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A Transaction Cost Economics Approach to Considering Environmental Policy

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1.0 Introduction

Recently governments in Australia have started to embrace market-based mechanisms to secure, or procure, environmental goods. In New South Wales, the Government introduced a tradable permits system for salt in the Hunter River. In Victoria, the Government has trialed the use of auctions for conservation contracts to procure biodiversity services. At the Commonwealth level, $5 million worth of funding from the National Action Plan for Salinity and Water Quality has been earmarked for "Market-Based Instruments" pilots that will investigate a range of approaches to environmental management.

Policy makers now have an increased interest in market-based mechanisms probably because market-based mechanisms are perceived to offer advantages in terms of cost-effectiveness or efficiency.

Historically, governments' first response to environmental problems in Australia, and around the world, has been to use a regulatory approach. For example, regulation has been used to prohibit native vegetation clearing, or to place technology standards on firms causing air pollution. Economists have long argued that this is inefficient: a regulatory approach does not cater for the fact that players have heterogenous costs, and hence it imposes a relatively large aggregate cost on the economy.

This is not to say, however, that a regulatory approach should never be used, or that it is not an appropriate part of the policy mix. In fact, Weitzman (1974) provides a rationale for a regulatory approach—which he calls a 'quantity' instrument—by arguing that it may better account for uncertainty. This is particularly valuable when environmental goods are subject to thresholds and irreversibility. Some of the current market based instruments utilise quantity restrictions and then overlay the advantage of incentives. For example a tradable permit (cap and trade) mechanism combines incentives and regulation. The cap on (say) pollution is a 'quantity' instrument that protects the resource, and the trade allows players to distribute the costs of maintaining the cap efficiently. So although economists have argued that regulatory approaches can be inefficient, they have not argued that regulatory approaches should be discarded.

If a regulatory approach is useful some cases, how does it fit with the variety of new market based mechanisms that are being promoted by economists? What is the right blend of these different mechanisms? Do market based mechanisms have different advantages and disadvantages in the short- and long-run?

In this paper we examine these questions. Our contribution is in terms of a framework for thinking about these questions, rather than a cut-and-dry answer to the questions in certain circumstances. However, we believe this is useful since many policy decisions are based on qualitative discussion.

Although we examine these questions using general economic theory, we rely heavily on transaction cost economics. Williamson (1996, pg 379) defines transaction costs as the "ex ante costs of drafting, negotiating, and safeguarding an agreement and more especially, the ex post costs of maladaptation and adjustment that arise when contract execution is misalinged as a result of gaps, errors, omissions, and unanticipated disturbances". Williamson (1985) says that transaction cost economics involves "making the transaction the basic unit of analysis, ascertaining the underlying attributes of transactions, and aligning institutions (incentives, controls, and governance structures) in a discriminating way".

Much of the transaction cost literature is based on the premise that systems evolve to achieve a certain outcome at minimum cost. Hence, if there is a mode of organisation or governance has transaction cost advantages it will replace less efficient modes through time.

Clearly in the private sector the search for modes of governance that are efficient is a natural part of competitive pressures. Innovating firms have a clear incentive to develop new modes of governance that will provide profit advantages. Once other firms discover these modes they will become widespread providing the economy with overall efficiency gains.

We also expect this to be true in public policy. Better policy mechanisms, and a better mix of mechanisms in the policy portfolio, initially used by some governments, should eventually spread to others. There will be a continual policy evolution towards more cost effective or efficient mechanisms. By writing this paper, we hope to contribute to that process.

1.1 Layout and Approach the Paper

This paper is mostly written for people with some economics background. It uses basic economic concepts throughout, and often these concepts are not explained within the text; we give appropriate references instead. However, people with a policy background, and a feel for economic concepts should be able to understand the main messages.

Although we have labelled this as a paper that has application to 'environmental policy' generally, many of our examples will focus on terrestrial biodiversity. This is because in large part these concepts have come from our consideration of this topic. However, many of the main messages contained herein apply to environmental policy more widely.

This is quite an extensive paper in terms of the number of topics that we cover, and the depth of our coverage. Hence, it is difficult to read in one sitting. We have tried to make the Sections separable to a large degree, so that they are self-contained. However, Section 2—on transaction cost theory—should be read prior to reading any of the other Sections.

The paper is set out as follows. In section 2 we give a brief statement about transaction cost economics, drawing heavily from Williamson's (1985) text, "The Economic Institutions of Capitalism". This provides some basic ideas on the approach that we use in much of the subsequent paper. Even though much of this paper is about the supply of environmental goods, we discuss the interaction of supply and demand in Section 3. Hence, Section 3 couches this report in the context of a standard economic framework. Towards the end of this section, we give a brief commentary on how transaction costs may affect decisions about demand; we look at how an environmental agency may organise its decisions regarding the demand side of environmental policy. In Section 4 we look at the problem of the initial allocation of property rights for an environmental good. We argue that the manner in which property rights are allocated can have significant effects on transaction costs, and hence that these need to be considered by policy makers. In Section 5 we consider the problem of constructing a portfolio of policy mechanisms to increase the supply of an environmental good. In this section, subsume transaction costs into the wider category of 'supply' costs—which include transaction costs plus all other (direct) costs. This discussion is mostly in terms of static efficiency. Hence, in Section 6 we expand our discussion to include considerations of how costs might change through time: we call this dynamic efficiency. Section 7 is about institutional structure, which attempts to look more broadly at environmental policy by considering not just the mechanisms that might improve environmental outcomes, but the structure in which they are implemented. This section explains that transaction cost concepts can be useful in terms of considering institutional structures. Indeed in his seminal piece in 1937, Coase argued transaction costs were at the heart of explaining the boundaries of the firm, ie, in explaining organisational structure. We summarise in Section 7.

2.0 The Transaction Cost Framework

In this section we will introduce the concept of transaction costs. We will give a brief definition of transaction costs and explain some of the economic problems for which it has provided useful insights. Then we will explain how it may be useful in thinking about environmental policy. This last point, however, will be illustrated more in-depth throughout subsequent sections of this paper.

In this section we will be very select in terms of the literature that we cover. We will draw heavily from Williamson (1985). The interested reader should see additional references including Williamson (1996), Holmstrom and Roberts (1998), and Williamson (2000).

2.1 Select Background on Transaction Cost Economics

Transaction cost economics can be dated back to Coase (1937). However, it was only during the early 1970's that economists began to develop it more fully (for example Williamson 1971; Alchian and Demetz 1972; Davis and North 1971). These writers drew on Coase's early contribution, but also the writing of organisational theorists such as Barnard (1938) and Simon (1961). Williamson was particularly important. He argued that it is useful to consider the characteristics of transactions because this will provide insights into the form of contract that is used; contract form will be adapted to suit the nature of the transaction. This is true irrespective of the players involved, whether it be transactions between two firms, or between employees inside the one firm (the employment relation). In this paper, we will argue that the transaction cost economic way of thinking is useful not only in terms of considering private sector transactions, but also public policy transactions. Governments have to engage consumers and producers when attempting to achieve public policy outcomes. In essence, governments must transact with people, whether this be individuals, such as in the case of individual management agreements, or a broad group in the community, via legislation for instance.

In his seminal contribution that predated the transaction cost literature revival, Coase (1937) asked a very simple but important question: what forms the boundary of the firm? He argued that the answer is transaction costs. Some transactions will be undertaken in the marketplace, but for other transactions, the market can be supplanted by internal organisation, ie, by the firm. The market and the firm compete as modes of organisation for a transaction. The market is not always a marvel, rather, sometimes it is inefficient relative to other structures, such as hierarchy.

Williamson (1985) agrees with Coase that transaction costs are important, and he goes on to explore the implications of this for economic organisation. Williamson, defines transaction costs as "the *comparative costs of planning, adapting and monitoring task completion under alternative governance structures*" (pg 2, italics in original). Williamson says that transaction cost economics involves "making the transaction the basic unit of analysis, ascertaining the underlying attributes of transactions, and aligning institutions (incentives, controls, and governance structures) in a discriminating way".

In the theory of competitive markets, transactions between firms and consumers happen in a one-off, costless way, and markets are cleared (prices set) via market signals. The contract in this form of analysis is extremely simple: buyers assess the price and quality of a product and decide whether to buy based on their assessment. Once the buyer purchases the good, the transaction is over. Hence, there is not need to consider any costs subsequent to the initial deal.

2.1.1 Behavioural Assumptions

Williamson (1985) argues that the standard competitive market theory is only useful in some circumstances. In many other circumstances, it is better to consider contracts in more depth. He states that "transaction cost economics poses the problem of economic organization as a problem of contracting". In order to consider contracting in depth, transaction cost economics uses two key assumptions.

- Bounded rationality—it is difficult if not impossible to structure contracts that take account of every contingency. Hence, mechanisms that ensure both parties are protected in the case of unforseen circumstances are needed.

- Opportunism—if two parties contract on initial terms, and these terms change, then the party that is favoured by this change may be prone to opportunism: the use of the changed conditions to extract a larger portion of the value created from the contract.

These assumptions mean that contracts are necessarily incomplete, and that if there are potential hazards due to uncertainty, then contract safeguards need be crafted by the relevant parties. This is especially the case when contracts are complex, and the interaction between parties will be ongoing. For example, many business-to-business transactions, and many transactions between the government and the community in terms of the procurement of environmental management, are on-going. Transaction cost economics considers all the costs of in these types of contracts, both *ex-ante* and *ex-post*.

2.1.2 Implications

Transaction cost economics argues that when contracts do not reach the neoclassical ideal of perfect information, and costless enforcement, the mode of 'governance' will be important. Governance structures help to ensure a contract can be workable or adaptable through time, even if circumstances change. It is unrealistic to expect that in the case of dispute, parties will relegate arbitration to the legal framework, since this may be very costly. Hence, firms and policy makers can use safeguards, or design systems that minimise the costs of contracting whilst still capturing value. Contract forms that economise on transaction costs will replace other, more costly, forms over time; contract forms have an efficiency rationale.

One of the often-cited examples in the transaction cost literature is the decision of a firm to 'make or buy': the situation where a firm compares the efficiency of producing some (say) component itself, or of contracting this service out. In making this decision, the firm will consider the transaction costs of different approaches. Williamson (1985) highlights the importance of the traits of the assets required to make the component. If the assets required to make the component would have no other use (the assets are 'specific') then Williamson argues that there will be a tendency towards in-house production. External firms will be loathe to invest in assets that can be used for only one purpose, and hence there will be a lack of interest in manufacturing this component, or very severe restrictions on contact terms—raising transaction costs. In essence, the boundaries of the firm are determined by the type of investment which affects the transaction costs. Hence, the firm is facing a choice: use the market, or use internal organisation. The two are substitutes, and in some cases the market is not superior—those cases where internal organisation has transaction cost advantages.

The make or buy literature highlights that ownership matters: one particular asset ownership structure carries with it incentives (and hence transaction costs) that may differ to an alternative structure. We will revisit this basic point repeatedly throughout this paper.

As stated above, transaction costs can be thought about in the context of any contract, whether this is a contract between two private firms, government and a single landholder, or government and the community as a whole. In some sense, the make or buy decision of a private firm resembles the decision by governments on how to structure contracts (an hence property rights) in terms of environmental policy. In some cases the government may procure assets, and manage them themselves. In other cases it may contract out services. There will be differential incentives and costs of these different approaches. Just as a firm will face differential costs of making, or buying.

But the view of transaction costs extends beyond this simple comparison. With regards to much public policy, the public sector is often contracting with society (citizens, or firms) to achieve ends. In any of these deals, the government needs to consider transaction costs. A policy such as prohibiting native clearing retention clearly places the government in a situation where it will have to face up to repeated negotiations. For example, if prohibition of native clearing is pushed through without community acceptance, then there may very large on-going monitoring and enforcement costs.

In other words, positive transaction costs mean that the form of a contract, or the organisation or structure in which a transaction is executed, matters. Different modes of organisation matter: whether something is produced in-house (ownership) or contracted out; the style of governance structure; the cost of monitoring the outcome, etc.

Most of the transaction cost literature has focused on private sector transactions. However, more recently there have been contributions that apply transaction cost thinking to the public sector, such as Williamson (1999) and Dixit (2000). In this paper, we attempt to take a further step in that direction. We will not introduce any new concepts, but rather apply standard transaction cost concepts to current environmental policy in Australia, with a focus on biodiversity policy.

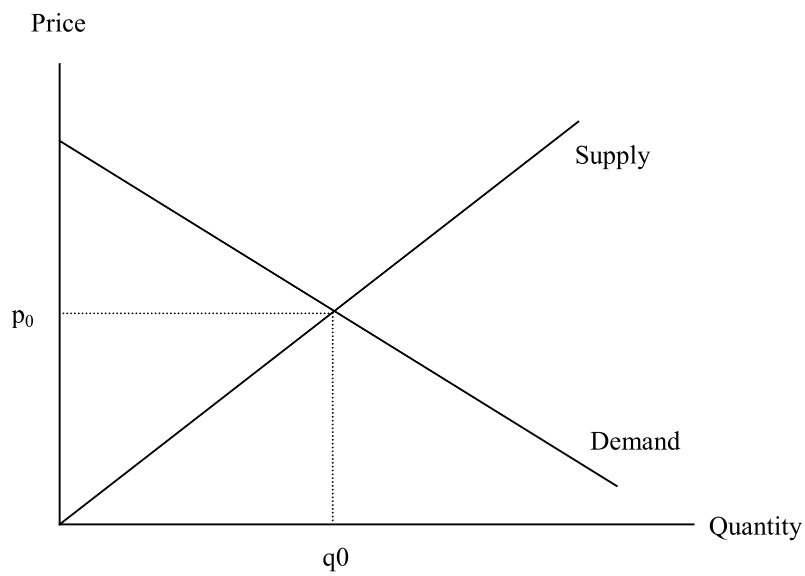
3.0 Efficiency and the Demand for Environmental Goods

The efficient provision of a good—including an environmental good—requires the connection of two factors: supply and demand. In this section we will explain how these two factors connect to provide a notion of efficiency, and then we will discuss in more detail the problem of discovering the demand for biodiversity. We will discuss mechanisms that facilitate the supply of biodiversity in subsequent sections.

3.1 Efficiency

Figure 1 provides a classic economic diagram: a demand and supply diagram. The quantity of the good such as biodiversity is on the horizontal axis, and the price of the good is on the vertical axis. The intersection of supply and demand form price, p_0. The provision of the quantity q_0, by suppliers who can provide at a cost of less than p_0 is efficient.

Figure 1: Classic Economic Diagram of Demand and Supply



The demand curve represents the different values placed on biodiversity by society. Briefly, these values are made up of the benefits that society enjoys from different quantities of biodiversity. Society enjoys benefits for a variety of reasons: the enjoyment from watching or viewing species; the benefit of knowing that species are being maintained now for future generations ('existence values'); and the option value of maintaining biodiversity for some as yet unforseen use.

The demand curve is shown to fall as the quantity of biodiversity increases. This reflects a basic assumption that when society has lots of biodiversity, it values a small increment relatively less. Sometimes the demand curve is called a 'willingness to pay' function. This is because the value derived from any good represents how much people are willing to pay for another unit of that good.

The supply curve in Figure 1 represents the cost of increasing biodiversity. This cost depends on the nature of the technology that is used to supply biodiversity (for example, the mechanism that is used). We discuss this more extensively in Section 5. However, for the moment we can assume that each point on the supply curve represents the minimum possible cost of obtaining another unit of biodiversity.

The supply curve is shown to slope upwards. This represents the fact that when there is already a large amount of biodiversity, it is harder to obtain another unit. This is because as we increase the amount of biodiversity we have to drag resources away from ever more valuable alternative uses. We can get the first few units of biodiversity at low cost, but once these low-cost options are scooped up, then we start to face higher marginal costs.

Going back to Figure 1, we stated that the supply of q_0 units is efficient. We can now state more precisely why this is the case. Securing an amount of biodiversity over and above q_0 would be inefficient because the benefits of those units would be less than the cost of supplying them. Securing less than q0 would leave units that have positive net value unsecured.

Figure 1 forms the basis for most of the thinking that is to come in the rest of this paper. In the next section we will focus on one aspect of Figure 1: the demand for biodiversity.

3.2 Demand for Biodiversity

The demand for biodiversity exhibits classic public good characteristics[1]. Hence, an environmental agency will face problems in terms of getting a gauge on the slope and position of the demand (willingness to pay) function. Still, any policy choices must make (at least implicit) assumptions about the importance of biodiversity relative to other environmental goods, and about preferences within the biodiversity mix. The more transparent these assumptions, the easier it is to design mechanisms that will achieve an agency's aims.

Although the value of biodiversity is inherently difficult to define and estimate, economists and others have considered the different values attributed to biodiversity. For a description of the different categories of biodiversity values see Stoneham *et al.* (2000).

[1] For a definition of a public good see Stiglitz (1988).

3.3 The Demand Side and Transaction Costs

If information were costless to obtain and transfer, then economists would prefer that every decision about public good resource allocation were made with complete information. That is, all citizens were fully informed about the relative merits of different public goods, and that a decision maker (such as a Minister) had citizens' fully-informed preferences at hand when allocating resources.

However, information is not complete.

Instead, there are transaction costs to obtaining and transferring information. In other words, information is imperfect (some things are not known), and the information that is available is dispersed amongst many individuals throughout society (information is asymmetrically distributed).

Transaction costs hinder information flows between all players in society, but in this section we note two types of information flow—that are relevant to demand-side decisions about public goods—that are affected by transaction costs. First, the flow of information between government and the community. Second, the flow of information within public bureaus. We will describe the first, but focus our analysis on the second.

Information Flows between Government and the Community

Governments make resource allocation decisions about goods such as biodiversity because of their public good nature (as argued above). The community does not observe all policy outcomes since information is costly to obtain and transfer. One form of transaction-cost economising that may result from this problem is the creation of a lobby group. A lobby group generally attempts to collect and distribute information about specific subject matter, for example, native timber harvesting. Governments' decisions about the demand for different public goods—and hence their resource allocation decisions—will then reflect a variety of factors, including the impact of lobby groups. When a number of different lobby groups affect a government's decisions, then the outcome is not necessarily efficient (Olsen). However, governments are still the prime decision-making body with respect to the environment in Australia. Hence, in the rest of this paper, we will take this decision-making system as given.

Information Flows Within Public Bureaus.

In this Section, we assume that governments (or their agency's) make decisions about the demand for environmental goods, and examine the nature of information flows within a public bureau.

As stated above, information is dispersed throughout players in an organisation. For example, some people at the 'coal face' of the public sector will have relatively more information about changing circumstances on a particular environmental issue. We could then ask a simple question: if some people have lots of the information, then why not let them make decisions about how to allocate some resources, ie, why not decentralise the decision making process?

Jensen and Meckling (1998) examine this question from the point of view of a private firm, yet their insights can easily be applied to decision making in the public sector. Jensen and Meckling break an organisation into two components: a principal that heads the organisation; and agents that serve the principal to help her achieve her aims[2]. Jensen and Meckling assume that information is dispersed throughout the organisation.

An organisation has two basic approaches that it can use to make decisions: it can move information—at some cost—to the principals and let them make decisions; or it can move the decision-making power to those who have the information, the agents.

It may be costly to transfer information to principals for two main reasons: there is lots of information spread throughout a firm and principals have limited ability and time to absorb all of it; and it is difficult to know *ex ante* which are the relevant pieces of information. In other words, there are transaction costs. Hence, a relevant decision for principals is the optimal level of decentralisation (or centralisation). The problem with relatively more decentralisation is that people down the chain (agents) may have different objectives to the principals, ie, people down the chain may not have the best thing in mind from the principal's point of view. Hence, there is a trade-off between:

- central decision making where principals make decisions but they must be given a bundle of information, that is costly to transfer; and

- decentralisation which lets the information-holders make decisions, but where the information-holders may not have the interests of the principal in mind (the principal incurs, what economists call, 'agency costs'[3]).

At a very broad level, society is interested in its preferences being represented in the public sector's decision making process. For example, society is very interested in decisions about funding allocated to education versus health. At this level, politicians will use their information about community concern, which proxies demand about these goods. It is at this broad level that methods such as non-market valuation have generally been used (see Sappideen 1997). These methods attempt to directly estimate the value of a public good to the community in monetary terms. The use of non-market valuation is a contentious issue, with the approach receiving strong support from some and being strongly criticised by others (see Sappideen 1997).

At a broad level, it is very costly to decentralise decision making to agents such as technical specialists. For example, consider the question about how resources should be allocated to salinity versus biodiversity. Technical specialists may not be the appropriate people to make these decisions. For example, a biodiversity specialist making a decision about this trade-off may be inclined to excessively favour biodiversity, compared to salinity—there are 'agency' costs of letting the biodiversity specialist make this decision.

However, at the detailed level of environmental policy, agents may have lots of information about public good priorities, and their incentives may be appropriately aligned. For example, a biodiversity expert may know a lot more about the importance of different types of vegetation, since they will be more informed about their scarcity in the landscape, and about their importance for the ecosystem overall. It would be very costly to transfer all this information to citizens, or senior managers/ministers, or both. In other words, it may be efficient not to transfer

[2] Clearly there are several levels of hierarchy in an organisation, not just two. Extending the analysis to several levels of hierarchy would not alter the main messages from this section.

[3] In the public sector, there may be instances where 'agency' provides net benefits rather than costs to society. For example, politicians may have incentives that pertain to short-run re-election concerns. With asymmetric information between politicians and the electorate, there is the chance that these policies are implemented without the electorate understanding their full cost, or political motivations. However, public servants may be well aware of these misaligned incentives, and in some cases would perhaps make better decisions from society's long-run point of view.

information about the details of (say) biodiversity. At this level, we could presumably rely on scientists with information about these traits to make sensible trade-offs.

3.4 Linking to Supply

In this Section we focused most of our discussion on the demand for a public good. In the next Section we begin our discussion about factors that affect the supply of environmental goods by considering the allocation of property rights. We will return to considerations that link with demand in Section 6.

4.0 The Allocation of Property Rights and Transaction Costs

In this Section we will consider how the allocation of property rights affects efficiency. This is in contrast to the classic so-called Coase theorem that states the distribution of property rights is immaterial to the efficiency outcome. In fact, this section will highlight Coase's (1937) argument that when transaction costs are positive, the manner in which contracts are organised—which includes how property rights are allocated—matters a great deal.

4.1 Property Right Allocation with Zero Transaction Costs

Coase (1960) argued that redefining property rights by clearly delineating environmental asset ownership would allow the market to efficiently solve environmental problems *if transaction costs were equal to zero*. That is, he argued that if property rights for environmental assets are clearly specified, the affected parties will enter into a mutually beneficial exchange that results in an efficient outcome. The initial distribution of the property rights will not affect the efficient level of (say) biodiversity conservation and deals will be readily made to distribute the costs and benefits between interested parties.

The Coase theorem is based on the assumption that there are no transaction costs involved in implementing policy or in exchanging payments between different affected parties. That is, the Coase theorem assumes that there are no costs in addition to the amount paid to the community by the landholder, or vice versa.

According to the Coase theorem the only difference between allocating the initial property rights to one party or another will be the distribution of wealth. This also assumes that transaction costs associated with the redistribution of wealth within society are equal to zero.

Figure 2: Bargaining solutions to achieve efficient quantities of biodiversity

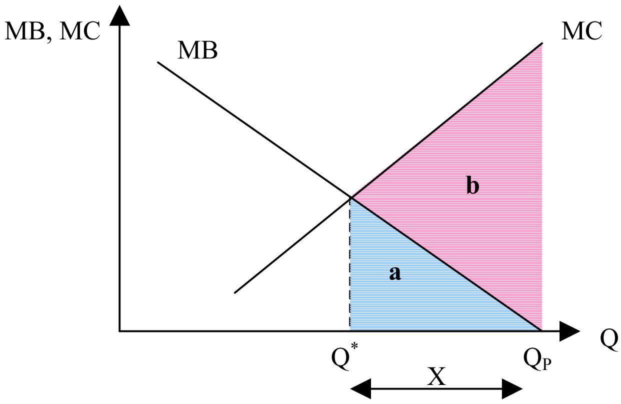


Figure 2 illustrates how bargaining may achieve the efficient level of biodiversity conservation. MB is the marginal benefit to the community of conserving biodiversity, or the amount that the community is willing to pay for biodiversity conservation. MC is the marginal cost, borne by landholders, of conserving biodiversity, which includes the opportunity cost of farming the land if it were cleared. Total costs can be derived from the marginal cost curve. These total costs would be exclusive of transaction costs—we call these 'direct costs'. Q is the total quantity of biodiversity conservation. The total quantity of biodiversity is Q_p. The efficient point is Q* (see Section 3).

Assume that the property right to Q_P belongs entirely to the community. The community will only be willing to allow landholders to clear X amount of biodiversity if they are paid at least an amount equal to the area *a* on Figure 2. This is the area under the marginal benefit curve between Q* and Q_p, it represents the total benefit that the community derives from these X units of biodiversity.

Landholders will be willing to pay the community an amount up to the area *a plus b* in Figure 2 in order to be allowed to clear X biodiversity. Area *a plus b* is the area under the marginal cost curve between Q* and Q_p, it represents the costs to landholders of conserving X biodiversity. Therefore, if landholders offer the community any amount greater than *a* but less than *a plus b* to clear X biodiversity, both the community and landholders will be better off. The total gains from trade will be equal to the area *b* (*b* = *a plus b* - *a*) and the total biodiversity level will be reduced to Q*, the point at which the marginal benefits of biodiversity conservation equal the marginal costs, which is the efficient level.

In short, if the amount that landholders are willing to pay the community to clear the land exceeds the marginal benefit to the community from having that biodiversity, they will allow landholders to clear it. The payment obligation (liability) lies with those not holding the property right. With zero transaction costs this bargain will occur because, *inter alia*:

- landholders can co-ordinate with each other and become a collective;
- the community can co-ordinate to bargain with landholders;
- the nature of aggregate costs and benefits can be estimated;
- any losses to individuals can be compensated from gains by others; and
- members to the bargain will fully comply.

4.2 Property Right Allocations with Positive Transaction Costs

In the above section, we assumed transaction costs were zero. However, in reality deals are often costly to make. While this may be true for many goods, it is especially true for environmental goods. Property rights for environmental goods are more difficult to define and enforce. This is largely due to a high degree of uncertainty, to the public good characteristics that many environmental goods have, and to the high degree of information asymmetry and non-standard benefits among landholders which may increase the cost of information collection.

The types of transaction costs associated with the transfer of a property right may include:

- ➢ Information search or research and development costs;
- ➢ Group coordination costs;
- ➢ Negotiation costs;
- ➢ Political costs;
- ➢ Administration costs; and,
- ➢ Monitoring and Enforcement costs.

Coase recognised that transaction costs exist, and that when they do they affect the efficient transfer of property rights. Consider the situation described in Figure 2. If the transaction costs incurred by landholders in paying the community for the right to clear X biodiversity exceed the area *b*, an exchange of property rights would not occur. The community will not be willing to accept an amount less than *a* in return for allowing landholders to clear X biodiversity. However, landholders will not be willing to pay *a* as the total costs (transaction costs, greater than *b*, plus the community payment, *a*) will exceed the benefit from clearing X. There would be no net gain from the exchange because the transaction costs incurred would outweigh the gain from trade.

The above argument says that transaction costs may affect whether there is a net-gain from an exchange, given that the property right is allocated in a certain way (ie, to the landholders). Several authors (see below) have argued that the manner in which property rights are allocated will affect transaction costs, and hence will have efficiency implications. This is hardly an extraordinary argument, since the Coase theorem is based *explicitly* on the premise of zero transaction costs, and perfect information.

In his 1937 article, Coase argued that the boundaries of a firm will be affected by transaction costs. In many instances, this is about the efficient allocation of property rights. For example, a firm asks a question such as the following: should we own the asset required to make some component, or should we contract-out that service to the market? If the market would deliver the good more efficiently, then the answer is no; the firm does not own (have the property right to) the asset. Instead, it allows others to own the assets and contracts them for the output. The 'make or buy' literature traces out the details of this type of decision for firms (see Holmstrom and Roberts 1998). Williamson (1985) examines how different property right structures affect efficiency in terms of franchising. In terms of environmental policy, Anderson (2001) examines the differential transaction costs of allocating property rights with regards to endangered species.

The presence of asymmetric information will also affect the predictions of the Coase theorem[4]. McKelvey and Page (2000) find that the Coase theorem is not supported in an experimental setting when there is asymmetric information. Strappazzon *et al.*

[4] Sometimes asymmetric information is presented as just another transaction cost (e.g. Williamson 1985) and sometimes not (e.g. McKelvey and Page 2000).

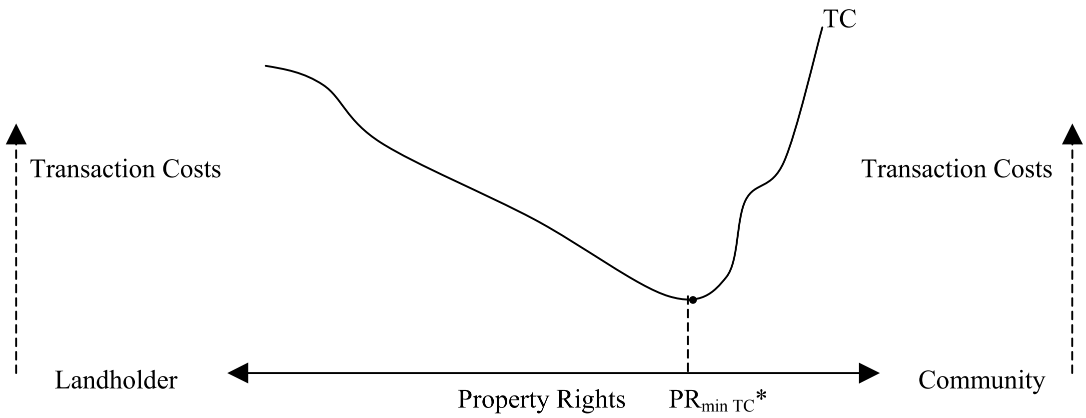
(2003a) examine how the allocation of property rights affects efficiency when several market-based mechanisms interact. They find that the allocation of property rights does affect the efficiency outcome, and explain this as being due to the presence of asymmetric information.

In the next few Sections we will illustrate, mainly via examples, how property right allocations can affect efficiency.

4.2.1 The Framework: Considering the Total Transaction Cost Curve

Imagine that a government is hoping to secure some level of environmental good, Q_T. The government can allocate the property right to (say) the community, or to landholders in varying degrees. These property right allocations are drawn on the horizontal axis in Figure 3, with complete property rights to the community to the right of the scale and complete property rights to landholders at the left. Each point on this axis, that is, each initial property right allocation, has a total transaction cost that is involved in obtaining Q_T shown by the line, TC. Note that we are considering total (not marginal) transaction costs in the diagram.

Figure 3: Property Rights and Transaction Costs of achieving Q_T



If the initial property rights are allocated entirely to landholders there will be transaction costs associated with the community paying landholders to conserve Q_T. If the initial property rights are allocated entirely to the community there will most likely be different transaction costs associated with landholders paying the community to clear so that more than Q_T is not conserved. This is because different property right allocations are likely to alter the characteristics of the transactions that are required to facilitate payments to exchange some rights to biodiversity.

Initial property rights should be set at the point along the axis where total transaction costs of achieving Q_T are minimised: PR_{minTC}. In the next section we use an example to help explain how to locate PR_{minTC} in theory.

4.2.2 Allocating Property Rights in the face of Thresholds: Focusing on a Quantity Target

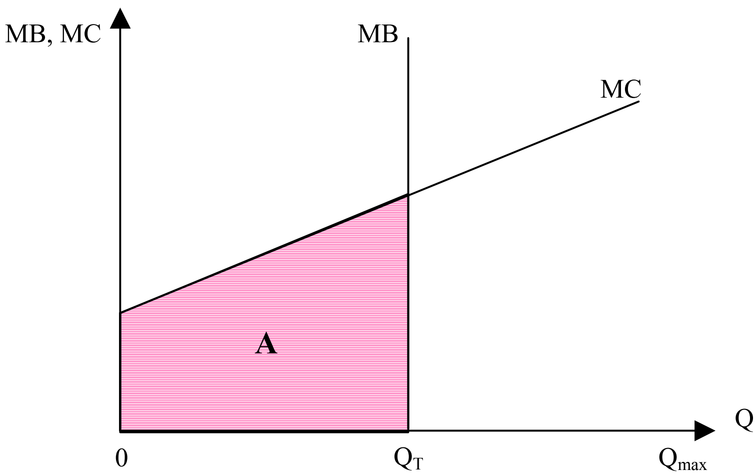
We can use an example to trace through some of the ways that transaction costs may differ with alternative property right allocations. In this section, we use the example of allocating property rights when an environmental good has an irreversible threshold level. The irreversibility problem occurs when (say) the clearing of biodiversity beyond a certain threshold level means that it can not be replaced (e.g. re-generated) at anything other than extremely excessive cost. For a rationale of thresholds with regards to environmental goods see Muradian (2001).

If an environmental agency chooses to focus on maintaining some threshold level of (say) biodiversity, then this is akin to the safe minimum standard (SMS) approach. The SMS approach is based on the premise that we should avoid causing irreversible species loss (or environmental damage in general) unless the costs of doing so are unacceptably high. Bishop (1978) provides a rationale for a SMS. His arguments are supported in a theoretical context by Weitzman (1974).

Diagrammatic representation of threshold

Consider Figure 4. The maximum level of biodiversity possible is Q_{max}. Policy makers choose physical conservation aims, such as Q_T, which might be the number of hectares of native grassland, based on scientific information and risk estimates of the threshold level below which irreversible loss occurs. The agency then minimises the costs of reaching and maintaining this target. If society uses Q_T as an SMS, then its demand curve for biodiversity conservation may be drawn as the vertical line, labelled MB, which represents the marginal benefit from biodiversity conservation. MC is the marginal cost of conserving biodiversity, Q is the total quantity of biodiversity conservation, area A (shaded) is the direct cost of achieving Q_T and is the area under the marginal cost curve between the origin (denoted by 0) and Q_T. This cost includes the opportunity cost of lost agricultural production.

Figure 4: Safe Minimum Standard Approach



Allocating the property right

In this section, we compare the transaction costs of allocating the property right to landholders versus the community. With regards to Figure 4, either landholders or the government, on behalf of the community, may be allocated the right to all biodiversity—the amount Q_{max}. For example, if landholders are allocated the right, then the government is faced with the liability to pay for Q_T units of biodiversity.

The transaction costs will depend on the mechanism that is used to facilitate the exchange of property rights. In this section we will not consider sophisticated mechanisms that facilitate exchange. Rather, we will consider a simple unstructured bargaining mechanism. We consider more sophisticated mechanisms in subsequent sections.

The two parties to an exchange will often have different incentives. If landholders have the property right, they will be making decisions about whether to clear based on private benefits and costs. If property rights are clearly defined, the landholders will be paid an amount that the government is willing to pay to conserve the biodiversity on their land.

In order for landholders to estimate the value of an exchange with government they will consider the government's willingness to pay, and their own costs.

To ascertain the government's willingness to pay landholders will need to collect information about the government's preferences (reflecting the community's preferences) and the quality and quantity of biodiversity on their land.

When landholders consider their private costs they will consider the value that they would derive from the available alternative uses of their time and other resources (land, etc), including the value that they believe they would receive for conserving the biodiversity on their land.

However, for various reasons it may be costly for landholders to accurately predict the value that they would receive from conserving the biodiversity on their land. Although the government may have (at least a portion of) this information, it may be costly for the landholder to obtain it. This may be, for example, because it requires learning with regards to scientific measurements of biodiversity quality and quantity, or paying someone from the government to come and measure the level of biodiversity on their land.

Also, landholders may not know, or may not trust the government with regards to future actions about the property right and this may affect their actions in the short term.

Given what landholders know and the transaction costs that they face in obtaining the necessary information, they may all choose to clear their biodiversity at once if that is privately financially rational, even if it is not socially optimal. This difference in incentives applies not just to the consideration of biodiversity benefits at one point in time, but also with regards to the future benefits of biodiversity: landholders may be less likely to consider the possible future value of biodiversity than the government. This may be because landholders tend to place a higher value on private returns now than at some time in the future. Therefore, landholders may be less inclined to adhere to the precautionary principal than government.

If the government were given the property right, then it may have more of an incentive to consider the environmental values in more depth. It may be less costly for the government to consider the loss of biodiversity in aggregate when an individual hopes to clear a certain patch than for landholders. However, allocating the property right to the government may come with large political costs in terms of landholder resentment and lobbying. This may increase monitoring and enforcement costs.

When considering the situation where irreversibility is an issue, one of the key differences that emerges in terms of the transaction costs of the two property right structures is the cost required to collect information. If landholders have the property right, then the government has to attempt to collect information about clearing rates, the total amount of particular types of biodiversity and how close these are to the irreversibility threshold. Generally, it will be more costly for landholders to keep abreast of the different species etc. which are at aggregate levels close to the thresholds, and to know what impact their patch of biodiversity has on each of those. Hence, if landholders have the property right then as this clearing happens, it will go unreported. Collecting this information before the threshold is crossed would require a government to conduct immediate, frequent and extensive surveys. This could be extremely costly particularly if the activity required requires a sudden increase in resource capacity.

This is in contrast to if the government—on behalf of the community—were allocated the property right. If the government owned the property right to biodiversity, landholders may have to apply for permits in order to clear patches. This would reveal information to the government, and allow it to coordinate individual clearing rates to ensure the threshold were not passed. Via this process, the government could then keep a tab on the quantity of the resource relative to its irreversibility threshold. Presumably the government would know (or have a best guess) about the level of the threshold due to its access to information from scientific experts. If the government becomes concerned about the level of applications for clearing it can restrict the clearing that it allows per period while more information is collected.

Thresholds, Property Rights, and Tradable Permits

Above we have been considering the allocation of property rights and the impact on transaction costs when parties attempt to bargain with each other in a decentralised fashion. Some mechanisms provide a formal system for exchange, and allocate property rights at the outset. As an example, consider a tradable permit system where an environmental agency is trying to keep salt in a river to some 'capped' level. The rationale for a cap is that if pollution were beyond the cap, then it could cause some large increase in marginal costs (due to say the irreversible loss of several fish species in the river).

With a tradable permit scheme, the community is allocated the right to the resource up to the point where the threshold exists. That is, the community is allocated the right to clean water that maintains pollution below the critical level. Private sector polluters are allocated the remainder—the right to an aggregate pollution level that is below the threshold. Private sector polluters can then trade shares of this aggregate pollution amount amongst themselves so as to distribute the pollution amongst the polluters efficiently.

Hence, when a tradable permit system is being used, it may be efficient to allocate the property right (of the environmental good) the community, at least up to the level of the threshold. This secures the threshold quantity at relatively low risk, and this is valuable because the losses from crossing the threshold are high.

4.2.3 Allocating Property Rights to achieve different levels of Q

In the above Sections we considered the case where the marginal benefit curve for biodiversity conservation is vertical. However, this may not always be appropriate, or it may only be appropriate over some portion of the demand curve. The government, on behalf of society, may have a downward sloping demand curve: it's willingness to pay for biodiversity conservation may decrease as the aggregate level of biodiversity conservation increases, as explained in Section 3. In this section, we will discuss the implications of assuming a non-vertical demand curve.

With a vertical demand curve, such as in Figure 4, then no matter what the position of the supply curve, the efficient quantity of biodiversity is always Q_T. However, this changes if we consider a downward sloping demand curve. With a downward sloping demand curve, the efficient level of biodiversity conservation will depend, in part, on the supply (or marginal cost) curve for biodiversity (see Section 3). This is because a change in the marginal cost (supply) curve will change the point of intersection with the demand curve, changing the efficient level of Q.

The efficient initial allocation of property rights to biodiversity will depend on the level of biodiversity conservation that is desired and the transaction costs associated with the property right allocation. For example, if one of the government's targets for biodiversity conservation, Q_H requires that almost all biodiversity in a certain area is not cleared then, accounting for transaction costs, it may be more efficient to allocate the property right for this area of biodiversity to the government. Landholders in this area that wish to clear will have to apply to do so, but the government will not allow the majority of landholders in this area to clear and so many will not apply. If landholders were given the property right in this case there may be significant transaction costs associated with the government paying significant numbers of landholders to conserve the biodiversity on their land. The transaction costs may be especially large due to the non-standard benefits and heterogeneous costs associated with conserving biodiversity on different landholders' land.

On the other hand, consider the case where the government's target for biodiversity conservation is Q_L and that this requires that only a small proportion of the biodiversity in an area is not cleared. Here the transaction costs associated with allocating the rights to the government may be high as the number of landholders applying for and being granted permits to clear will be significantly higher. In this case allocating the property rights to landholders may be more efficient, because the transaction costs associated with the government paying certain landholders to conserve the biodiversity on their land may be less (particularly if cost-effective mechanisms are used) than those associated with many landholders having to obtain permits.

We can consider the transaction cost of obtaining different levels of biodiversity conservation by looking at Figure 5. For every level of biodiversity conservation there will be a graph like Figure 3 that results in a point of minimum transaction costs.

Figure 5: Finding the Minimum Transaction Costs for a Range Of Q's

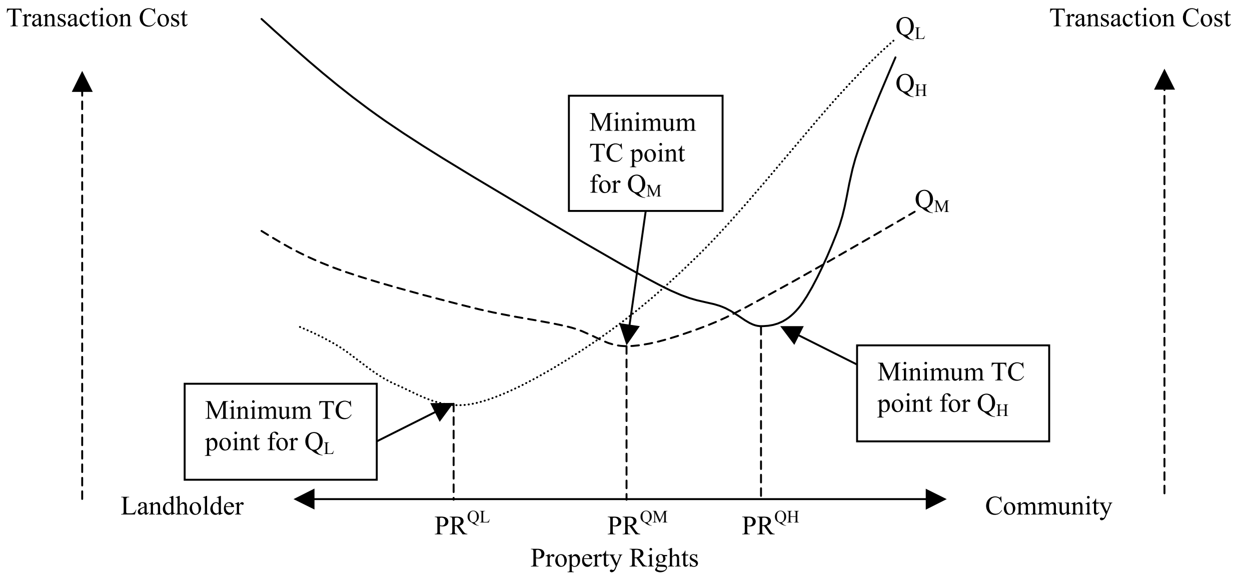


Figure 5 illustrates, hypothetically, the way that transaction costs for three different levels of biodiversity conservation—a high level (Q_H), a medium level (Q_M) and a low level (Q_L)—may vary for different initial property right allocations. For example, the Q_H curve illustrates that if a high level of biodiversity is going to be achieved and the property rights to biodiversity are allocated entirely to landholders then transaction costs may be very high, for the reasons discussed above.

When transaction costs exist, they should be considered in addition to the direct costs when assessing the cost of achieving a particular level of biodiversity conservation. The efficient level of biodiversity conservation will be at the point where the marginal (direct plus transaction) cost of achieving that level of biodiversity conservation is exactly equal to the marginal benefit of achieving that level[5].

4.3 Using the Theory

It may be difficult to estimate the transaction costs associated with different levels of biodiversity conservation. However, there are some practical implications that arise from our discussion.

[5] We discussed problems of estimating demand in Section 3.

It is very important that, in order to achieve the socially efficient level of biodiversity conservation, the likelihood that different property right allocations will result in transaction costs of different magnitudes be considered. The magnitude of the transaction costs should be considered in relation to the level of conservation that the property right allocation is likely to achieve and taking account of any irreversible thresholds that may exist. While precise estimates of transaction costs may not be possible, an assessment of the likely magnitude—given current conditions in the community—should be attempted. That is, the agency should at least use its best available prediction.

An example of the application of this thinking is in regards to the appropriate 'duty of care' of landholders. Changing landholders' duty of care is likely to face some resistance, and the magnitude of the resistance will depend on whether the duty of care requirements are in line with community's expectations. As landholders become better at and more accustomed to conserving biodiversity on their land, they may be less likely to resist as strongly the introduction of a change in property rights that increases landholders' duty of care towards biodiversity on their land. This may be especially likely if landholders can engage with mechanisms that reward their management of these public goods. For example, contracts awarded via auction that pay landholders for management of biodiversity that is beyond the new increased level required by the duty of care (see, for example, Section 5.2). If the auctions provided a signal that the community did indeed intend to reward landholders who tended to the public good, then they could be more accepting of an increase in the duty of care. This would lower the transaction costs (e.g. political costs) of this increasing the duty of care. Therefore changing the duty of care whilst implementing other mechanisms simultaneously—such as management agreements or education and information—may potentially reduce transaction costs, and make an increase the duty of care an efficient option.

In our discussion throughout Section 4 we have mostly considered the allocation of property rights when players are then left to bargain in a decentralised manner. Generally, we have not specified the mechanisms that might be used to facilitate this bargaining, or exchange, process. The ability of alternative policy mechanisms to obtain the desired quality and quantity of biodiversity conservation with smaller transaction costs should be considered when allocating property rights. We will consider alternative mechanisms in more depth in the next Section.

5.0 A Portfolio of Mechanisms

In Section 4 we considered in depth the affect on transaction costs of the government allocating the property right to an environmental good in different ways. In Section 4 we focused on the example of terrestrial biodiversity, and drew heavily on the theory of transaction costs. In this section, we will consider the general issue of policy choice, and consider all costs: transaction costs; plus other costs—which we called 'direct' costs in Section 4.

There are a number of different policy mechanisms that may be used to conserve biodiversity on private land. The most efficient policy portfolio will be one that achieves the desired level of biodiversity conservation at least total cost to society. The approach we take below is to examine the ability of different mechanisms to deal with biodiversity conservation and enhancement when the aims of the agency are clear. An agency should consider a mechanism's cost and benefits relative to that of alternative mechanisms. To attain the next few units of an environmental good, the agency should choose the mechanism (or combination of mechanisms) that is most cost-effective or efficient. At the point where society receives diminishing returns (in terms of benefits relative to costs) of a mechanism, then an agency should switch to an alternative mechanism that is more cost effective/efficient. In considering each mechanism, an agency should consider all costs including transaction costs.

An agency should not consider obtaining the next few units using one mechanism alone. Rather, in some cases it will be efficient or cost effective to use two or more mechanisms jointly. In other words, an agency should consider the cost of obtaining the next few units of an environmental good using any single mechanism and any combination of mechanisms together. Using mechanisms jointly may provide synergistic effects, and hence improve efficiency or cost effectiveness.

The policy mechanism that will be the most suitable in a particular situation is likely to depend on the total level of biodiversity conservation that has already been achieved and the policies that are already in use. Biodiversity conservation on private land is beset by problems of incomplete information, including asymmetric information, poorly defined property rights, non-standard benefits, multiple benefits and non-market values. If different policy mechanisms handle one or other of these problems differently, then it will probably be the case that an agency needs to use a mix of policy mechanisms to adequately deal with biodiversity conservation.

For many goods and services in the economy, prices assist decision-makers to identify optimal combinations of inputs or outputs that achieve their goals. Unfortunately information about *supply prices* (the cost of an additional unit of biodiversity) and willingness to pay are not automatically available to an environmental policy maker, hence, environmental markets are missing or severely limited (see Stiglitz 1988). However, the use of market-based instruments does raise the prospect of revealing supply prices where markets can be created.

Our general approach in this section is to consider regulation as the backdrop for other mechanisms. Hence, there is a regulatory structure that underpins biodiversity policy. In essence, we are making some claims about how regulation should fit in with other mechanisms, using the theory from Section 4. After briefly discussing legislation/regulation, we consider the use of some additional mechanisms: auctions; flat-rate subsidies; land purchase, offsets, and eco-labels. We do this mostly by looking at these additional mechanisms one by one. However, we comment on connections between different mechanisms throughout[6].

We limit our focus in this paper to the policies discussed below because we believe that they are relevant to the Victorian State Government, particularly in the area of biodiversity policy.

5.1 Legislation/Regulation

In section 4 we considered the allocation of property right in depth. Legislation/regulation often involves the allocation of property rights because this mechanism commonly sits as a backdrop to other mechanisms. Hence, much of our discussion in Section 4 is relevant here. For brevity, we will use the term 'legislation' to describe both legislation/regulation.

[6] Strappazzon *et al.* (2003a) examine the 'portfolio' problem in the context of two specific mechanisms: an auction system and a tradable permit system.

Generally, those who advocate legislation stress that it is a tool that must be used in conjunction with other mechanisms (see for example Young *et al.* 1996). The use of market-like mechanisms for environmental management will rely on legislation to define property rights, facilitate the modification of property rights and to specify the rules within which markets will operate.

Legislation is often used to allocate the initial property rights to biodiversity on private land, that is, to define landholders' 'duty of care' for biodiversity on their land. Other policy mechanisms can be used to alter the property rights in particular cases (for example where there is very high quality biodiversity, or where there are gains to be made from voluntary contributions). Different legislation allocating property rights to different extents between landholders and the community will have different transaction costs associated with achieving the efficient level of biodiversity conservation, as discussed previously. In this way legislation forms the foundation of a policy portfolio for biodiversity conservation on private land.

Legislation is likely to be an appropriate (cost effective) tool that can be used to achieve biodiversity conservation when it is used to maintain a critical mass of biodiversity through control of actions and inputs (for example, limits on clearing) which are non-specific, readily observable and enforceable. Legislation may be cost effective when assets and values are seriously under threat and any further damage may result in irreversible losses, and when preventing these losses has considerable benefits.

However, legislation may be difficult to use in terms of obtaining *pro-active* management from landholders. Attempts to employ legislative approaches for pro-active management may raise transaction costs per unit of biodiversity conservation since legislation generally affects all landholders. Hence, all would need to comply with a pro-active management requirement. An agency would have to monitor this, and enforce the management if it were not being undertaken. This is likely to be strongly resisted in the community, raising the transaction costs associated with compliance and enforcement.

The inability of legislation to identify specific actions needed on different areas of land and its inability to discover the opportunity cost of abatement action raises the cost of employing legislation for biodiversity conservation at higher levels. There are significant costs involved in designing and implementing legislation that is able to accommodate non-standard benefits and heterogeneous opportunity costs.

5.2 Auctions

Stoneham *et al.* (2003) advocate the use of an auction mechanism to reveal supply rices. Auctions work by having an environmental agency request that landholders submit bids to supply biodiversity services. Landholders with native vegetation on their property know what cost they will incur to supply environmental services. The agency knows its preferences in terms of environmental goods. By asking landholders to bid the price at which they are willing to supply services, the auction reveals information to the agency about landholders' relative cost of supply (albeit imperfectly). Further, because the agency asks landholders to submit bids to undertake certain activities (e.g. weed control), landholders learn about which activities improve environmental quality, and even which environmental assets are most valuable to the agency. In other words, the auction works as an information-sharing mechanism that should improve decision making by the agency.

An auction appraoch has been used by the Victorian government to procure services for biodiversity improvement and maintenance. This approach is called BushTender. Th implementation of BushTender was made possible by two important developments:

- Ecologists were able to construct a metric to express biodiversity preferences. This was made up of a scarcity element (the Biodiversity Significance Score (BSS) in BushTender) and a Habitat Services Score (HSS); and,

- Economists were able to design a mechanism that revealed the opportunity cost of changing land-use for biodiversity conservation (the bids provided by landholders).

Using this approach, each proposal for conservation actions submitted by landholders was assesed on the basis of the expected biodiversity outputs (BSS*HSS) per dollar of additional investment. This ratio is the *supply price* referred to above.

If the aims of an agency in terms of biodiversity could be summarised by considering this metric, then other mechanisms could be compared to an auction mechanism by considering their supply price, relative to an auction's (or more generally, the next best option). This is our conceptual framework for considering the mechanisms below.

5.3 Flat-rate Taxes and Subsidies

Two policy tools that have received lots of attention from economists are taxes and subsidies. A tax makes (say) a landholder pay a levy on each unit of either output or input. For example, a landholder may have to pay a tax on each unit of native vegetation cleared, or a tax on each unit of fertilizer used. A subsidy offers a payment to a landholder for each unit of output or input. For example, a landholder may receive a fixed payment for each meter of fence that she constructs. A subsidy per unit of output could be a fixed rate per unit of biodiversity produced.

Taxes and subsidies are similar tools. However, a tax attempts to prevent an excessive amount of bad behaviour, and a subsidy tries to encourage more good behaviour. Due to the fact that taxes and subsidies are 'symmetrical' in this way, we will base our subsequent discussion on fixed-rate subsidies. Many of the advantages and disadvantages that we discuss about flat-rate subsidies also hold for flat-rate taxes.

If an agency aims to encourage more native vegetation management, then standard economics textbooks would generally advocate that the agency subsidise the output directly; the agency should not subsidise inputs. The argument goes that subsidising outputs produces more of the goal that the agency is interested in, rather than encouraging some proxy behaviour. However, in some circumstances output is costly to observe, or monitor. Therefore, an agency may need to target inputs as a proxy. Obviously this suffers from the problem that inputs can generally be used in varying amounts to produce a given output. Hence, unless there is a constant transformation from inputs to output, subsidising inputs will have uncertain impacts on output.

5.3.1 Some Comparisons between a Flat-Rate Subsidy and an Auction Approach

In the BushTender auction approach, the environmental agency measured the estimated output that would come from landholder services. However, the contracts that the agency signed with landholders are based on inputs, such as fencing out of stock and weed control. This is due to the fact that it is costly for the environmental agency to accurately specify and observe output (where output is a high-level goal such as improved biodiversity resilience, or improved probability of survival of species). By basing contracts on inputs, the agency bears relatively more risk about the contract outcome since a landholder need only provide the services contracted, and does not get punished if this does not result in the agency's desired output. However, this is probably sensible in the short term, since output is costly to measure, and the transformation function from inputs to outputs is not well understood. Importantly, input-based contracts in the short term help the agency to observe the whether recommended actions lead to desired outputs, via contract monitoring. As the agency learns from this monitoring, it may be able to base future contracts, or part thereof, on output-based measures.

In terms of payments for inputs, an auction has a distinct advantage over subsidies: the auction allows the agency to pay landholders for bundles of inputs. With a flat-rate subsidy, the agency would have to specify beforehand the price on each input. This would be very difficult to do, and the outcomes would be difficult to predict (see below).

If output can be observed at relatively low cost, then the agency may be able to use a flat-rate subsidy on outputs. In this case, the agency would pay landholders for each unit of biodiversity output supplied. In some ways this is similar to an auction approach like BushTender, which assesses landholders' management proposals based on the expected biodiversity outputs. It is particularly close to a one-price auction, which would pay all landholders the same price per unit of output[7].

[7] In this section we compare a flat-rate subsidy to a one-price auction; we do not compare a flat-rate subsidy to a discriminatory-price auction (such as BushTender). This makes the comparison simpler. Further, although a discriminative-price auction may be more cost-effective than a one-price auction, there is no literature that proves that it is more efficient.

However, an auction may still have several advantages. First, with an auction the agency receives relatively more information about suppliers' opportunity costs—the bids provide some information about this. This provides important information to the agency about the efficiency of the scheme. This is important because the agency wants to know something about the economic supply price. Second, the auction allows the agency to target the quantity that it purchases much more readily: an agency can assess bids and choose the price that provides it with a certain quantity of output. In a subsidy scheme, the agency would be uncertain about the quantity that would be provided from a certain price. Hence, the agency would also be uncertain about the budgetary cost. The agency would have to learn landholders' responses using some iterative procedure: if a given price prompts 'too much' quantity (or too-high a budgetary cost) this period, then the agency needs to reduce the price in the next period.

The trade-off between a flat-rate subsidy and a one-price auction scheme is that although a flat-rate subsidy may provide less information revelation, and worse targeting, it may be administratively simpler. Historically this has been because subsidies have been based on inputs, with little subsequent monitoring. Hence some previous schemes have not been very accountable. If there were a scheme using an output-based subsidy that were to take on a stronger accountability focus, then outputs would probably have to be monitored. For example site visits might be needed to ensure that certain outputs have been produced. In this case, however, a flat-rate subsidy loses some of its administrative simplicity, and starts to mimic a scheme such as BushTender in many respects.

5.3 Land Purchase

Government is a supplier of biodiversity through its public reserve system and has the option of increasing the supply of biodiversity by purchasing and managing private land.

Land purchase could be analysed on the basis of its supply curve, and hence marginal supply price. Land purchase would be included in a policy portfolio where this mechanism offers better value for money than other mechanisms.

Whether land purchase is cost effective/efficient depends on a range of factors including the cost of managing the land, its purchase price, and the biodiversity gains associated with the land.

Large areas of land adjoining an existing reserve may have low on-going management costs, as these areas would more effectively utilise existing management resources, but may offer habitat that is relatively well represented in the existing reserve system.

Alternatively, government could consider purchasing small isolated areas of habitat distant from existing reserves. These assets might involve high management costs and incorporating them into the publicly administered reserve system would not take advantage of local knowledge, expertise and resources.

Colman (1991) strongly advocates land purchase to UK policy makers. This is mainly because land purchased in the UK can subsequently be rented out with restrictions on the agricultural practices allowed. Therefore, government can earn rental income and farmers can still earn profits from agriculture (even though profits would be lower than if agricultural practices were unrestricted). This is generally different to the Victorian situation, where remnants already come under native vegetatation retention laws, and it is not clear that government procurement and subsequent sale would be more cost-effective than simply buying environmental-good management (as in an auction).

Colman also advocates that government reduces budgetary costs by co-purchasing land with private conservation groups that are willing to bear some of the subsequent costs. However, the usefulness of this approach depends on the alignment of the conservation group's aims with the government's, and the transaction costs associated with such a partnership approach.

Land purchase could easily be incorporated into a general auction approach. We can imagine a situation where an environmental agency calls for bids for a variety of contracts: short-term management; long-term management; and property sale (where the agency undertook subsequent management). In this way, landholders could choose what type of contract they preferred, and the agency could assess bids using supply price as the common basis.

5.4 Offsets

Offsets sit very closely to legislation. Offsets attempt to maintain a given quantity of environmental good but at a lower total economic cost than regulation on its own.

Offsets generally operate as follows: they hold the quantity of a good (e.g. biodiversity) constant, and then require that a developer who hopes to reduce the stock of the good (e.g by clearing) to organise and fund an offset of the exact amount that would be lost. This offset may come in the form of revegetation somewhere else, or improvement in the quality of other existing remnants, etc.

Offsets should improve efficiency because they allow remnants that are on land that is valued very highly the private sector (due to say very profitable opportunities forgone) to be exchanged with remnants that are on land that is less highly valued by the private sector. However, the offset should provide the exact same amount of an environmental good from the agency's perspective. Hence, the quantity and quality of the environemntal good should be constant, whilst the cost to landholders (in aggregate) falls.

Of course, whether offsets are a viable option in practice requires that units of biodiversity can be cost-effectively defined and offset. An agency needs to be careful about this, since the US scheme of offsets for wetlands resulted in large losses due to inadquate care taken by the regulator about the quality of the offsets (Sunding and Zilberman 2002).

In this sub-section we have considered how offsets relate to the supply side of biodiversity. In Appendix 2 we explore one mechanism for how the agency may might reveal the demand for offsets.

5.5 Eco-Labels

Eco labelling refers to the use of a label that signals some product attribute that is difficult to verify for a consumer, and hence some mechanism is needed to prove the attribute to a consumer. An example is dolphin friendly tuna.

One of the key economic issues associated with eco-labelling is that it suffers from an asymmetric information problem: there is no way for the public to discriminate between (say) alternative companies claiming large investments in biodiversity conservation. Whether the conservation actions promoted by company *A* generate more habitat services than that of company *B* is difficult to discern without further information.

The essential challenge for eco-labels is to prove a claim to consumers' satisfaction in a cost effective manner. An eco-label will persist in a market when the costs of proving claims are less than the benefits from the label (in terms of market share or higher prices, etc).

Cole and Harris (2003) have argued that the role of government in eco-labels is generally quite limited. However, where private firms are making claims about attributes that are relevant to government policy, then a government may consider the nature of the claims and whether some co-ordinating and/or facilitating functions could be worthwhile. For example, a government may promote a standard way of measuring biodiversity improvement for the eco-label. In the case of biodiversity, a government may promote the use of its own metric in terms of the claims. This would allow the government to 'free ride' on any biodiversity improvements made by the private sectors. However, if the use of government metrics is expensive, then private firms may decide to use simpler metrics. These would be less relevant to government policy because the eco-label would then not be increasing the supply of the same good that government is seeking.

A government could consider providing private eco labellers with enough incentive to adopt a government-authorised metric, *where they would not otherwise*. Whether this is cost effective/efficient again depends on the benefit-cost criterion. That is, it depends on how much of the environmental good per dollar this would supply to the government, relative to other mechanisms.

5.6 A Note on Agency Aims

We have assumed above that an agency has very clear and specific aims: it aims to obtain the next few units of a specific environmental good in the lowest cost way. Specifically, we have referred to the biodiversity benefits index: BSS*HSS per dollar.

Although this is a useful starting assumption, and it could perhaps be applied in a policy context, it is not the complete story: different mechanisms will have objectives that are more general than one index score, and some of these other objectives may be difficult (costly) to quantify. Hence, different mechanisms will be able to achieve different goals to different extents. For example, the aim of an auction can probably not be summed up purely in terms of an index change per dollar. The process of visiting landholders imparts knowledge that affects attitudes and knowledge. This may have effects on other government objectives. Decision makers should be presented with information about any significant effects of a policy, whether quantitative or qualitative, since they should bear all these effects in mind when choosing how to allocate resources.

6.0 Dynamic Efficiency

Dynamic efficiency refers to the efficient use of resources over time. It differs from static efficiency, which is concerned with efficiency in one time period.

To achieve dynamic efficiency, an environmental agency may need to invest in mechanisms that are not the most efficient in one time period alone, but that may cause transaction costs to decrease in future periods, or that may facilitate feedback about the supply of biodiversity conservation back to policy makers.

In this section we will first consider why some average costs will fall through time (Section 6.1). Then, in Section 6.2 we will consider the importance of policies that enable information to be fed back to decision makers. In Section 6.3 we consider the traits of policies that should facilitate improved dynamic efficiency.

6.1 Decreasing Costs Associated with Policy

We split our analysis of decreasing costs associated with policy implementation into two sections: the reduction in government costs; and landholder learning and attitude change. Implementing a policy requires many costly activities that may not be necessary, at least not to the same extent, when the policy has been running for a length of time. As learning takes place and attitudes change costs associated with certain policy mechanisms may decrease over time.

6.1.1 Reduction in Government Costs

Let us consider three examples of why the cost to government of a policy mechanism should be considered over the predicted lifetime of that policy rather than (say) in the first year alone. A mechanism's costs to government are often more significant when the mechanism is first implemented so that the cost per unit of output falls over time.

First, research and development will be required to develop a policy and fine tune it so that it is suitable to be rolled out into the community. However, once the policy is in place and has been for some time many of these activities will not be necessary, or not necessary to the same extent, and the transaction costs per unit of (say) biodiversity conservation will therefore decrease. A second example is education and information campaigns. These let the relevant players know that the policy exists and how it may affect them. After some period of time, such campaigns will not need to be as extensive and all encompassing as they were initially, when everyone was unfamiliar with the new policy. Third, data collection and collating systems may require some large up-front costs, but these are likely to fall through time. It is unlikely that the agency will need to collect data each year in the same way as had to when the policy was first rolled, since much of initial data gathered and collated will be usable in subsequent years.

6.1.2 Landholder Learning and Attitude Change

Learning by landholders can also help to decrease the costs associated with a policy. If landholders learn more about how a policy works through time, then this is likely to decrease their cost of complying with or participating in the policy. For example, a policy that involves auctioning contracts for the management of biodiversity on private land (like BushTender) may involve learning costs, in the form of time, to landholders participating in the auction. This might include landholders learning how to take part in the bidding process and learning how to perform the biodiversity management actions required by a contract most efficiently[8]. As landholders become familiar with these activities, the costs associated with conducting them may decrease.

[8] As the cost to landholders of management actions decreases with learning, this may also result in a reduction in the direct cost to government of the mechanism. For example, in an auction if landholders are bidding competitively for management contracts their bids are likely to decrease as their costs decrease, therefore the price of biodiversity in the auction will fall.

Some policies may change landholders' attitudes towards the conservation of biodiversity on private land by exposing them to the private and public benefits of doing so. As landholders become better informed and more familiar with the conservation of biodiversity and what it involves for them they may be likely to be more accepting of policy that requires them to perform these tasks. If landholders are more accepting of a policy the transaction costs, particularly those associated with monitoring and enforcement, are likely to decrease.

6.2 Feedback Loops: Supply Interacting with Demand

As discussed in Section 3 an agency that purchases biodiversity conservation is not able to readily observe the demand for biodiversity. As the purchasing agency will generally be administered by the government, demand will generally be estimated via the political process which will result in the allocation of a budget to the agency, with the expectation that the agency will spend the budget on biodiversity conservation.

Some policy mechanisms generate information about the supply of biodiversity conservation, or the cost of conserving certain biodiversity, and this information is likely to generate efficiency gains as it is learned and fed back into the process by which biodiversity aims and budgets are set. The generation and use of this information can be called feedback loops, they allow policy makers to learn more about the costs of achieving certain levels of biodiversity conservation.

Due to the uncertainty associated with the benefits of biodiversity, policy makers are unlikely to have a clear idea of what the social demand for biodiversity is or would be if society knew what the experts know. However, if they are able to learn about the supply of biodiversity through the implementation of certain policy mechanisms they will be better able to set and revise targets or budgets so that they are more closely aligned with the demand that they believe exists. Similarly, if the community learns some information about the supply of biodiversity through the use of certain policy mechanisms, they may be able to identify their preferences for biodiversity conservation better. If they are able to express these preferences to the government, this may also result in more efficient outcomes.

For example, if policy makers want to conserve some bird habitat in order to prevent the extinction of a particular species but find that this is very costly, they may choose to focus on other priorities instead given the resources available. In other words, policy makers will find it easier to judge whether they believe it is worth devoting resources to one area instead of another. They may also find that significant increases in conservation could be achieved by allocating just a slightly larger budget, or that reducing the budget will not have a significant impact on the level of biodiversity conservation. This type of information should allow policy makers to more efficiently set aims and budgets for biodiversity conservation. Resources may then be allocated on the basis of "value for money" so that they create more value to society as a whole.

6.3 Traits of Policies that Improve Dynamic Efficiency

The extent of the decrease in transaction costs of a policy over time will depend on the characteristics of the particular policy and perhaps on the mix of policies that it is implemented along with. Some policies are more likely to result in a decrease of total (transaction plus direct) costs on both the government and the landholder sides, and will therefore be likely to result in a more significant overall decrease in costs as time progresses.

The above discussion suggests that there are at least four important things that are needed to improve dynamic efficiency. These are:

information about the quantity of environmental good that would be achieved/secured using any mechanism (e.g. a biodiversity metric);

- ➢ consideration of the cost of obtaining these units, including transaction costs (this will be different for different policies);
- ➢ a process for the relevant agency to analyse the above information; and,
- ➢ a system that feeds the above information to decision makers, and allows choices to be updated as new information comes to light.

A system that has these features should improve dynamic efficiency. The first two points provide information that can be joined to provide a supply price. The last two points allow the information to be used in a decision-making framework.

Obviously the form of this decision-making framework will be important. In the next section, we consider the importance of the institutions that implement certain mechanisms, and suggest some principles and approaches for institutional analysis.

Some examples of mechanisms that can be designed to reveal information about the supply price of biodiversity conservation include land purchase and auctions. These policies will reveal the supply price when a standard metric is used. Standard metrics facilitate the use of connecting policies—such as eco-labeling and offset schemes—which should improve the efficiency of the overall policy mix.

The dynamic efficiency characteristics of policy mechanisms are sometimes discussed in relation to their potential for increasing the potential to efficiently raise landholders' duty of care through legislation. For example, the use of auctions of biodiversity management contracts may mean that landholders that are most efficient at conserving biodiversity are able to extract rents from an auction mechanism over time, as their costs are comparably low and they are aware of this. If information rents accrue to landholders, this may influence land markets and encourage investment in nature conservation. Landholders might come to know exactly what scarce biodiversity assets they have that the government values, and could better self select into the auction process. This may achieve a better matching between government priorities and bidders in an auction, which may increase the total efficiency of the auction (even if cost effectiveness falls from a budgetary perspective). However, if the agency is concerned with a loss in cost-effectiveness, it can always attempt to design the auction so as to improve its cost-effectiveness, and minimise landholders' information rents[9].

As stated in Section 4 as landholders become better at and more accustomed to conserving biodiversity on their land, they may be less likely to resist as strongly the introduction of legislation that increases landholders' duty of care towards biodiversity on their land. This may be especially likely if landholders are still able to bid for management contracts for levels of biodiversity conservation that is above the new increased level required by the duty of care. If landholders are more accepting of the increase in the duty of care, the transaction costs (for example, the political and monitoring and enforcement costs) of this increase in legislation are less than they would have been if landholder attitudes hadn't been changed through the use of the auction mechanism. Therefore the use of an auction mechanism (or the provision of education and information) may potentially make an increase in the duty of care an efficient option.

However, in increasing the duty of care it should be remembered that legislation does not possess many of the attributes that lead to dynamic efficiency. In particular it does not create a feedback loop to policy makers because it doesn't provide information about the amount of biodiversity conservation that it achieves or the opportunity costs of doing so. The objective of legislation is to protect the core values of society. Transaction costs are likely to increase the more that legislation is used to achieve gains in biodiversity beyond the threshold stock, due to many factors in addition to landholder attitudes, including the existence of non-standard benefits, information asymmetry and poorly defined property rights[10].

7.0 Institutions for the Environment

The above sections have focused mostly on the mechanisms that could be implemented to increase the supply of biodiversity. However, policy advisers need to consider more than just mechanisms to increase biodiversity: they need to consider the institutional structure in which mechanisms are implemented and designed.

Transaction cost theory is intimately linked with thinking about institutions. In fact Williamson calls transaction cost economics a subset of the 'new institutional economics' (NIE). In the broadest sense, an analysis of institutions has to be concerned with all manner of factors that influence economic behaviour, including religion, customs, tradition, etc.

In this section, we will focus mostly on the transaction cost literature, and how it affects our thinking about institutions, rather than incorporating all of the ideas in the NIE. That is, we will see institutions mainly as a set of contracts between the relevant parties. This may seem a bit restrictive, since the efficiency of different institutional structures is affected by more than contract form, as stated above. However, high-level factors such as customs and tradition change only slowly. Focusing on

[9] Although the government needs to be clear that it may sacrifice efficiency in order to do this.
[10] Information asymmetries and non-standard benefits are discussed in Appendix 1.

transaction cost aspects provides a simplifying framework from which we can still glean many insights.

Since the focus here is on transaction cost economics as applied to institutional structure, many of the ideas introduced in Section 2 are relevant. Hence, we will not provide much background material in this Section. Rather we will focus on the application, mostly by using an example (Section 7.2.1).

The potential institutional structure issues to which transaction cost theory can apply are plentiful. For example, we could use transaction cost theory to think about the way to organise the:

- broking of offsets for native vegetation;
- use of native forest products by the private sector; and
- regional structure of an environmental agency (which is considered briefly below).

7.1 A Suggested Approach

One of the problems with institutional design in the public sector is that the number of possible institutional forms is very large. If (say) we are considering the way that biodiversity policy is implemented at the state level, then there are a myriad of ways that institutions might be designed.

Given this, a tractable way of considering institutional structure is to consider the problem in the following sequence:

1) The nature of the problem,
2) The best policy mechanism,
3) The institutional structure that would best implement the mechanism.

In Section 7.2 we use this approach to examine the problem of an environmental agency trying to implement policies throughout a number of regions. Attempting to think about institutional structure without thinking about its aims is very problematic. Our approach reduces considerably the number of institutional forms, and allows a more concrete analysis. So, for example, if an agency is considering the best way to implement an offset scheme, then it is useful to consider the mechanism first, and the institutional structure second. This allows the analyst to think hard about what the incentives *need* to be, rather than setting up an institution that can then define its own aims. This latter strategy is only likely to work if the person who will lead the institution has the same aims as the principal[11].

In terms of applied analysis of institutional structures, a very useful tool could be experimental economics. Experimental economics allows a researcher to test how different policies might work, by getting participants in an experiment to play a 'policy game' according to certain rules. Participants receive rewards based on their performance in the game. This way, the researcher can analyse how different policies operate. In particular, the researcher can test whether people behaved in a manner consistent with theory.

7.2 Things to consider with regards to institutional structure

In this section we will introduce two other issues that policy makers should consider, along with transaction costs, when altering institutional structure. These are:

- *Economies of Scale*: when long-run average costs fall over a large range of output. Economies of scale imply that policy makers should consider the use of a sole provider. Of course, this raises other hazards that then need to be circumvented, such as mode of price setting.

- *Economies of Scope* when it is cheaper to produce two goods jointly (in one firm) in certain quantities, than it is to produce them in specialised firms.

These two could be viewed as 'technology' explanations for institutional structure. These are clearly relevant, but Williamson has argued that policy makers and academics have overused them as explanations for particular contractual forms in the past. This is particularly the case with regards to the US approach to antitrust (Williamson 1996).

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[11] This may be the case in some circumstances. For example, if an agency wants a very strong 'consumer advocate' in a competition council, then some people will be likely to already have this reputation, and could be earmarked for the job.

7.2.1 An example

In this section, we consider an example to show how the issues that we explained above can be used to illuminate the relative merits of different institutional structures. Our example is taken from Strappazzon *et al*. (2003b) where a hypothetical central office attempts to implement environmental policies throughout a number of different regions. We briefly consider two different structures that might be used (these are given below). We call the bundle of regions, the 'community'. In both structures, we assume that the central office provides funds to each region for policy implementation. Further, we assume that the central office receives funds from a broad tax base (that is, the central office tax base includes the whole community).

The two types of institutional structure we consider are:

- Structure 1: the central office designs policy mechanisms and gets them implemented by the regions. Regions must accept the policy directive—the regions are simply passive in this structure.

- Structure 2: the regions suggest the appropriate policy mechanisms, and the central office funds these. Each region has its own board, and governance structure. This governance structure is set up to serve regional interests. The central office must negotiate with the regions if there is disagreement about the policy mechanism.

Note that these two structures are by no means exhaustive. A more thorough analysis would consider a larger array of institutional forms. However, these are perhaps representative of some structures that have been used in Australia over the past 30 years.

Strappazzon *et al*. analyse the efficiency of the above two structures. They consider the three issues outlined in the previous section: transaction costs; economies of scale; and economies of scope. They find that the issue of economies of scope is less relevant to this example, and make the following observations about the merits of the two structures:

- The funding stream in Structure 2 results in misaligned incentives since regional managers will attempt to implement policies that benefit their regions (e.g. local biodiversity), yet the central office is concerned with the balance of environmental assets over the whole community. The problem has been constructed in a way that means regions are implementing projects that are community funded, yet their incentives will be region-oriented. This causes a basic mismatch between the regions' brief, and their funding structure. This draws the central office into conflict with the regions, and raises transaction costs. This leads to a corollary point:

- It may be sensible to have a regional structure if the funding is local. In this case, the regional structure allows managers to focus on regional goods.

- If information about policy design requires specialised skills, and information sharing, it may be inefficient to delegate this task to regions (as in Structure 2), who will also have an operational focus[12]. There are relatively larger transaction costs if the central office tries to impart all of this knowledge to regions

- Structure 1 may have lower transaction costs of handling the co-ordination of economies of scale, such as the need for a community-wide research facility. Although it would be possible for the regions to co-ordinate with each other to agree to a joint facility, this would probably incur higher transaction costs. Further, several regions may be inclined to argue that the facility should be located in their region, without regard to the efficient location of the facility.

Viewed from the Jensen and Meckling (1998) perspective that was introduced in Section 3, we argue in this example that delegating decisions down the chain—to regions—involves large 'agency costs'. The incentives of the regions are locally oriented, and this means that they will be prone to misallocate resources. Further, given that lots of expertise about policy mechanisms resides in the central office (by assumption), it does not seem sensible to feed information about mechanisms from the regions upwards to the central office. Regions can supply information about

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[12] This mimics the arguments in Williamson (1985) about why the M-form became an important part of private sector organisation.

community sentiment, but this is not equivalent to providing information about the most appropriate policy mechanism.

8.0 Summary

In this report, we have considered a suite of issues related to environmental policy. These could be listed as follows:

- The transaction costs associated with different property right allocations, particularly those associated with using a legislative/regulatory framework;

- The way to consider the policy portfolio problem in environmental management, and the importance of decision makers obtaining information about the supply price of using different mechanisms;

- The importance of dynamic efficiency—which is the costs of operating a policy over several time periods—and how considerations of dynamic efficiency further emphasise the need for a mechanism that reveal information to decision makers; and

- The importance of institutional design in environmental problems.

Much of our work in this report is qualitative. For policy makers to use this report to make decision may require further quantitative investigation. For example, whether transaction costs fall through time in an auction system could be empirically examined if the current BushTender trials were to become a program.

However, even if the issues highlighted as important in this report are not considered in more quantitative depth, this paper still presents a useful framework for analysis. Policy makers currently make decisions about the allocation of property rights, about the portfolio of mechanisms, and about institutional design. Presumably these decisions are made using some framework. We suggest that our approach has thrown up some useful considerations for these policy makers.

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Appendix 1: The Nature of Environmental Goods

In this section we give an overview of some of the economic issues that we consider to be important when an environmental agency considers the design of mechanisms to facilitate biodiversity enhancement on private land. We consider three issues: asymmetric information; non-standard values; and multiple outcomes.

3.1 Asymmetric Information

We can analyse how individuals make choices when their decisions affect others by using game theory economics. If individuals' decisions depend on the expected reactions of other players, then there is strategic interdependence. If policy makers can understand how decisions are made when there is strategic interdependence, then they can better formulate policy.

By taking account of strategic interdependence, game theory helps policy makers focus on incentives: the incentives faced by individuals who make a decision and the incentives faced by others who react to the initial decision. All of these decisions are made in the context of social institutions (for example, laws and government). Therefore, game theory provides a means for analysing social institutions and policies (Myerson 1999).

In the context of environmental policy, government is involved in a game with landholders. Government needs to take into account landholder reactions to policy initiatives. Individuals' reactions will depend on the information they have. Further, the government and landholders will have different information; there is asymmetric information. For example, a landholder may know the value of forgone profit if she exerts effort on conservation, if she performs (say) weed control for conservation purposes, she may forgo profit because valuable time is spent on weed control rather than sowing or harvesting. However, the government, which places a value on weed control and fencing for biodiversity maintenance, does not know how much short-run profit the landholder forsakes when she diverts her time in this manner. Government, on the other hand, knows how much it values various elements of the environmental estate. Landholders may have little information about the values that government places on different biodiversity assets.

Alternatively, there might be two private landholders that have valuable native grasslands on their property. One of these landholders is by nature a developer and the other a non-developer who gains personal fulfillment from conserving. The government wants these landholders to undertake conservation, and is willing to pay (compensate) for their services. The non-developer could, theoretically, undertake conservation at a relatively lower price (compensation payment) than the developer even if their holdings were exactly the same. This is because the non-developer enjoys undertaking conservation activities. However, the non-developer may not reveal this if she might extract full compensation—equal to the total forgone profit—by 'acting' like a developer. In other words, the non-developer might be able to extract 'information rents'.

Landholders also have information about the types of biodiversity on their own land. Even though NRE has good quality information about the quantity and location of many flora and fauna species, this information base is not complete; landholders may have rare species or relatively good quality flora and fauna that NRE does not know about.

3.2 Non-Standard environmental values

For many environmental problems, each unit of conservation effort yields benefits that do not have a standard value. For example, changing land use in different parts of Australia will generate very different environmental outcomes. In some areas, there will be large benefits (to other farms) from recharge control, while others have only a localised impact on watertables. Similarly, because of the diversity in habitat, habitat quality and species composition, there are non-standard benefits from activities that conserve remnant vegetation on private land. Recognition of the non-standard benefits nature of environmental management suggests that the location and type of intervention will be very important in determining the effectiveness and costs of environmental management actions.

3.3 Multiple Outcomes

Many environmental outcomes can arise from one change in natural resource management. Changing land-use on one area of land could yield benefits in the form of weed control, nutrient control, native vegetation conservation, carbon sequestration etc. These represent joint products.

When interactions in the landscape lead to multiple outcomes then it may be sensible for the agency to deal with these issues using one mechanism, rather than separate mechanisms. We would expect three potential advantages from using a single mechanism. First, if the agency needs to undertake site visits to implement the mechanism, (e.g. to discern the quality of native vegetation), then there would be a transaction cost saving in terms of landholders visits. This benefits both the agency and the landholders since the agency needs to visit a landholder only once regarding several environmental goods. Second, there would be cost savings in terms of the mechanism design; the agency would not have to design separate mechanisms for each environmental good. Third, there should be better outcomes in terms of the agency considering the range of outcomes in an integrated way. In the past some programs may have aimed to increase tree cover for salinity reasons, without considering the biodiversity perspective adequately. Hence, different schemes may have had countervailing effects. Considering both salinity and biodiversity jointly would force the agency to explicitly consider the interactions, and hence trade-offs, involved.

Appendix 2: The Demand for Offsets

Implementing an offset program requires an agency to analyse information on the demand for clearing (by developers), and facilitating a link between this demand and the supply of offsets.

When we discussed mechanisms in Section 5 we introduced the concept of the supply price of additional units of an environmental good. Many of the mechanisms listed in Section 5 could be used to acquire offsets, or to increase the quantity of environmental good beyond the regulated amount. Hence, offsets are intimately linked to other mechanisms; offsets are part of a portfolio of mechanisms. Allowing offsets to be achieved using any mechanism is preferable to restricting the sources of offsets, *as long as the quality of offsets can be held constant.* In this section, however, we do not focus on the supply of offsets; we focus on demand[13].

With regards to demand, an agency needs to get developers to reveal which land parcels they would value most if it could be cleared. The agency can do this using an auction approach. For example, the agency could restrict the supply of clearing credits per time period to some amount (q_0) and then auction off these units. Those who most valued clearing would bid higher for offsets.

The agency could control the type of land clearing that occurred by subdividing q_0. For example, the agency might break q_0 into two categories. One category (q_H) could called 'high-value vegetation', and the agency could offer only very small amounts of this type each year. Another category (q_L) could be called 'low-value vegetation' and the agency could offer very large amounts of this type each year. The total land offered up for clearing would be $q_0=q_L+q_H$.

[13] Note that this is private demand for clearing vegetation and should not be confused with the demand concepts introduced in Section 3 where we spoke about a community's demand for more biodiversity.