it will usually be necessary to make some estimate of the social value of the return from these resources. Despite the advances in estimation techniques which have occurred in recent years, the methods available for this purpose will not always give accurate results.

government supply . . .

The most common areas of government involvement in resource management are in the provision and management of conservation reserves (such as national parks), forest management, minerals exploration and the regulation and supply of information to operators of farms, mines and fisheries.

Where a resource is non-excludable — that is, it is impossible to exclude non-payers from

consumption of the resource — it may nevertheless be possible to develop a 'parallel' market which will enable allocation (possibly by auction) and trading of limited rights of access or use. One area where such parallel markets have been developed is fisheries. Here, the natural impediment to ownership of the resource results in overexploitation and excessive fishing effort. Regulation of fishing effort has not been effective. One solution has been to allocate quotas for size of catch, and allow these quotas to be bought and sold. This provides quota owners with the incentive to economise on the effort employed to catch their individual allowable limits, and with an asset to trade in the process of rationalisation of the size and structure of the industry. A move toward the establishment of a system of transferable irrigation water rights provides another example of the introduction of a market into a situation in which allocation of a resource was previously entirely by regulation. However, there is potential for much further progress in setting up marketable water rights. In addition to fisheries and water use, such solutions have also been suggested for the limitation of salinity resulting from irrigation and from the clearing of trees from farmland.

. . . or individual quotas

Untapped potential for quota markets

Non-market supply and 'off-site' effects

Although markets have broad current and potential applicability, regulation has in the past been a more common approach to the management of natural resource use and may, in fact, be relevant where other methods of management fail. This seems most likely to be the case where production and consumption decisions have significant side-effects. For example, other approaches may fail if there are important off-site conservation benefits associated with a natural site which has conflicting development potential for agriculture, mining, forestry or perhaps urban use.

If regulation is used, full costs should be considered

However, for a regulatory alternative to be efficient, it must not only result in the desired change in individual or firm behaviour, but also

do so in such a way that the gains outweigh the costs. To make such an evaluation will often not be a simple process. Estimating the value which people place on non-market benefits can be difficult. In addition, consideration must also be given to the likelihood of the regulation succeeding. Further, the costs of regulation — information, administrative and enforcement costs — are seldom considered in full and are not always obvious. Finally, regulation may impose significant costs by leading to distortions in resource use.

CHAPTER 1

Introduction

Federal and state government policies concerning the allocation and use of Australia's natural resources have come under increasing scrutiny in recent years. This is the result of increasing competition for access to resources and growing concern over the preservation of environmental quality.

Natural resource based industries form an important component of the Australian economy, with farm, forestry, fishing, mining, energy and minerals processing industries contributing around 12 per cent of total gross domestic product in 1989-90. The same industries dominate Australia's export sector, accounting for 67 per cent of total exports in 1989-90. At the same time, many of the resources on which those industries are based play an important role in recreation and nature conservation.

The importance of the natural resource base to the Australian economy means that the adequacy of government policies, and their effects on the economic system, are crucial to the well-being of society. Impediments to the efficient allocation and use of resources will reduce the well-being of both current and future generations in terms of wealth forgone and lowered standards of living.

The purpose in this paper is to provide an economic perspective on issues and policies concerning the use of Australia's natural resources — minerals, energy, fish, forests, water, soil and air. In the next chapter, some background is provided on the role of natural resources in the Australian economy, with attention to both the commercial and non-commercial aspects of resource use. The major economic issues, and possible policy approaches, are discussed respectively in the two following chapters.

A recurring theme in the analysis is the potential for increased use of the market system in allocating the uses of natural resources, both between economic agents and over time. Markets have been used successfully in the management of a number of resources for both commercial and environmental purposes. Extending the use of markets, either by changing current institutional arrangements or by providing additional price signals through taxes and subsidies, is likely to result in more efficient use of resources than can be achieved through the present heavy reliance on regulation. These issues and some examples of the potential for expanding the use of markets are discussed in an Australian context by Moran, Chisholm and Porter (1991).

CHAPTER 2

The nature and sustainability of resource uses

The use of Australia's natural resources has clearly been a major factor behind the growth in national income and the well-being of the community. The importance of natural resources — minerals, energy, fish, forests, soil, water and air — to the Australian economy cannot be over-emphasised. However, the well-being of the community does not depend only on the commercial development of resources. Natural resources provide a range of 'conservation services' which are also valued. In this chapter, the relative significance of the resource sectors — agriculture, forestry, fishing and mining — is briefly reviewed and the characteristics of conservation services are discussed.

Also discussed in this chapter are two topics that are fundamental to the allocation and use of natural resources in such a way as to ensure that the greatest net benefits accrue to society as a whole. These are, first, the nature of the trade-offs inherent in resource use, and, second, the sustainability, across generations, of commercial and alternative resource use options.

2.1 The role of natural resources in the economy

Natural resources can be seen as a stock of wealth from which society can gain value. This value arises either from the resources remaining in their natural state or by their transformation into other goods and services. This stock of wealth plays an important role in Australian society by providing a flow of goods and services, through both the commercial development of some resources and the enjoyment of services arising from conservation of others.

Natural resources and resource industries

The success of Australia's economy has been based largely on the use of its natural resources, and this dependence will continue for the foreseeable future. Australia is heavily reliant on the export of commodities derived from the use of these natural resources. Of the $58.9 billion total exports of goods and services from Australia in 1989-90, around $39.6 billion can be attributed to the use of natural resources (ABARE 1991, p. 114) (see figure A). These exports are obtained either by direct extraction, as in the case of minerals and fish, or indirectly from soil and water resources, as in the case of farm commodities.

The resource industries' importance in the composition of exports contrasts with their smaller shares of gross domestic product and employment. In 1989-90 the resource-based industries together accounted for 12.7 per cent of gross domestic product (figure B) and 7.7 per cent of total employment (figure C). On the other hand, the mining and

basic metal products industries are relatively capital-intensive, and generated around 17 per cent of private new capital expenditure in 1989-90 (ABARE 1991, p. 120).

Natural resources and environmental amenities

As well as providing the base for Australia's major export industries and for important domestically oriented sectors of the Australian economy, natural resources provide a wide range of environmental amenities. These can conveniently be considered in four broad categories.

First, forests, streams, seas and other natural areas may be important in the conservation of pools of plant and animal genetic material which may be of commercial value in the future. Second, there are strong commercial and consumer demands for access to clean air and water. Third, forests, wetlands, coral reefs and a range of other natural features serve as the venues for a wide range of recreational activities and as fields for scientific research and education. Finally, people may gain satisfaction from the knowledge that particular species and ecosystems are protected, quite apart from any act of visiting the sites of that conservation.

It is particularly important to distinguish between 'on-site' benefits and 'off-site' benefits associated with environmental amenities. On-site benefits arise from current use of the site for recreational pursuits and from values associated with potential future uses of the site (see the discussion of option price and quasi-option value in box 1). Off-site benefits — usually associated with the conservation of natural features

A Contributions of resource sectors to exports, 1989-90

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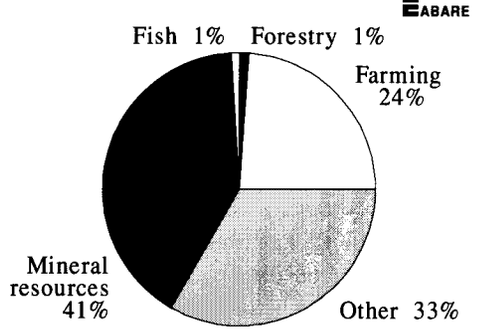

B Sectoral shares of gross domestic product, 1988-89

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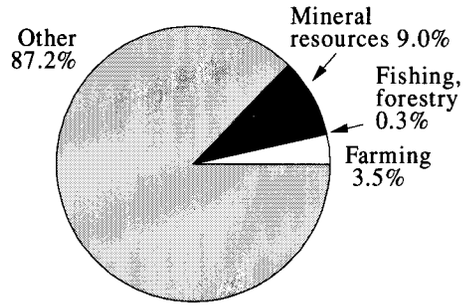

C Sectoral shares of employment, 1989-90

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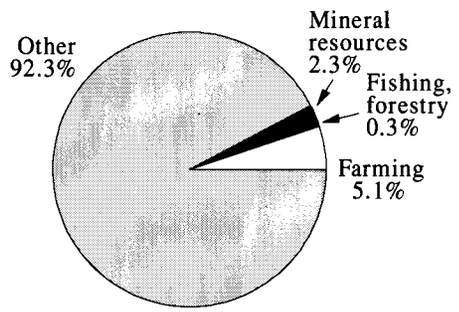


— can be broadly defined as 'existence values' (see box 1).

Existence values are important, but are difficult to define clearly and to measure easily or accurately. Off-site amenities are not traded in markets and, as a result, have no observable prices. The same may frequently be true for option prices and quasi-option values. A considerable effort has been put into the development, testing and refinement of methods of estimating the monetary value to people of unpriced environmental services. Three major methods which have been developed are the travel cost method, the indirect market method ('hedonic pricing') and the contingent valuation method.

These methods are outlined and discussed briefly by Young and Allan (1986) and Rose (1990). Each of them may have some advantages in particular circumstances. However, none is cheap to apply and none is guaranteed to give accurate results. There may be a considerable degree of inaccuracy and, particularly with contingent valuation, bias introduced by attempts of the people surveyed to influence the results. Samples, Dixon and Gowen (1986) and Bergstrom, Stoll and Randall (1990) show that estimates produced from contingent valuations are strongly dependent on the information provided to survey participants and on the context of the survey. There is also the problem of defining 'the extent of the market' (Smith 1991) relevant to any contingent valuation study. Smith raises two questions. The first concerns the ability of people participating in contingent valuation surveys to distinguish between values of particular assets, such as an addition to a specific national park, and more general conservation issues, such as values of all national parks. The second concerns the geographical extent of the relevant market; whether values should be sought from local, regional, national or even larger populations. The economic issues associated with incorporating non-market values into policy development are considered in section 3.2.

2.2 Maximising the social benefits of resource use over time

From an economic perspective, the major objective of natural resource management is to maximise the net benefits society receives over time from the use of available resources. As was noted in the previous section, use of natural resources in this sense includes both commercial and conservation aspects of production and consumption decisions. The need for choices to be made in relation to natural resources stems from the scarcity of the resources relative to competing demands. At an aggregate level, the policy question is relatively straightforward: what trade-off between current and future use of the available resources will yield society the greatest overall benefits?

Natural resources constitute a stock of capital, and are used in ways which provide a flow of goods and services to society. The distinction between renewable and non-renewable resources (box 2) is important when considering broad policy approaches to resource management. For non-renewable resources, the key issue is how fast the resources should be used. In the case of renewable resources, the central

Box 1: Values of environmental amenities

In addition to values arising from current uses of natural resources, a range of values may be derived from environmental amenities.

Off-site values

Existence value: A value which is derived purely from the knowledge that an amenity exists and which is not associated with actual or potential on-site use. People may, for example, value the knowledge that Antarctic penguins or nocturnal marsupials exist, without having any prospect of seeing them directly. Existence values may take a number of forms. People may, for example, enjoy the observation of natural amenities in print media or through wildlife documentaries on television. People may also derive satisfaction from a sense of 'stewardship' associated with protection of natural assets.

Existence values have conventionally been associated with wildlife and other natural assets. However, people may derive existence values from other sources. For example, some people may derive a sense of 'stewardship' (or a 'bequest value' — see below) from knowledge that the country's mineral resources have been used to provide income for the welfare of the current generation and for investment in capital to improve the welfare of future generations.

Bequest value: The value of the assurance that future generations will have access to the amenities.

On-site values

Option price: The maximum price people are willing to pay to retain the option of making future use of an amenity. Option prices arise because of the risks which are inherent in making development decisions which may be difficult, or impossible to reverse should future demands and technologies increase the value of a different course. Option prices are reflected in the prices of a wide range of market goods, such as commercial stock and commodity options, and also in insurance premiums.

However, there is also a range of amenities for which markets for options may not exist. People may, for example, value the option of visiting a number of nature reserves without any certainty of doing so. People may also value the continued existence of genetic diversity in plant and animal populations because of the option of future economic uses of those resources.

Option value: Much of the economic discussion of options for natural resource preservation has been couched in terms of a measure of 'option value' defined as the difference between option price and the average satisfaction realised when the opportunity to exercise the option arises. Option value defined in this way is normally treated as an off-site value. Smith (1987) has demonstrated that there is no logical basis for addition of a separate 'option value' to off-site values. The relevant concern is with option prices for the site.

Quasi-option value: The expected increase in the value of returns from a resource due to access to improved information about its alternative uses, over time, if the resource is not used up now.

management question is whether to use up the resources now or to maintain a sustainable flow of resources into the production and consumption processes. In either case, the underlying questions are how society wishes to hold its wealth or capital, and how it wishes to manage the flow of goods and services over time.

Trade-offs and efficiency

The choices to be made can be seen as trade-offs, which will invariably involve some form of substitution. Trade-offs may be made between natural and manufactured capital, between different types of natural capital, between different types of manufactured capital, or between income and assets today and income and assets at some time in the future.

The critical elements in the first three types of choice are the extent to which substitution is in fact possible between the different forms of capital, and uncertainty over future production possibilities. The ease with which manufactured capital, renewable resources and non-renewable resources can be substituted depends largely on the existing technology. Future possibilities for substitution will depend on the rate of technological progress.

In principle, if substitution between the different forms of capital is easy, there is a wider range of means by which the flow of goods and services to society can be optimised. For example, in some energy applications, it is relatively easy for consumers to substitute away from non-renewable, fossil fuels to renewable energy sources, such as solar energy. In other cases, the possible extent of substitution may be limited by some minimum level of, say, a non-renewable resource input required in a production process. For example, a number of 'strategic' minerals, such as chromium and gallium, currently have no viable substitutes in important applications in defence and high technology industries. How and when stocks of such a resource are used may then be more important than in the case of a resource for which there are feasible substitutes. However, as is discussed in section 3.1, market processes tend to provide incentives which will in such cases assist in stock management and in

Box 2: Classes of natural resources

The range of natural resources is usually divided into two broad groups according to their physical characteristics:

Renewable resources are those which have some significant natural rate of growth, and resources unaffected by human activity. These resources can supply productive inputs to the economic process indefinitely, though in the former case this requires that their regeneration not be prevented. Fish, forests, surface water and solar energy are examples. In some cases soils, such as alluvial soils, may be renewable.

Non-renewable resources are those resources for which the rate of replenishment is either zero, or so low that it does not offer potential for augmenting the stock of the resource within an economic timeframe. In effect, however, the life of the resource stock can be extended through recycling and/or technological change. Minerals and fossil fuels are examples. Other examples are water from artesian basins and soils developed as a result of past glacial activity.

the generation of substitution possibilities.

The fourth type of choice — between income and assets today and income and assets in the future — is considered in the subsection below.

To speak of maximising the social benefits of resource use implies a concept of efficiency. The allocation and use of resources is said to be efficient when all resources are applied to their highest valued combination of end uses, including both commercial and conservation uses, and uses both current and future. It can be shown that, under certain assumptions, efficiency in this sense will be achieved by market systems. However, in the present context 'value' includes not only commercial value but also the values of goods and services which, for any reason, are not priced in the marketplace. Economic issues raised by the absence of markets and lack of prices for certain goods and services are discussed in the next chapter.

Intergenerational choices

Decisions made by current generations, in making efficient trade-offs between uses of resources, will have consequences for future, as yet unborn, generations. The view might be taken that high income generated by the current generation's use of natural resources entails lower standards of living and poorer environmental quality for future generations. On the other hand, high income now may result in high investment, increasing the income of future generations. At the broadest level, society faces choices as to whether, and if so, how, to transfer its wealth over time.

The current generation has a number of choices: using any given resource now and consuming the proceeds; using it now and putting the proceeds toward generating other kinds of wealth (for example, investing in education or technology); and saving the resource in its natural state. When considering these choices, it is not necessary to presume that the consumption patterns of all current and future generations will be identical. Indeed, the use of some resources now in order to build up capital stock and to contribute to new knowledge and technology might be a more effective way of passing on wealth to the next generation than leaving a resource intact. It is not possible to determine how future generations will wish to hold their wealth. This argument has been summarised by Solow (1986, p. 142):

> The current generation does not especially owe to its successors a share of this or that particular resource. If it owes anything, it owes generalised productive capacity or, even more generally, access to a certain standard of living or level of consumption. Whether productive capacity should be transmitted across generations in the form of mineral deposits or capital equipment or technological knowledge is more a matter of efficiency than of equity.

In some instances, the current generation may wish to make a commitment never to use a particular resource or change some part of the environment. However, Fisher and Thorpe (1990, p. 90) argue that by saving a resource in its natural state, rather than allowing its commercial development, '. . . the community trades-in a stream of financial returns over time for an uncertain future income or for some intangible benefits that may be associated with an unchanged environment'. Generally there will be some degree of uncertainty about the future development alternatives and the value of benefits from not developing the resources.

When considering the distribution of income and assets between generations, it is necessary to decide what is an appropriate discount rate. The discounting of future costs and benefits has generated much debate, and a substantial literature exists on this subject. Some groups have argued against such discounting, claiming that current and future generations should be treated equally. Note, however, that people using a zero discount rate for comparing costs and benefits over time would reduce current consumption to subsistence levels in order to reap the gains in future consumption that would be generated by the compound interest on their savings (Chisholm 1988, p. 23). The co-existence of positive rates of interest and consumption levels well above subsistence implies that society has a positive discount rate.

Of more immediate concern is the possibility of a divergence between the discount rate of society as a whole and the private discount rate of individuals. Fisher and Thorpe (1990, p. 100) note two possible reasons why the social discount rate might be less than the private discount rate. The first is that agents acting collectively may reduce their individual risk by pooling risk or spreading risk among the group. So the risk premium and, therefore, the discount rate, required by the group may be lower than that for individuals acting alone. Second, if members of the current generation attach a value to the welfare of future generations, but an individual can affect that welfare only to a negligible extent, then if the current generation is able to invest collectively it will do so with a lower discount rate than is used by people acting individually (see Marglin 1963). However, as is evident from discussion in papers presented in Lind et al. (1982), a range of factors — including taxation, other distortions in the economy and risk — may influence the relationships between observed market discount rates and those appropriate to public decision making. At any time there will be a range of private discount rates. Which rate is appropriate in particular circumstances may depend on whether consumer or producer spending is involved, on risk and attitudes to risk and on a number of individual or corporate characteristics. Stiglitz (1982) points out that social discount rates appropriate to particular projects may likewise vary, depending on project characteristics and economic conditions. He argues that the social rate appropriate to a particular project may be greater or less than some or all of the private rates.

The reason why the choice of discount rate is important can be seen from the following example. In the case of a specific depletable resource, say a mineral deposit, a market operating with a discount rate above the social rate will bring about too rapid a depletion of the resource from the social standpoint. Relative to the socially optimal solution, the market solution will involve greater supply and lower prices for the mineral in early years, with consequently lower supplies and higher prices in later years. Consequently there will be transfers of welfare between present and future mineral consumers and producers,

favouring consumers in the present and producers further into the future. Such transfers between producers and consumers may outweigh any efficiency benefits of using a market solution rather than a non-market allocation method (Rowse 1990).

2.3 Sustainability and resource use

Concerns about environmental quality have increasingly been pitched in terms of maintaining 'sustainable' production, rather than merely achieving trade-offs between consumption of market goods and environmental services in the current period (see, for example, Commonwealth of Australia 1990). Two concepts of sustainability are compared in box 3. Much of the emphasis to date has been on physical or ecological, rather than economic, definitions of sustainability. Some economic perspectives are provided by Chisholm (1988) and Pearce et al. (1989). In this section, these and other concepts of sustainability are considered, drawing attention to some of their implications for resource use options.

Box 3: Sustainable development and economic policy

'Sustainable development' has received support from most sections of society as a means of integrating economic and environmental aspects of development. However, the term seems to have been used by different people to mean different things. The danger of this is that without an agreed definition of the principle, it is not clear how it can be made operational. In order for the principle to be of use in policy development, some degree of consensus on what it entails is essential.

Pearce, Markandya and Barbier (1989, p. 48) provide a broad interpretation of sustainable development, as 'providing a bequest to the next generation of an amount and quality of wealth which is at least equal to that inherited by the current generation'. This concept of sustainability requires, at the minimum, a constant capital stock comprising a mix of natural and manufactured capital, with no artificial constraints on the substitution possibilities between the forms of capital. Under this definition, economic and social policy affecting resource use will be concerned with intergenerational equity and the transfer of wealth between generations. As long as successive generations have access to a generalised productive capacity or standard of living which is at least equal to that of the current generation, then sustainability is achieved. It has previously been suggested (Hartwick 1977) that such a target is feasible: that in theory it should be possible to invest the rents from resource use (one of the conditions being that the rents obey the Hotelling rule, see box 4) so that the decline in resource stocks is offset by the accumulation of reproducible capital, both physical and human.

On a narrower definition of sustainable development, the integrity of the environment as a life support system becomes a central goal. Turner (1988, p. 352) has proposed that the condition for sustainability should be that society 'maximise the net benefits of economic development, subject to maintaining the services and quality of natural resources over time'. Using this definition, the focus of policy would be on the impact of economic activity on the services provided by the environment, particularly the off-site costs and benefits, and on ensuring that users of resources are made fully accountable for the environmental impacts associated with their activities.

Pearce et al. (1989, pp. 40–3) and Barbier, Markandya and Pearce (1990) suggest that a useful concept related to the sustainability of any production or economic system is the system's 'resilience' — defined by Pearce et al. as its ability 'to maintain its structure and patterns of behaviour in the face of external disturbance'. For example, a farming system could be regarded as sustainable only if it was capable of surviving periodic droughts, floods and other random, but normal, weather events. Thus the call for the maintenance of diversity of the genetic base may be justified on the basis of the range of options that are provided by that base in the event of changes in pest or disease populations, in commodity demand or in climate. Natural resources, both renewable and non-renewable, should be used so as to minimise the stress imposed by environmental degradation on the economic system.

The view may also be taken that the sustainability of an economic system depends on whether any of the resources it relies upon are being irreversibly lost. For example, concern about the depletion of existing fossil fuel reserves has (leaving aside the more recent attention to the greenhouse effect) centred on the possible difficulties of adjusting economies based on fossil fuels to the eventual disappearance of those fuels. Concern about soil erosion and other forms of land degradation centres on the possible consequent difficulties of food supply in future. Similarly, at least part of the call for conservation of species and habitat is based on the possible loss of opportunities for commercial development of plants and animals if the present broad and varied genetic base is greatly reduced.

These concerns can be seen as expressions of option or bequest values. Because development decisions which lead to irreversible change entail some loss of option, quasi-option or bequest values (see box 1), the costs of development may be greater than is obvious from the market values of resources used in the development. However, this is not to say that the status quo should necessarily be preserved: merely that these values should be taken into account in the trade-off between current options and future options. By exercising development options the current generation could well expand the range of possibilities for future generations, at least in the sense of the range of technologies available to them.

There may also be trade-offs between options for technological progress. For example, although retaining the diversity of existing gene pools may appear to be important, continued development of genetic engineering techniques is likely to reduce the costs of alternative ways of achieving similar outcomes to those that would at present require the use of natural genetic material. The probability of any particular preserved species or variant having future commercial use may be fairly low.

In evaluating the loss of the future option to use a given resource, it should be remembered that there are a number of commodities which were once highly valued resources but are now mere curiosities — for example, draught

horses, native copper and flint. In the traditional theory of changes in the use of materials, such as metals, in the course of industrialisation, there is a 'life cycle' in the demand for any material (Cox, Nagle and Lawson 1990, pp. 15–7), under the influence of technological progress. Consumption of a newly introduced material — for example, a metal — initially increases much faster than the rate of growth of the economy. This leads to improvements in the technology of processing and use and thereby to lower prices and higher product quality, further stimulating use. In the next phase of the cycle, consumption may still be increasing but at a slower rate than economic growth, as innovations make it possible to use the material more efficiently and new market opportunities begin to diminish. In the final phase, technological development of substitutes in production or use of the material results in demand levelling off or declining.

An economic interpretation of sustainable development would centre on the observation that an economy's capital stock comprises both natural and manufactured capital and that reductions of natural capital stocks can be offset by conversion of at least part of that wealth into other forms of capital. As a result, future generations need not be disadvantaged. While such a form of sustainability may be an appropriate goal for a society, it may not be consistent with some of the more ecologically based definitions of sustainable development. Demanding that particular natural resources be passed on to future generations may place a significant constraint on the society's ability to create and pass on wealth in total.

2.4 Summary

Making sure that the use of Australia's natural resources produces the greatest benefits for current and future generations involves a wide range of considerations. Under most circumstances, markets will have an important role to play, both in rationing current uses of resources and in providing the signals necessary to adjust future use to changes in technology and resource availability. However, for significant groups of goods in the Australian economy, clear rights of ownership are not defined and this will inhibit the operation of markets. It is those groups of goods which are considered in chapter 3.

Economic issues in natural resource use

The major issues in natural resource use which are of economic significance can be considered in two broad groups. The first, and more significant, group comprises the problems which arise from the absence of markets for some goods, or the failure of existing markets to operate effectively. The second set of issues concerns the assignment of rights of access to and use of publicly owned natural resources.

3.1 The role of markets in the economy

For a wide range of goods produced and used in the Australian economy, production, distribution and consumption are managed through markets. In a mixed economy, markets are often taken for granted in those areas where they have been allowed to evolve but treated with some suspicion in areas in which they have, by law or convention, not developed. Markets fill several roles. Market prices, along with the existing distribution of wealth, serve to ration supplies of available goods. At the same time they provide signals to producers about people's demands for goods, and about possible returns from innovations.

Market prices embody an enormous amount of information, and markets for labour, consumer goods and inputs to productive processes provide a way of coordinating the voluntary efforts of a wide diversity of people. Markets are not the only way of arranging production and use of goods, but non-market systems can fulfil that coordination role only by costly collection and centralisation of all of the information held by individuals, or by regulations which suppress some individual choices, or both.

An essential characteristic of markets is the incentive they provide for innovation. Changes in relative prices provide a major stimulus for technological change. Rising costs resulting from increasing resource scarcity create opportunities for profit from the development and use of technologies. For example, the oil price rises of the early 1970s resulted in a concerted drive to develop energy saving and fuel substituting technologies in all aspects of economic activity. In cars, high strength steels, aluminium and plastics were substituted for conventional steels, and size and weight were reduced (Weinberg, Harris and White 1987). Hayami and Ruttan (1971) show that product and input price relativities have played a crucial role in shaping the differences in agriculture between countries and in providing incentives for technological change in plants, animals and associated inputs.

Markets are not perfect. Information is expensive, and there is always uncertainty about future wants and future events. Some market participants may hold and abuse power over others.

However, these problems are prevalent in non-market allocation systems as well. Consequently, markets will often provide the most efficient means available of rationing limited available resources between competing uses and signalling pressures and opportunities for future development.

Markets work effectively only if the full consequences of individual actions, in consuming or producing goods, are borne by the individuals taking those actions. Such matching of individual actions and their consequences is possible only if there are well defined property rights over resources and freedom of individuals to make choices concerning their work and consumption. There must also be a high degree of community respect for those rights and freedoms if markets are to work.

3.2 Absence of markets

The absence of markets for some goods arises from either of two general reasons. For some goods, the nature of the goods themselves, or of the resources from which they are derived, is such that developing markets is too difficult or expensive to justify the effort. For some other goods, markets may not exist because the nature of the ownership or other rules governing their use precludes their development.

Natural impediments

Goods which are easily produced and distributed in markets generally have two common characteristics. First, a purchaser can fairly simply and cheaply exclude other people from using the good. Second, consumption of a unit of the good by one consumer precludes consumption of the same unit by anyone else. These characteristics are often termed, respectively, excludability and rivalry in consumption. Goods which lack one or other of these characteristics may be difficult or impractical to produce and distribute through markets.

Inability to exclude non-payers from consumption of a good is likely to make it uneconomic to produce the good. Potential consumers have a strong incentive to wait until somebody else has supplied the good and then use it without paying, or 'free-ride'. This is not to say that people will always fail to contribute to the cost of supplying goods for which exclusion is infeasible. As can be observed by peoples' voluntary contributions to such organisations as charities and private conservation agencies, difficulties in exclusion do not always result in none of the good being supplied. However, where exclusion is not possible it is almost certain that less than the socially desirable contribution to the cost of supplying a good will be paid.

Another form of non-excludability occurs in the case of animals in their natural state. A commercially important example is fisheries. Because there is a history of institutional attempts to assign ownership rights in fisheries, they are dealt with in the next subsection.

Non-rivalry in consumption can also lead to problems in supply of goods. A good is said to be non-rival in consumption if one person's consumption of the good has no effect on any other person's enjoyment of the good. The cost of supplying the good to one more person, once it is supplied to anyone, is therefore zero. Clean water for Sydney's beaches, for example, would be a non-rival good (at least up to the point where all the beaches become crowded, and the beach itself becomes a rival good). If it were made available to one individual, there would be no extra cost in making it available to others. The costs of supplying a non-rival good are independent of the number of consumers. So if it is worthwhile supplying the good at all, the total net value to society is greatest when all people who derive any positive value from it are allowed access (again, short of the point where crowding occurs). However, a private supplier will generally need to charge the same price to all purchasers of the good, at any given time and place, and will need that price to at least cover average cost. In that case all those people who value the good, but at less than its average cost, will be excluded from its consumption. Excluding those consumers will lessen the total value derived from the good, without lowering the cost of its supply. There is no market mechanism which will allow those consumers who value the good at less than its average cost of supply to have access to the good, and still allow the producer to cover total costs. Thus, non-rival goods may be provided through markets (theatre performances being a common example), but markets cannot be expected to provide them at socially optimal levels.

The main areas in which natural impediments to market development and function are important in the use of natural resources relate to the conservation of environmental amenities. Not all environmental amenities, however, present natural impediments to the use of markets. For the types of consumption which involve the enjoyment of environmental features through on-site recreation, there may be no significant impediments to the use of markets. For example, the enjoyment of natural recreational features is economically no different from the enjoyment of a 'theme park'. Entry fees can be charged, provided that exclusion of non-payers is possible. Reiling and Anderson (1985), in a study of forest-based recreation, show that if such facilities are publicly provided at no charge the result can be an inefficient use of resources and an unfair burden on low-income taxpayers. However, there may be cases where the income from fees is not sufficient to cover collection costs. In such cases, whether or not the recreational facilities are provided is likely to be incidental to other uses of the resources.

For benefits from environmental amenities which accrue off-site, there are likely to be much greater impediments to market function, since they tend to be non-exclusive as well as non-rival. There is no obvious way of identifying those in the community who benefit, off-site, from conservation of the amenity. Further, once an environmental amenity is conserved, its off-site benefits can be available to any number of people at no further cost. Thus, there is little prospect of individuals being made to pay in proportion to their gains from conservation of the amenity.

The existence of significant off-site values of a conservation site may, however, provide an additional reason for charging for on-site uses. Increasing levels of on-site use may increase pressure on the ecosystems on which off-site benefits depend. It is then

appropriate for on-site charges to reflect the cost that such pressure imposes on off-site beneficiaries.

Examples of economic problems arising from the nature of natural resources and of conservation demand can be found in mining, agricultural, forest and fishing industries. Some of these specific problems will now be reviewed.

Native forests may provide a number of non-marketed benefits, through protection of water quality, conservation of genetic diversity and provision of both on-site use of natural ecosystems and off-site benefits (Cameron and Penna 1988). Some of those benefits may be compatible with commercial forestry activities, some may not. Richards et al. (1990), in their study of the National Estate areas of the Eden Native Forest Management area, concluded that 'the conservation reserve system should be expanded to provide adequate representation of all environments and their associated plant and animal species'. However, they also indicate that commercial wood harvesting activities in the areas, but outside the reserves, are consistent with maintenance of the full range of species. Periodic disturbance is a normal occurrence in forests, and a dispersion of ages of trees may be necessary for the continued existence of a full range of animal species.

The main impediment to efficient resolution of forest use problems is the difficulty in identifying those who value off-site aspects of conservation. Given a valuation of those benefits, it may be fairly simple to design strategies for multiple use. According to Bowes and Krutilla (1989), taking non-marketed benefits into account may entail changes from the purely commercial management of forests, but only sometimes will it lead to exclusion of wood production from those forests.

Significant off-site values may also attach to the incidental preservation of plant and animal diversity on farms. All farms will provide some coincidental conservation benefits. How farmers manage their land may influence the degree of conservation. However, it is not really clear whether there are sufficient differences in conservation values under alternative management choices to justify an economic interest in assisting or regulating farm activity.

Similar questions may arise with respect to siting and structure of mines and to mine site rehabilitation. Mining may involve major changes in the structure of localised landforms and, at least in the short term, localised displacement of plant and animal populations. However, mining may disturb only small areas, and may last for only a fairly short time. The latter point leads to questions about the viability of plant and animal populations on rehabilitated sites, perhaps in the face of changes in concentrations of particular minerals and in soil, vegetation and landform structure. Conservation issues associated with mine and mineral processing sites are likely to be simpler than those associated with farming and forestry. Any problems in conservation of plant and animal communities are typically those of a single site. Similarly, where there is air or water pollution associated with the mining activity, it is mostly from a single source. Information, administration and enforcement costs are thus likely to be lower than in the case of dispersed agricultural activities.

In all of the above examples, difficulties arise in taking account of demands for the full range of goods producible from land and other natural resources, because of the nature of some of those goods. Because of difficulties with exclusion of non-payers and non-rivalry in consumption, market solutions to the supply and distribution of these goods are unlikely to be optimal, and their provision by government may be recommended. However, it is not necessarily the case that none of those goods will be supplied if they are not supplied by government. Grove (1988), for example, describes the Nature Conservancy's involvement in the conservation of wildlife and plant populations. The Nature Conservancy is a US-based non-profit agency which is financed by membership fees and corporate sponsorship. The Conservancy manages a large number of reserves for specific habitat and species conservation purposes. Recreational and other uses of the land are incidental to this primary purpose. Some areas purchased by the organisation have also been incorporated into state and federal national park and wildlife reserve systems.

More broadly, people give substantial funds to charities and to other private organisations involved in the supply of such amenities as recreational and conservation facilities. Even when there is an incentive to free-ride, some people will make a voluntary contribution. Individuals may obtain satisfaction both from the act of giving, and from the fact that a supply of certain amenities is made available to others.

It has been argued that, if the latter motive is dominant, government supply of the amenities will tend to 'crowd out' private contributions. Andreoni (1990) cites empirical findings that such 'crowding out is quite small'. He argues that if people derive satisfaction from the act of giving, as well as from the provision of the amenity, private contributions will never be totally eliminated by government supply. It would seem important to consider ways in which private supply of such amenities could be fostered, rather than suppressed, by public actions. As well, it needs to be kept in mind that government supply entails the use of tax revenue from the whole community to provide a good which not all people will value.

The examples cited all concern natural amenities. There are natural impediments also to the market solution of problems of a contrary kind. An example may be taken from the agricultural and grazing industries: the adverse off-site effects of farmers' land clearing, stocking and cultivation practices on the incomes of other farmers. While individual farmers bear the on-site consequences of practices which deplete their soil, the downstream effects of increased run-off and siltation may sometimes be serious[1]. Similarly (see Grieg and Devonshire 1981), the contribution of tree clearing to down-stream salinity may be substantial. In the absence of specific arrangements for internalising those costs, individual farmers have no incentive to consider them.

Institutional impediments

The existence or success of markets can be strongly influenced by government

1 As Verdich, Douglas and Abbot (1989) point out, the costs of some forms of land degradation, such as deterioration in soil structure, are almost totally incurred on-farm.

through four broad sets of activities. First, governments are responsible for the definition, assignment and enforcement of property rights to resources. Second, governments influence economic activity through the use of taxes and assistance. Third, a wide range of regulations on the use of natural resources, on marketed goods and on the side-effects of economic activity may influence resource use. Finally, direct government involvement in the production of goods and services is important in some parts of the resource sector. These are all legitimate areas of government activity. However, failure to account fully for the economic consequences of these activities can have significant effects on the efficiency of resource use. They are considered in turn below, with the exception of regulation which is deferred to section 4.3.

Clear definition of rights of ownership or access to resources is necessary for the same reason that physical excludability of non-payers for a good is important to the successful functioning of a market. Only if resource users bear the full consequences, both positive and negative, of their individual actions will they have the incentive to make those choices which will be of maximum benefit to the community as a whole. In many cases, the simplest way of ensuring that this is so is by vesting full rights of resource ownership in individuals.

The absence, or lack of full definition, of rights of ownership is a primary reason for overexploitation and excessive effort (relative to the catch) in open-access fisheries. There may be considerable gains for a fishery as a whole, for example, from limiting fishing effort in the current period in order to allow the capture of more fish or larger fish in future periods. But as long as access to the fishery is open, no fishing operator can gain significantly, in terms of greater yield of fish or reduced costs in future periods, from individually lowering effort in the current period[2]. The problem is not solved by limiting the number of operators or boats. Because of lack of ownership of the resource, the incentive to overfish remains. Except by granting an individual or firm exclusive rights to fish in a particular area, it is generally impossible to assign effective property rights over fish in the water.

In principle, it would seem that granting exclusive rights to a fishery would provide the owner with the incentive to choose the most efficient level of use, but it would still leave issues arising from the migration of fish unresolved. However, granting individual catch quotas may effectively proxy rights of ownership. Geen and Nayar (1989), for example, estimate that net annual gains of $6.5 million were realised as a result of the establishment of individual catch quotas in the southern bluefin tuna industry.

In setting individual quotas, it is first necessary to decide on the most efficient total quota (see box 4). The fisheries management authority must, in effect imitate the choice that would be made by a single owner of the fishery, the boats and gear, on the basis of what is known about the population dynamics and life cycle of the species. Each operator has an incentive to economise on the effort required to catch his or her allowable limit, rather than to compete with all other operators for the available fish. Further, if the quotas are transferable (as in the case mentioned) each operator has an asset to trade in the process of rationalising the size and location of individual businesses. Making a quota transferable should ensure that it is channelled into the hands of the most efficient operators.

Governments may also have a strong influence on the success of the operation of a market through taxation and industry assistance programs. It is useful to view taxes affecting the natural resource based industries in three broad categories: general revenue taxes, resource rent charges and specific pollution taxes. An ideal general revenue tax is one which is 'neutral' in that it does not influence production, consumption or investment decisions. Such neutrality is a desirable feature also of resource rent charges. In contrast, neutrality is generally not an objective in the imposition of pollution taxes. Application of pollution taxes and some alternatives are discussed in detail in section 4.3.

Resource rent charges are a mechanism for redistributing the net returns from the users of publicly owned resources to members of society more generally. It is difficult to make a resource rent charge completely neutral. Hinchy, Fisher and Wallace (1989) find that, when risk is taken into account, the form of resource rent charge adopted may strongly influence the overall efficiency of exploration, development and use of resources. Resource rents are considered further in section 3.3.

Assistance to a particular industry acts on returns or costs in that industry and, therefore, on its competitiveness with other industries. For most Australian natural resource based industries, there is little or no direct assistance. Rates of assistance for agriculture are low, with the exceptions of the dairy, sugar, rice, eggs and some horticultural industries, such as citrus and dried vine fruit (table 1). The same is true of most mining and the bulk of minerals processing industries (Industry Commission 1990*a*).

For some forest products processing industries, rates of assistance are fairly high. However, it is difficult to assess the effect of assistance on forestry and forest products processing industries because of the high degree of government involvement in production and in regulation of forestry and processing. It is also difficult to assess the distortions arising as a result of assistance to the fishing industry (Geen and McKelvie 1990). As has been explained above, because of the lack of private property rights due to the open-access nature of fisheries, government intervention is required to correct market failure, regardless of any attempt at assistance. In any case, as many fisheries are currently overexploited both biologically and economically, there is no scope for increasing output as is done (however inefficiently) by assistance measures in other industries such as motor vehicle manufacture. Bearing in mind these caveats, Geen and McKelvie estimate that the levels of total non-management assistance to the south-east trawl, southern bluefin tuna and northern prawn industries, respectively in 1989-90 were 3.5 per cent, 1.5 per cent and 26.4 per cent of their unassisted value added.

2 Blyth and Kirby (1985) and Young (1987) argue that a similar lack of incentive may affect leasehold land in Australia's pastoral areas. Leasehold tenure does not necessarily guarantee that current land users will gain the full benefits or bear the full costs of investment or other land management decisions, and as a result they may underinvest in land care. This situation is discussed further in section 4.1.

1 Estimated effective rates of assistance for agricultural, mining and minerals processing industries, 1988-89

Activity/commodity	Effective rate of assistance %
Agriculture	
Horticulture	16.5
Wheat	1.4
Other extensive cropping	1.2
Sugar	20.0
Cotton	5.7
Rice	50.0
Beef	9.3
Wool	2.8
Sheep meat	3.6
Pigs	–2.3
Poultry	3.3
Eggs	22.0 a
Dairying	55.0
Total	8.6
Mining b	
Ferrous metal ores	–4.1
Bauxite	–1.9
Copper ores	–3.9
Gold ores	–2.7
Mineral sands	–3.2
Nickel ores	–2.1
Silver–lead–zinc ores	–2.9
Tin ores	–3.1
Uranium ores	–2.3
(Mining continued)	
Non-ferrous metal ores nec	–2.8
Black coal	–2.2
Brown coal	–1.5
Crude oil and natural gases	–1.5
Other minerals	–2.7
Petroleum and mineral exploration (own account)	–9.1
Mining and exploration services nec	–3.0
Total	–2.4
Basic metal products	
Non-metallic mineral products	3.3
Basic iron and steel	12.0
Copper smelting and refining	0.0
Nickel smelting and refining	0.0
Silver, lead, zinc smelting and refining	–0.4
Alumina	–9.1
Aluminium	–2.2
Non-ferrous metals nec	2.6
Secondary recovery of non-ferrous metals nec	2.0
Aluminium rolling, drawing, extruding	49
Non-ferrous metals nec, rolling, drawing, extruding	36
Non-ferrous metals casting	15
Total	8.6

a 1987-88 estimate. **b** Average effective rates of border assistance.
Source: Industry Commission (1990*b*, tables A9.3, A10.1 and A11.5).

For the vast majority of natural resource based industries the major relevant assistance measures are those for a small group of manufacturing industries. The most significant groups of highly protected industries are motor vehicle manufacturing, textiles, clothing and footwear. Protection of those industries, and of others mentioned above such as dairying and aluminium processing, can act as a significant disincentive for the development of the unassisted resource industries, through both direct competition for resources and more general macroeconomic effects. Martin, Waters, McPhee and Jones (1988), for example, found that removal of all protection in the economy would raise real net returns by around 7 per cent and 16 per cent for agriculture and mining, respectively. Those increases in resource sector activity would be associated with a fall in the general price level of around 7 per cent and by substantial increases in the efficiency of operation of the economy as a whole.

Government objectives in assisting specific industries generally centre on a desire to raise the incomes of particular groups. Tullock (1975) points out that there are generally only transitional income gains to be made from

government-granted rights or subsidies. The value of the rights will be quickly capitalised into the value of the asset involved. An exception may be the case where a strong union is able to appropriate part of the subsidy for its members. Since there is no asset associated with the right to work, the benefits may flow to those fortunate enough to be part of the restricted workforce. Alternatively, part of the subsidy may be used by the union to pursue political or other ends. In the cases where the values of subsidies are bid into asset values the owners of the assets at that time will make large gains. However, successive owners will not make exceptional profits from those rights and may indeed be adversely affected by changes to or cancellation of the rights. So the income problems originally perceived are likely to remain despite the assistance and its damaging effects on other sectors in the economy.

Governments are directly involved in the production and distribution of some goods and services. In the natural resource sector an important area of government production is irrigation water, considered below. Another is the provision of environmental amenities through management of national parks and other systems of reserves. Governments are also involved in the production and dissemination of information for farm, fishing and mining industries, and in the provision of management services for fisheries. In addition, there are more direct forms of involvement in production of commercial goods. For example, all state governments are directly involved in the production of wood and other commercial forest products.

There may be an economic argument for direct government involvement in the production of some goods and services. As is discussed above, it is likely to be difficult or impractical to bring about the supply of socially desirable quantities of some environmental amenities through markets. Although the use of regulations governing resource users' behaviour, or taxation of some activities, may sometimes provide a solution to economically significant problems (see p. 44), there may still be cases where the best option is direct government management of the resource or government production of the good.

The provision of water for irrigation illustrates most of the above forms of government involvement. Irrigation water supplies in most of Australia's watered areas have been heavily subsidised. Governments have generally provided the storage dams and associated capital works free of charge, and in many cases extensive water delivery services have also been subsidised (Randall 1981). In general, explicit rights to water delivery have not been available: implicit rights to delivery of water have become associated with irrigated land, and have not been separable from particular parcels of land. As a result, the current value of expected future access to water has been bid into land values.

Attaching implicit water rights to particular parcels of land has had a number of detrimental effects. When water cannot be traded freely, those who have water allocations may frequently not be those who can make the most productive use of them. For example, on many irrigation farms, land area rather than water allocation may be the

effective constraint on farm activity, while extensive irrigated land with less than optimal water supply may exist nearby. It may be that water can be used more economically in combination with a greater land area and more capital, such as the development of laser-graded bays. Only if there is a market in water will those farmers with enough water and little land have an incentive to make efficient use of water and other resources, by selling water and changing the nature of their own farming operations.

Most states have, over recent years, moved toward explicit, tradable rights, but still with significant restrictions. Delforce, Pigram and Musgrave (1990) give details of the current and planned changes of this kind. They argue that even full development of all the proposed moves toward transferability of water rights will still leave significant impediments to efficient water use. Essentially, the systems which exist, or are proposed, in most states will still involve considerable regulatory control and uncertainty about the security of the assets being traded. Without clearly defined and secure rights of resource ownership, existing and potential owners will come to regard investment in, or related to, the resources as risky. As a result, investment associated with those resources will be less than that which would maximise the returns to the community as a whole.

3.3 Resource ownership, resource rent and risk

Resource ownership and resource rents

The nature and degree of public and of private ownership of resources vary considerably between resources, and to an extent between states. For a substantial part of Australia's urban and agricultural land, and to a lesser extent forest land, ownership has clearly been vested in private hands. Rights to minerals (with some local exceptions) and oil and gas fields, at least up to the point of discovery, are held by state governments or the federal government. Those governments assign private rights to mine at varying stages during or after exploration. For the bulk of fisheries and a considerable proportion of pastoral lands, forests and other land, ownership has also been retained by governments. State governments have retained ownership of water supplies, although in recent years, as described above, most states have moved toward granting transferable rights to water and toward increased duration of such rights.

The task of obtaining the greatest possible benefits to the community from scarce natural resources can be viewed as that of maximising the long run net returns to those resources. For a broad group of privately owned and managed resources, how to do this is an individual owner's problem. The involvement of the general community in private decisions is warranted only to the extent of defining the rights of ownership and use such that the private owners bear the full consequences, both positive and negative, of their decisions. However, there are two broad groups of natural resource issues in which quite different forms of community involvement may be considered. The first concerns those cases where the types of off-site benefits of conservation discussed above are important. These have been discussed in section 3.1. The second concerns the

distribution of net financial benefits, or resource rents, from the use of resources currently owned by state or federal governments.

The term 'resource rent' is used to describe the part of the return from use of a natural resource which is due to the scarcity of that resource. Rent to a resource is the return to ownership of the resource, net of all production costs other than the cost of acquiring the use of the resource itself (see box 4). In agriculture, for example, returns over the long term, net of all production costs except the costs of land purchase, constitute rents to the land resource. Similarly, returns from a mine net of costs of exploration (including some share of the costs of failed exploration), development and operating costs can be regarded as a resource rent. Operating costs, in this sense, include the normal return to operating capital that could be earned elsewhere in the economy.

There may be an important question about the degree to which the general public should retain a share in the rents when the development of that resource is assigned to a private firm. What effect such sharing has on the incentives for exploration and development of resources may also be important. These questions are considered in the next subsection.

A further issue is the extent to which rents are used to invest in capital for future use. This has implications for intergenerational equity and sustainability, particularly in the framework proposed by Solow (1986) referred to above (p. 16). Hartwick (1977) shows that, under certain conditions, a society can be maintain a constant stream of consumption over time if it invests in manufactured capital the full rents from its current use of non-renewable resources (see box 4). Eliasson (1984) has raised the question of the implications of private resource owners investing rents in 'paper assets' rather than in creating new productive capital. Regardless of whether the rents are acquired by private owners or governments, the ability of the society to generate income in future periods will be increased only by investments in physical capital or in knowledge which has productive uses.

Public and private shares in resource rents

For publicly owned resources, rent may be shared between the resource users and the rest of the community. Considerable effort has been put into the analysis of resource rent charges (see, for example, Garnaut 1983; Industries Assistance Commission 1988; Hinchy, Fisher and Wallace 1989; Hogan and Thorpe 1990; and ABARE 1990*a*). The emphasis of much of that work has been on the design of resource rent charges and titles to resources which will allow governments to collect some share of the resource rents without greatly distorting the incentives for resource users.

There are several ways in which governments may obtain a share of the rent from private use of publicly owned resources. The most common are royalties proportional to quantity or value of production. Other mechanisms used include resource rent taxes, set as a specified share of some net income measure for successful projects (only), and competitive cash bidding for access rights (where the 'tax' is the winning bid). Royalty charges are generally not

Box 4: Resource rents

Resource rent is the long run excess of revenue from use of a natural resource over the long run costs of using that resource. The availability of such an excess is an effect of scarcity. Long run costs include a 'normal' return to capital used with the resource (excluding the capital cost of the resource itself), which equals the amount that the capital could earn elsewhere in the economy. The concept of rent has its origins in late eighteenth and early nineteenth century economists' investigations of the determinants of agricultural land prices, but is applicable also to other uses of land and in fisheries and mining activities.

Land rent

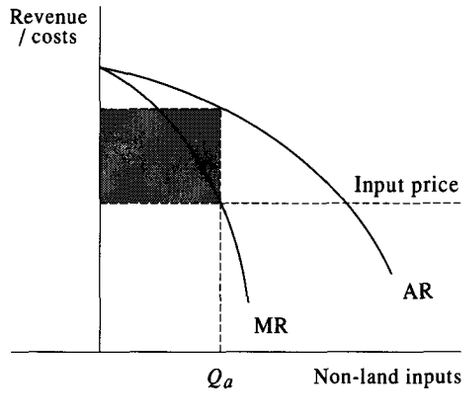
Figure a illustrates the costs of and returns from use of a single plot of agricultural land on which increases in the intensity of use of other inputs, such as labour and fertiliser, increase production but at a diminishing rate. The curve MR represents the additional revenue earned from the application of each additional unit of non-land input. The price of the non-land inputs is assumed constant. Rent is the difference between average revenue (AR) and unit input cost, multiplied by the input quantity used. Maximum rent (illustrated as the shaded area) occurs at a level of input, Q_a, where the marginal revenue equals the unit input cost.

Rent in fisheries

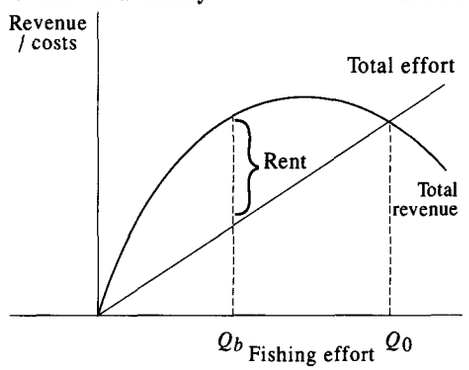
In any fishery, sustainable fish catch, and therefore revenue, will tend to increase with fishing effort up to some point. Beyond that point, increased effort will lead to a lower total catch because of the lower sustainable fish population. The relationship between sustainable total revenue, total cost and fishing effort is illustrated in figure b.

D Types of natural resource rent

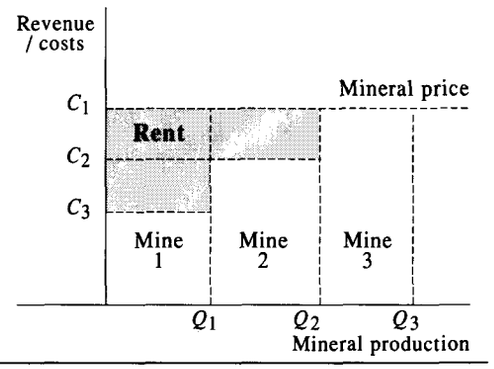
a Agricultural land rent ABARE



b Rent in a fishery ABARE



c Resource rent in mining ABARE



(For simplicity, the diagram depicts only steady-state situations, not dynamic relationships. In the general case, returns to a given effort vary with the history of the fishery.) Rent, the difference between total revenue and total costs, is maximised for effort Q_b. However, in an open-access fishery, fishermen will continue to enter up to the point, Q_0, where sustainable total revenue just covers total costs and no rents are earned in the long term. For rent to be earned, management devices are needed to limit effort.

Mining industry rent

Resource rents in mining can most simply be illustrated by considering quality differentials between mines. In figure c it is assumed that there are three mines, 1, 2 and 3, with unit production costs of C_1, C_2, and C_3, respectively. If the mineral price is equal to C_3, rents represented by the shaded area will accrue to the owners of mines 1 and 2. There will be rents to mining only to the extent that mining revenues exceed not only development and operating costs but also exploration costs including those of failed exploration efforts. However, see 'Hotelling rule' below.

Origin of rent

All resource rent arises because of scarcity of natural resources. The amount of rent accruing to the owner of any resource will be influenced both by quality differences of the type illustrated in the mining case and by diminishing returns from increased intensity of use of other inputs of the type illustrated for land in figure a.

The Hotelling rule

It can be shown theoretically that, if a non-renewable resource such as a mineral is extracted at the most economically efficient rate, the resource rent (the difference between sale price and extraction cost) will increase over time at a rate which equals the general rate of interest. Owners of non-renewable resources will — if they are profit-maximising — limit their rate of extraction of known resources so that this condition is met. This rule provides a theoretical measure of resource rent, independent of actual local variations of quality.

Rent and profits

In a market economy, a present valuation of the expected future flow of rents from a natural resource will generally be bid into the market value of the title to that resource. So the buyer of a mine, a farm or an individual fish catch quota will pay a capital value for access to future rents. If the expected flow of rents is realised the buyer will earn only the normal rate of return on the investment earned on other assets in the economy. So, although there will be excess returns, or rent, to the resources, there will not be excess profits to the owner. The capital value of the rent will accrue to the initial owner.

closely related to rent, and it can be shown that for this reason they may distort an otherwise efficient use of a resource. On the other hand, a system of resource rent charges which takes account only of successful projects, with no deduction for the cost of failed projects, will provide a disincentive for exploration. In principle, a non-distorting alternative is a 'Brown tax', whereby the government shares in both gains from successful projects and losses from failed projects. Under conditions of certainty as to returns from resource investments, such a tax has no net incentive effect on private resource users and therefore will induce no loss of efficiency (Garnaut 1983; Hinchy et al. 1989).

However, the returns from exploration and development of mineral deposits are normally subject to considerable risk, both commercial and geological. Risk, and resource users' responses to risk, complicate the choice of mechanisms whereby governments extract a share of rents. Hinchy et al. (1989) show that even a Brown tax can distort mineral exploration and development choices under conditions of uncertainty. They indicate that it would in principle be possible to modify Brown taxes or resource rent taxes so that they are neutral in their effects in conditions of uncertainty. However, the information required for the government to do so correctly would be extensive. A system of competitive bidding for rights will be efficient — that is, neutral — in conditions of both risk and certainty. However, when risks are high, none or only a small proportion of the expected rent is likely to be bid.

It should be kept in mind that resource rent charges are distributional devices, like any other system of transfer payment. They are necessarily associated with some allocation of usage of rights to resources, but that is not their purpose. Neither should the above discussion of their relative efficiency give the impression that their purpose is to improve economic efficiency. If assignment of private property rights to a particular resource can lead to efficient resource use, then arbitrary assignment through, for example, a ballot would ensure efficiency. Provided that a market exists, or can be developed, for the trading of rights, it will generally make no difference to the eventual efficiency of use of the resource who is granted the initial rights to it. Adding a resource rent charge will most likely reduce overall efficiency, because no such charge is likely to be completely neutral in its effect on resource use. Its purpose is to return resource rent to the community at large.

How the distribution of resource rent across the community will in fact be affected by a rent tax will depend, in part, on the pattern of shareholdings in the community. In Australia, only a small percentage of the population directly holds shares in natural resource using businesses through, for example, farm ownership or ownership of shares in mining companies. A much larger percentage have an indirect stake in the operations of resource based businesses through their interests in superannuation funds. Thus a large part of the population may share in resource rents in the absence of government rent charges.

One question which may be important in considering whether or not to impose resource rent charges is that of the efficiency costs not only of different means of obtaining a share of resource rents but of alternative means of raising government revenue more generally. While it is desirable that any general revenue tax have the least possible distortionary influence on people's production and consumption choices, in practice all taxes are distortionary. So there is always some efficiency cost, additional to the administrative costs to the taxpayer and taxing agency. As Ballard, Shoven and Whalley (1985) point out with respect to United States taxes and Findlay and Jones (1982) indicate for Australian income taxes, these efficiency costs may be substantial. So in deciding whether or not to levy a resource rent charge, governments should

consider the likely distortions to market behaviour induced by both the rent charge and the probable alternative ways of raising the same amount of revenue.

Where government is committed to capturing a part of resource rent on behalf of the broader community, the optimal choice is likely to involve a sharing of not only rent but also risk. That end may be achieved by some combination of a cash bid (which entails no risk to government) with one of the abovementioned taxes whose proceeds are outcome-dependent and thus uncertain. Hinchy et al. (1989) argue that under those circumstances there may be a case for the government seeking and disseminating additional information on mineral prospects. Doing so would reduce risk and increase government revenue. Ultimately, the appropriate solution will depend on a combination of factors including individual and public attitudes to risk, distributional judgments and the costs of using alternative revenue raising channels.

Public ownership and private incentives

Whether public ownership of resources is retained, how access to public resources is managed and how private rights are assigned if public ownership is surrendered may have a large bearing on the efficiency of resource use.

Any system of resource management in which individuals or firms can increase their chances of access to or ownership of the resources by activities such as lobbying or exploration is likely to lead to the dissipation of a considerable proportion of the potential rents from use of those resources. As is pointed out by the Industries Assistance Commission (1988) and again by the Industry Commission (1990*a*, pp. 3–12), the system of work program bidding for mineral exploration rights widely used in Australia encourages firms to carry out excessive and inappropriately timed exploration and development work in the hope of gaining rights to exploit profitable deposits. In setting up such systems, governments may succeed in dissipating most or all of the rents. Indeed, as Tullock (1980) shows, it may even be possible for these types of competitive rent-seeking activities to use up more resources than are actually available as resource rent. Bearing this in mind, it is important to ensure that systems of assignment of rights to use resources are set up in such a way that wasteful competition for access is limited.

The rent-seeking incentives created by systems of assignment of mining rights are only one example of a problem of much broader consequence. Governments' ability to assign or modify property rights, or to provide assistance to particular groups, provides some incentive for rent-seeking over a broad range of activities. Baumol (1990) argues that a society's entrepreneurial effort will be directed to those areas most rewarding for the individual entrepreneur. Which are the most rewarding areas of activity will depend on the society's laws and institutions. Those activities may or may not be economically productive ones. In the present context, if there are significant rewards from lobbying for assistance or access to unassigned property rights, effort and creativity will be expended there. Such direction of effort will be a loss to productive pursuits — creating

new goods or more efficient ways of providing existing goods. So there may be good reason on grounds of allocation of entrepreneurship for limiting the extent to which public title to resources is maintained.

3.4 Summary

While markets serve as effective ways of ensuring that the best use is made of natural resources in many circumstances, there are a number of impediments to the operation of markets in some resource uses. Some of those impediments arise from the nature of goods yielded by natural resources, others from the ways in which rights of use or ownership are defined, or left undefined. In some cases, much can be achieved by full and clear definition of private property rights over resources and by discovering how best to transfer title to resources from the general community to individuals.

Policy approaches

A number of alternative approaches could be taken to ensuring that the Australian community derives the greatest net benefit from use of its natural resources. Basically those approaches reduce to four broad groups, and combinations of these. The first is the free operation of markets. The second is the direct management of resources by government agencies. The third is the development of 'parallel' markets by public resource management organisations. The fourth option is reliance on regulation of the activities of market participants. For a wide range of natural resources and resource uses, reliance on markets will result in efficient use of resources.

4.1 Use of markets

Markets are the dominant mechanisms for organising the production, distribution and use of a wide range of natural resource based goods. While markets may not be perfect, they frequently offer a cost-effective alternative to regulatory management of resources even in those areas where public, rather than private, management has been conventional.

Market provision of goods derived from privately owned resources is the primary system of production in much of the Australian economy, including most of the rural sector. Markets are also the dominant means of handling production and distribution of mine outputs and of processed forest products. In contrast, in the production of forest raw materials and in minerals exploration there is considerable reliance on government production or direction.

Three requirements in order for markets to function efficiently are the specification of property rights, freedom of transfer of those rights and the availability of information. These conditions are here considered in turn, illustrating the extent to which they are fulfilled in Australia's resource industries.

Property rights

The degree to which rights of resource ownership confer the full costs and benefits of individual actions is important to the efficient operation of markets. Property holders have an incentive to consider only those consequences of their actions from which they gain benefits or incur costs. If ownership rights are such that a resource owner's actions can impose significant costs on other individuals without compensation by the owner, markets will not function well. Neither will markets work well if there are significant benefits to other people for which the owner cannot charge.

Most land in the cropping and high rainfall grazing areas is privately owned as freehold or similar title. In these areas, therefore, except for certain off-site

effects, the full consequences of farm management and investment choices will be reflected in the operator's net income. Individual owners will generally have a strong incentive to maximise the long run returns from use of their land. The relatively unfettered provisions for transfer of title ensure that individual owners are able to capture from the land market the full value of any land-specific improvements, and will generally bear the consequences if they have made poor management decisions.

Some questions have been raised as to how effectively land market values reflect the values of resource conserving practices. Blyth and McCallum (1987), for example, cite historical evidence that in some cases only visually obvious land degradation appeared to influence market prices. More recently, however, King and Sinden (1988) find that values of conservation structures and practices are reflected in land values.

In this connection it is important to note that the appearance of changes to, or physical degradation of, land does not necessarily indicate the existence of a significant economic problem. There should be no presumption that the original state of the land has some intrinsic value in agriculture. In some cases it may be rational to use up some of the stocks of soil or of particular soil qualities such as nutrients. The clearing of forests and woodlands has played an essential role in the development of Australia's crop and grazing lands. On the other hand, it may be worthwhile to upgrade some sites from their original condition. An example is the extensive land levelling and development of delivery and drainage systems on irrigated farms. Farming may also involve improvements to soil nutrient content or other soil characteristics.

The actual management of most Australian farmland appears to follow similar principles to those suggested by Pearce et al. (1989, pp. 40–3). Their concept of 'resilience' seems closely related to the enterprise diversification practices and associated flexibility of enterprise combinations common in much of the cropping belt of Australia. Diversification of enterprises allows modification of the total risks from market price changes, disease and pest problems and weather fluctuation faced by Australian farmers.

The bulk of Australia's low rainfall and tropical pastoral areas are leased from state governments. Terms and conditions of the leases vary considerably between states and, to some extent, within states. However, generally lease terms are quite long (99 years being common). As was mentioned in chapter 3 (p. 26), Blyth and Kirby (1985) and Young (1987) argue that aspects of leasehold tenure discourage efficient use of the land. Because the operator does not own the land there may be inadequate incentive to invest in fixed structures or in land saving management activities. For example, it may be rational for a leaseholder to stock more heavily, and run greater risks of damaging soils and pastures, than would an owner who would bear the full future consequences of those actions. This consideration could be important in relation to short term leases and and the closing years of long term leases. The degree of uncertainty about renewal of the lease will also be important.

Private property rights tend to be assigned over minerals, at least once

their location has been established by exploration. For an established mine, a mine operator will generally have a reasonable degree of security in the right of use of the minerals still in the ground. So, once a mine is established, there is likely to be a considerable coincidence between the actions taken by the owners in their own best interests and those which would be in the interests of the community as a whole. Prior to that point, however, because of the dependence of most governments on a range of implicit and explicit taxes and on 'work program' methods of assigning rights (see p. 35), there may be considerable divergence between the actual exploration and development efforts and those which would be most efficient.

Problems may arise when property rights are poorly defined, or when rights to rural or urban private land and to the minerals under that land overlap. In general, under common law private landholders have a right to use their land, including its minerals, as they see fit. In Australia, these rights generally no longer extend to minerals. Under state mining acts, explorers and miners have certain rights of access, and (with minor exceptions) property rights to minerals have been transfered to the Crown. (For a review of this complex field, see Forbes and Lang 1987.)

This combination of property rights may result in inefficient use being made of available resources, as not all the costs and benefits of individuals' actions are taken into account in their decision making. For example, in some states landowners do not have a veto over access by explorers and miners. In such cases, unless there is adequate provision for compensation of landholders, miners may be able to undertake exploration or mining without taking full account of the costs they are imposing on the landholders. On the other hand, a right of veto (unless a fee for permission is freely negotiable) may allow a farmer to deprive the community of the benefits of exploiting the resources without bearing any of the costs of doing so.

The simple market-based solution would be to vest mineral rights with the owner of the land (which, except for gold and silver, would be to restore the common law position). Such a solution may now present problems. Granting existing landholders mineral rights would constitute a substantial redistribution of wealth from the community as a whole to private landholders. On the other hand, it would make no immediate difference to the ownership of minerals on Crown land. However, it would create a 'new' mechanism for allocation of rights to those minerals: sale of the land.

As has been discussed (p. 26), many fisheries provide examples of the problems which arise from incomplete or inappropriate specification of property rights. In an open-access fishery, there is a strong incentive for operators as a whole to put in too much effort and take too many fish. Restricting rights to fish to a limited number of people is unlikely to have any useful effect: the incentive is still to waste rather than economise on effort. Regulating the ways in which fish can be caught, as has often been done will not be useful. While such restrictions may reduce effort, they will do so only by increasing costs. An effective form of property right is, instead, to give each individual operator a right to a particular catch volume.

Transferability

Transferability of rights is essential to the establishment of a market and encouragement of efficient resource use. Easy transferability of rights allows individual operators in an industry to rationalise the size and structures of their businesses as circumstances change, and it will normally facilitate relatively free industry entry and exit. Freedom of entry and exit may be important to the encouragement of investment and competitiveness in the industry. The efficiency of market solutions to problems of resource use generally depends on those markets being competitive, or at least contestable by potential participants. Ease of entry and exit are important to the contestability of markets and, therefore, to their efficiency.

Where property rights to resources can be transferred easily, those operators who can make most efficient use of them, and therefore value them most highly, are able to obtain access to them. If property rights are not transferable, resources may remain in the hands of less efficient operators and businesses may be unable to adapt the size and structures of their operations to changing economic and environmental circumstances.

Information

There are three important issues concerning the acquisition and use of information in the resource industries. The first concerns the relative costs of and pay-offs from acquiring and using information about resource use alternatives. Processes of gathering information and decision making are costly. These costs need to be considered against potential gains from more informed decisions. For example, more intensive exploratory drilling at a mine site will generally provide better information and allow more profitable planning and development of the mine. But drilling, evaluation of drilling results and consequent delays in mine development will have significant costs. Ultimately the mine owner must seek the most profitable trade-off between the costs of further exploration and the gains from making marginally better development decisions.

The second information issue concerns the extent to which information, once made available to one individual, can be made available to others at little extra cost (the 'non-rivalry' problem described in section 3.2). Excluding non-paying users can also be difficult. So private market supply of information may be less than that desirable from a broader social perspective. How effective private markets are at supplying information may depend on the form in which the information is held. Information which is embodied in, or closely related to use of, equipment may be quite effectively supplied through private markets, since exclusion of non-payers from access to the equipment will generally be possible.

Despite these problems of non-rivalry and exclusion, the information industry has been a major growth area in all modern economies. Nevertheless, it may be that information is not supplied in socially optimal forms and quantities. But that is not necessarily an argument for large scale government involvement. Government suppliers of information face analogous difficulties to those of private suppliers in assessing the forms

and amounts of information that should be supplied.

The final information issue concerns attitudes to risk. As long as anything less than perfect information is available about resource use alternatives, there are risks inherent in the choices made. If there were complete markets for risk, these risks — and individual attitudes to risk — would not influence the efficiency of production and consumption decisions. However, although there are a number of market devices for spreading or transferring risks across market participants, they amount to less than full markets. It is likely that individuals are constrained in the degree to which they can pool risks. So they will take less risk than would be desirable from a broader social perspective. On this basis, there may be an additional case for governments to be involved in the production and dissemination of information, as a risk reducing strategy.

4.2 Government production and parallel markets

For some resources there may be either economic or other reasons for not depending totally on markets. Two general approaches are considered here: reliance on government resource management bodies, and establishment of markets for quota rights to particular activities, such as clean water use and addition of pollutants to streams or air. To some extent the two approaches apply to different sets of circumstances, but there is some overlap. The third possible approach, regulation, is discussed separately in section 4.3.

Government resource management

Government institutions have long had a direct involvement in resource management. The most common areas are in the provision and management of environmental amenities, such as national parks; forest management; and the regulation of, and supply of information to, operators of mines, farms and fisheries. In agriculture, that involvement has been extended to marketing and other service activities such as grain handling. Issues in the allocation of mineral rights were discussed in section 3.3.

The agencies which manage the major part of Australia's forests are of considerable importance to current natural resource management issues. In essence, state forest services fulfil two general roles — supply of sawlogs and pulplogs, and provision of environmental amenities from forests. This dual role has grown from a degree of complementarity between wood supply and conservation in native forests. (The South Australian Woods and Forests Department is an exception, being primarily concerned with commercial provision of raw and processed wood from pine plantations.)

For the most part, charges for wood, and systems of allocating access to native forests, have been administratively, rather than market, based. However, in recent times there has been an increasing move toward market related systems, through auctioning and opening for tender access to specific parcels of logs. An important issue in moving toward a market system is how price and production risks should be distributed between the wood producer, the forest service, and the wood processor. It may be that some combination of long term access

agreements and auctions of access on an annual basis is appropriate.

A source of difficulty arising from the historical basis for government involvement in forestry, particularly in native forests, is the multiplicity of objectives assigned to most state forest services. In addition to the provision of wood supplies and responsibility for conservation, state forest services have generally been expected to meet objectives such as supporting the development of regional processing industries. As is pointed out by ABARE (1990*b*), conflict between objectives may have detracted from the efficiency of wood supply and conservation management.

A presumption underlying the objectives set for state forest services is that all native forests should be managed to provide a wide range of wood, conservation and other services. That presumption may not be reasonable. The Industry Commission (1990*c*), in an investigation of returns to wood production alone for a range of sites and species, found that optimal harvest ages were mostly less than forty years — generally less than half of current practice. The Commission acknowledges that if account is taken of increase in wood value with increasing log size and of conservation benefits which increase with forest age, the optimal ages may prove greater than those indicated. However, they may still be much less than current harvest ages. Where particular conservation values, such as those associated with preservation of populations of mammals dependent on tree hollows, are obtainable only in the presence of very old trees, it may not make sense to attempt to provide both wood and a full range of conservation values from the same forests. The best solution may be intensive management of some forests for wood production, with incidental conservation and watershed protection, with other areas managed specifically to provide particular conservation values. Such areas may not have to be large if the primary aim is to maintain an acceptably low probability of extinction of species rather than to facilitate frequent on-site observation.

Parallel markets

Though the dominant forms of response to the difficulties involved in the supply of environmental amenities have been regulation or production by government agencies, in many cases it may be possible to allow a market to develop which would handle a good part of the problem of rationing resource access in an efficient way. One way of encouraging such market development is to assign, or auction, a limited set of access or use rights.

Two examples have already been described (section 3.2): the use of transferable catch quotas in fisheries and of transferable water allocations in irrigation areas. There is probably considerable scope for further development of the individual transferable quota system in Australian fisheries. Geen, Brown and Pascoe (1990) show that the extension of this system to the south-east trawl industry would produce considerable gains. The continued movement toward a system of private water rights, transferable separately from irrigated land, has considerable potential to improve the efficiency of use of irrigation water

(Randall 1981; ACIL 1984). The same principle may be applicable to polluting activities.

Setting up a market in pollution quotas involves an initial decision on an environmental standard. This in turn is likely to require estimation of the economic value of non-marketed costs and benefits. The available methods for, and difficulties of, such estimation have been mentioned in section 2.1 (p. 13). In that sense, and in the sense that there are administrative and enforcement costs of a similar nature, quota markets have some similarity to conventional regulation. The essential difference from regulation is that the use of quotas allows the choices about distribution of pollution between producers and about input and output use to be decided between producers. Those choices are, therefore, made on the basis of the relative efficiency of the market participants. As Chisholm (1985) points out, marketable quotas also encourage technical innovation, where regulation does not. Any individual quota holder has a clear incentive to find cheaper or less polluting ways to produce, so that excess quota can be marketed. A market in quota rights also provides a simple means for government to lower the extent of the polluting activity in future periods, by buying back quota on the open market.

For a conventional market to develop and operate efficiently, there needs to be a large enough number of potential buyers and sellers to ensure competition. Quota markets for items such as pollutants from minerals or forest product processing, which tend to be produced in a few geographically scattered plants may not, therefore, be particularly successful.

Simmons and Hall (1990) suggest the use of transferable salt permits as a way of overcoming some of the economic problems associated with the salinity resulting from irrigation in the Murray–Darling basin. Provided that individual farm contribution to total salt loads could be monitored in a reasonably inexpensive fashion, such a system could encourage more efficient resource use.

A related suggestion, for dryland salinity, is the use of tree-clearing or cleared-land quotas (Hodge 1982). Clearing of trees, at least in some areas, has led to greater water inflow to saline subsoil and rock strata, resulting in the output of saline water to other land and into streams. Preventing further clearing, or planting more trees, could limit the salting effect. Regulation of the planting or clearing of trees, however, places the burden of deciding which areas are least economic as cleared land (and therefore most appropriately treed) on the regulator. Setting up a system of (regional or watershed based) marketable quotas places that responsibility on landowners. When relative values of land in alternative uses change, market participants may find it worthwhile to change the location of treed areas through an exchange of permits, with a resultant clearing of some areas and planting of others. The advantages over a regulatory system are likely to be flexibility and simplicity of operation. Both the market system and the regulatory system will require a similar degree of knowledge of the hydrology of the region and the relationship between trees, cleared land and salinity. Both will involve similar enforcement costs. Hodge argues that, because of the variation in effect of clearing between

different areas, some combination of zoning of land and marketable clearing quotas may be optimal.

4.3 Regulation and taxation

Though conventional markets, or markets in pollution quotas or related rights, have broad current and potential applicability in the management of natural resource use, regulation has been a more common practice. Examples of direct controls are plentiful across production and consumption activities, such as closely monitored water quality and emission standards. Important examples of direct regulation in natural resource industries include very detailed forest codes of practice, and requirements for mine site rehabilitation.

In cases where other methods of management fail, regulation may be relevant. This seems most likely to be the case where production or consumption decisions have significant spillover effects. In particular, other approaches may fail where there are important off-site conservation benefits associated with a natural site which has conflicting development potential for agriculture, forestry or mining. For example, the benefits from preservation of species on a potential mine site may be significant, but not sufficiently important to justify total exclusion of mining from the site and reservation of the area for purely conservation purposes. Regulatory controls over the form of mine development and site rehabilitation may then be a cost-effective option.

However, for regulatory solutions to be economic, some fairly stringent conditions must be met. In relation to any problem, it needs to be established not only that the desired change in individual or firm behaviour is produced, but that the gains from doing so outweigh the total costs of the regulation.

Considering the full benefits and costs of regulations and of alternatives will seldom be a simple process. First, as in the setting of environmental quotas, it may be necessary to estimate the value which people place on various non-marketed benefits. The second major consideration in assessing the potential benefits of regulation is the likely degree of success of the regulation. The 'expected benefit' of regulation can be defined as the product of the benefits, if the regulation works, and the probability that it does work. For example, suppose that soil erosion imposes significant costs on downstream farmers and road management authorities because of increased flooding and siltation. In general, it will not be possible to track down the source of these costs to a specific point, so it is not certain that regulation of any particular activity will have the desired result. Banning tree clearing on steep slopes, for example, will not work if the most significant contribution of silt is from slightly sloping cropping land.

Costs of regulation are seldom considered in full, if at all, in choosing whether or not to regulate and in designing regulations. Yet the questions of which is the most cost-effective regulation and whether the benefits of its use outweigh the costs are obviously vital — particularly since the costs of regulation are potentially significant. For example, Jorgenson and Wilcoxen (1990) estimate that environmental regulation

in the United States over the period 1973–85 has resulted in a long-run reduction of 2.6 per cent in the level of the US gross national product. Broadly, there are four groups of costs of regulating. The two most obvious are the information and administrative costs involved in setting up and operating the regulatory system. The third is enforcement costs. Finally, and perhaps less obviously, there may be significant resource costs arising from incidental distortions to economic activity as a result of the regulation.

The intent in imposing regulation may be to remove a distortion to economic activity. However, as Wills (1987) points out, it is important to recognise that governments, as well as individual producers and consumers, have less than perfect information. So while it is possible that some desirable effects will result from regulation, it is unlikely that the changes in behaviour produced will be optimal, and it is possible that the result will be worse than that in the absence of regulation. It may be that in many cases, where there are apparent problems with reliance on markets, the best solution is to live with those problems rather than incurring the expense of less than satisfactory, or costly, intervention.

Pollution taxes

Pollution taxes are equivalent in some ways to regulations and quotas. First, the measurement problems mentioned above arise whether the policy instruments being considered are specific pollution taxes, quotas or regulations. Second, for any chosen level of tax, there is a quota or a set of regulations which could be expected to result in the same level of activity. Third, taxes, like regulations, will be effective only if they can be targeted effectively.

Taxes can easily give rise to greater costs than benefits if they are too high relative to the damage caused by the taxed activity. However, they have two clear advantages over regulations. First, they are clearly included in both government and private budgets, so at least some of the cost of the regulatory system is obvious to decision makers. Regulations are off-budget, both for governments and for those who bear their consequences. In consequence, they can easily be ignored even when they are costly and ineffective.

The second clear advantage of taxing specific polluting activities, rather than imposing regulations on them, is that it allows producers the freedom to seek and use the most economical input and output combinations. A tax on a particular polluting activity allows the producer to decide on the optimal trade-off between production of the pollutant and consequent payment of the tax, and the alternative costs of lowering production or of changing the means of production. There are no impediments to the producer's choice of least-cost combinations of inputs. Quotas for polluting activities offer a similar freedom. Though they set particular levels of those activities, they also allow producers to choose the least-cost ways of meeting those limits. If the quotas are tradable, they also allow the distribution of quota to those producers who value it most highly.

Setting regulatory standards may, on the other hand, impose both a particular level and form of activity on producers. Unless the regulation is set up with full

consideration of the costs and benefits of alternatives, and near perfect information, it is unlikely that the performance specified will be as cost-effective as the production strategy that would be selected by the individual producer. Even if it were efficient at the time of imposition, the regulatory solution would need to be continually adjusted with changes in economic conditions in order to remain efficient. With quotas, such adjustment is a fairly simple matter of government entering the market and buying back quota which is regarded as excessive. Similarly, a tax rate can easily be changed.

Pollution taxes may also have an advantage relative to other forms of taxation. As has been pointed out (p. 34), the process of raising government revenue has significant efficiency costs. This being so, there is a case for revenue to be raised by means whose effects on welfare are designedly positive.

4.4 Policy opportunities

There are a number of possible directions for future policy developments. Public discussion of environmental and resource policy tends to drift toward ways of regulating private activities to limit the spillover effects on other members of the community. However, as is indicated in section 4.3, there are a number of limits on the usefulness of regulation. The primary limitations of regulatory approaches lie in the costs of information and possible unintentional distortion of economic activities other than those targeted.

There are also a number of opportunities to induce more efficient use of natural resources by providing market incentives through specification of private property rights. Significant opportunities exist to improve the efficiency of resource use in fisheries and in irrigation water use by further development of individual, transferable, rights of ownership. There may also be opportunities to allow more market-based systems of resource allocation in public forests and in the allocation of rights to explore for minerals. Allowing markets to handle at least part of the resource allocation problem for pollution problems such as salinity may also have potential.

Conclusions

For a wide range of goods, markets serve to coordinate the consumption and production activities of large numbers of people. Markets work most efficiently when there are clearly defined and tradable individual property rights to resources, and when the users of goods can easily be identified and induced to pay for their use of those goods. In such circumstances markets can ensure flexible and efficient responses to changing demands and changing technology. Importantly, the operations of efficient markets are open to scrutiny and the costs of alternative resource uses are, therefore, easily observed.

For many of the environmental amenities derived from Australia's natural resources, individual ownership of the resources and market supply of the amenities would be difficult to implement. While this almost certainly means that some degree of government involvement is required, through such devices as regulations or pollution taxes, care is needed to ensure that there are net social benefits from such involvement. Regulations have three disadvantages. First, they are generally slow or difficult to adapt to changing circumstances. Second, even using the best information available, the impact of regulations is likely to be somewhat off-target and may produce some unintended resource costs. Third, because the costs of regulation are not recorded in a specific budgetary sense, those costs may be largely hidden.

In recent times, there has been increasing concern about the long term sustainability of present and expected levels and patterns of economic activity. Much of that concern has been reflected in suggestions for greater conservation of natural resources. There are clearly legitimate demands to conserve some specific natural assets, in view of the risks inherent in making development decisions based on incomplete knowledge about future demands for resource use and future technology.

However, the question of sustainability of economic welfare needs to be approached from a broader perspective than that of simply retaining resources in their present state. Account must be taken of technological change and opportunities for substitution between forms of capital. The question is not just one of maintaining current income levels and patterns of resource use. It is true that using up some of the non-renewable natural resources now may place some limits on production and consumption possibilities in the future; but if enough of the income from current resource use is invested in the creation of physical capital and in improving the technological abilities of the workforce, the total income of future generations may be increased by such use.

There are several areas of the Australian economy in which potential exists for the more effective use of markets. Areas of particular potential

are likely to be the extension of use of individual transferable quotas in fisheries, the development of transferable pollution quotas in the protection of environmental amenities, and further use of bidding and other market related devices to price and allocate access to public forests and mineral deposits.

Markets may not always work perfectly but in most instances they offer the most efficient solutions to problems of supply and distribution of goods. It needs to be recognised that there may be apparent problems in many areas of the economy for which the best solution is to take no action. Only if it is clear that a proposed action would yield benefits greater than its cost can that action be said to be in the interests of the community.

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