An Australian Government Initiative

Market-based tools for environmental management

Proceedings of the 6th annual AARES national symposium 2003

A report for the RIRDC/Land & Water Australia/FWPRDC/MDBC Joint Venture Agroforestry Program

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October 2004

RIRDC Publication No 04/142
RIRDC Project No WS034-01

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ISBN 1 74151 050 3
ISSN 1440-6845

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Project No. WS034-01

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Published in October 2004
Printed on environmentally friendly paper by Canprint

Foreword

The potential of market-based instruments is increasingly being considered in the debate about the appropriateness of alternative options for management of natural resources and the environment. More particularly, there is a growing interest in creating market-like mechanisms to manage environmental outputs at the lowest economic cost. With this focus comes a need to build capacity in communities, government and research organisations as to how, when and where these tools should be applied.

To meet this need, the Australian Agricultural and Resource Economics Society, with the generous support of sponsors, organised a two-day symposium focusing on market-based instruments that was held 2-3 September 2003 at CSIRO Discovery Centre in Canberra. Contributors included individual members of the Society, invited speakers and authors of poster papers. Each of these contributors gave a great deal of their time to prepare and present a series of papers of the highest quality which have been captured in this edited volume of proceedings from the symposium. Where papers were not available, or the level of interest merited additional information, the editors have sourced additional papers together with more complete papers from the winners of poster paper prizes at the symposium.

I would like to commend and thank the AARES organising committee (and editors of this volume). The committee was chaired by Dr Stuart Whitten (CSIRO Sustainable Ecosystems), and comprised Mr Marc Carter (Environmental Economics Unit, Australian Government Department of Environment and Heritage) and Mr Gary Stoneham (Victorian Department of Primary Industries). The conference organiser was All Occasions Management. Together they have done an excellent job in constructing an outstanding program that has resulted in the high quality papers published herein.

These proceedings were funded by the Joint Venture Agroforestry Program (JVAP), which is supported by three R&D Corporations - Rural Industries Research and Development Corporation (RIRDC), Land & Water Australia, and Forest and Wood Products Research and Development Corporation (FWPRDC), together with the Murray Darling Basin Commission (MDBC). These agencies are funded principally by the Australian Government.

This volume, a new addition to RIRDC's diverse range of over 1000 research publications, forms part of our Agroforestry and Farm Forestry R&D program, which aims to integrate sustainable and productive agroforestry within Australian farming systems.

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Acknowledgements

On behalf of the Australian Agricultural and Resource Economics Society, the Symposium Organising Committee; Stuart Whitten (CSIRO Sustainable Ecosystems) Marc Carter (Environmental Economics Unit, Dept. of Environment and Heritage) Gary Stoneham (Victorian Dept of Primary Industries); wish to thank the Symposium sponsors; listed on page *iv*; the assistance of: Professor Jeff Bennett, Colin Mues, Cathryn Geiger, Heather McGilvray, Martin van Bueren, Wendy Proctor, Dave Shelton and Mandy Yialeloglou; and all participants and speakers at the symposium.

Abbreviations

BMP	Best Management Practices
CO_2	Carbon dioxide
COAG	Council of Australian Governments
CRP	Conservation Reserve Program
DIPNR	Department of Infrastructure, Planning and Natural Resources
EBI	Environmental Benefits Index
EPA	Environmental Protection Agency
FI	Flexible Incentives
HRSTS	The Hunter River Salinity Trading Scheme
LMT	Land Management Tender
LPCIS	Liverpool Plains Catchment Investment Strategy
LPLMC	Liverpool Plains Land Management Committee
MBI	Market-based instruments
MRET	Federal Mandatory Renewable Energy Target
NAPSWQ	National Action Plan for Salinity and Water Quality
NEM	National Electricity Market
NGAC	NSW Greenhouse Abatement Certificates
NHT	Natural Heritage trust
NRE	Natural Resources and Environment (Victorian Department of)
OC	Opportunity Cost
OECD	Organisation for Economic Co-operation and Development
P-NP	Point, non-point
PPA	Power Purchase Agreement
PRC	Pollution reduction credits
REC	Renewable Energy Certificate
RECLAIM	Regional Clean Air Incentive Market
SO_2	Sulphur dioxide
WTP	Willingness-To-Pay

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Opening address

Mr Roger Beale

Secretary, Department of the Environment and Heritage

I'm really delighted that AARES is holding its main symposium this year on how market-based tools might assist in environmental management.

I well remember 17 years ago, the then Treasurer remarking that every parrot in every pet store in Australia was talking about micro-economic reform - this was in the wake of his 'Banana Republic' call to arms. And of course that led to a program of determined market reforms working through almost every sector of the economy.

We can look back and see that this micro economic reform program paid off handsomely for the Australian economy with economic and productivity growth well above the OECD pack for more than a decade.

Natural resource management issues

And lots of people are wondering about the opportunity to use competition and markets to address intractable environmental issues:

- biodiversity conservation;
- salinity;
- climate change; and,
- water management.

But should we have such high expectations of the scope for markets in these areas to unleash major gains in sustainability?

Not necessarily – there are lots of problems, but I think that are also some very real opportunities.

Policy context

Defining what we mean by a market-based initiative – or MBI as we call it in the trade – and thinking about what conditions are necessary for effective markets will help us sort out the opportunities from the blind alleys.

What defines an MBI?

- We would essentially see it as a mechanism to reveal the 'value' of an environmental good and service in a way that enables this value to be reflected in an exchange between the producers of the value and those who would see advantage in consuming it.
- Of course, the value could be positive or negative – ie either the creation of a positive good, or the avoidance of an environmental bad.
- And the "consumers" could be either individual market actors, groups of actors or governments who stand in the market place to buy or sell on behalf of a community.

Clearly the hope is that if we can define specific natural resource management (NRM) outcomes in this way through either the modification of an existing market or the creation of a new market.

- We can inspire a search for the lowest cost solutions to abate environmental bads, or encourage the production of environmental goods.

So far so good - but what do we normally need to support effective markets?

Normally we would talk in terms of:

- clearly defined and legally enforceable property rights;
- access to information concerning the quality and quantities of goods and services to be traded;
- good, or at least reasonable, knowledge about the supply function of the goods and services to be provided; and
- establishment of efficient and low cost ways of transacting, recording and tracking the trades.

The classic success story for market-based initiatives in the environment is the North American experience of trading in SO_2 under the Clean Air Act. This has provided a mechanism in which the community created value for abatement services by setting a quantitative restriction allowing market participants to explore the least cost ways of meeting those limits through the media of exchange of emission permits.

- Other examples have attached a price to the externality and allowed the market to solve for the quantity of good provided – for example load based licensing of industrial pollutants, or carbon charges or climate levies as proposed in New Zealand.

In the NRM context MBIs attempt to leverage private benefits for enhanced outcomes by funding only the public good component of those outcomes. Eg:

- enhanced biodiversity conservation or enhanced water quality in wetlands.
    - By using markets to reveal the lowest opportunity cost for achieving the nominated objective.

This helps us deal with asymmetric information as between the community and those providing the environmental service:

- farmers have more and better information about the cost of NRM processes than governments and can better estimate the level of assistance that would change their management practices;
- irrigators in a market where water can be traded will reveal the minimum price at which they would willingly give up it up to be applied to environmental flows.

Lack of uptake of MBIs

But many of the wicked issues in environmental management are difficult to fit into the market box: For example it is often difficult to establish the information base that will support a market. If

- search and information costs;
- bargaining and decision costs; and
- policing and enforcement costs,

are too high or too uncertain, then you do not have the basis for market tensions to work positively.

This can be the case with many biophysical outcomes – particularly for example, diffuse sources of pollution, biodiversity, dryland (as distinct from irrigation) salinity, and other areas where it is not easy to measure or value the outcomes, or where they might be very substantially displaced in time or space from the “production” decisions.

Sometimes property rights simply do not exist, or the other frameworks that create value and certainty for the outcomes sought are not in place. In many respect our nascent water markets are like this – a matter to which I will return.

In other cases we know so little about the potential supply curves for these environmental products that governments are unwilling to risk what might be an expensive gesture for what might be a small net gain – let me give you the example of land clearing.

Broad scale land clearing can be a problem for biodiversity reasons, from a salinity and soil point of view, and because it produces greenhouse gases. In relation to greenhouse gases, it is not only how much land is cleared but when. Australia is committed to every effort to meet its Kyoto target. Land clearing is one of our major sources of emissions. But it is only reducing land clearing that would otherwise have occurred in the years leading up to and during the Kyoto commitment period of 2008-12 that is relevant.

A simple approach would be to offer to buy the right to clear any land not yet cleared:

- effectively to buy conservation and greenhouse covenants.

If governments were just to stand in the market and do this up to some budget amount, it is obvious that you would first be offered all those parcels of land for which there were no economic clearing options in even the long term future.

Of course the cost per hectare would be low, but even so, you might find that you had exhausted the budget before you had worked far enough up the supply curve to be actually making a difference to the rate of clearing in the relevant time frame.

And you would have provided a windfall gain to many landholders.

Finding the intra-marginal potential clearers, i.e. those who would otherwise have cleared without the market intervention is very, very difficult. There is a potential to waste a lot of public money for little environmental gain.

So, one is forced back to regulatory approaches that aim to be fair but also provide some surety of effectiveness. And this is exactly what the Australian Government is exploring at this time with the farm groups and the Queensland Government.

National Market-Based Pilots Program

We already have one successful national MBI in place. This is the Mandatory Renewable Electricity Target program under which electricity retailers and other final consumers are required to surrender a proportion of renewable electricity certificates for each kw of power sold. This proportion increases overtime. These certificates can be created only by certified renewable generators of electricity as they supply power to the grid – the resulting market can then underpin investment in the most cost effective supply of renewable electricity. The scheme is currently being reviewed but I note that there has been a broad level of support from those making submissions to the review.

We are about to witness a significant increase in the experimental use and assessment of MBIs for NRM. This was a conscious feature of the design of the National Action Plan on Salinity and Water Quality, a $1.4bn program jointly sponsored by the Commonwealth and the states. As a first step

- Natural Resources Management Ministerial Council is funding $5 million for 10 projects under the first round of the National Market-Based Instruments (MBI) Pilots Program.
- These pilots were selected from 53 applicants and cover all States and Territories with the exception of the NT and Tasmania;
    - the aim of the National Market-Based Instruments Pilots Program is to: ‘increase Australia’s capacity to use MBIs to deliver natural resources outcomes’.
- The 10 pilots will investigate ways to use innovative financial arrangements to encourage better land and water management and to reduce salinity in irrigation-based agriculture.
- Pilots are currently getting underway and are due to be completed in mid-2005.

- It is envisaged that an additional project will shortly be added to the program to address dryland salinity.
- The aim of the program is also to build capacity in the application of MBIs.

Capacity building and knowledge transfer

There will be a number of significant benefits to be gained from the greater adoption of MBIs resulting from the program:

- knowledge transfer;
    - up to policy makers; and,
    - down to practitioners.
- experience will create a fund of knowledge that should rapidly increase their wider effectiveness; and,
- smaller jurisdictions will be able to adopt MBIs where currently they have only a limited capacity to implement new approaches.

And we will develop the confidence to apply them in broader contexts including through the NHT.

Water

The other critical area is water. Here there was a break through agreement at the Council of Australian Government last week to establish a National Water Initiative.

The National Water Initiative will implement a robust framework for water access entitlements that encourages investment and maximises the economic value created from water use, while ensuring that there is sufficient water available to maintain healthy rivers and aquifers.

The framework will be compatible between jurisdictions and reflect regional variability in the reliability of water supply and the state of knowledge underpinning regional allocation decisions

COAG also noted that member jurisdictions of the Murray-Darling Basin have agreed to provide new funding of $500 million over five years to address water overallocation in the Basin.

Key elements of the framework will be water access entitlements including:

- firm pathways and open processes for returning overallocated surface and groundwater systems to environmentally sustainable levels of extraction;
- unless fixed-term water access is required for particular purposes, access entitlements to be defined as open-ended, or perpetual, access to a share of the inevitably variable water resource available for consumption (subject to water users meeting their conditions of entitlement);
- clear identification and assignment of risks between governments and water users over possible future reductions in water availability;
- water access entitlement holders should generally bear the risks associated with natural events, such as reductions in water due to climate change or drought, and risks associated with bona fide improvements in the knowledge of water systems' capacity to sustain particular extraction levels;
- Governments should bear the risks arising from changes to water access entitlements not previously provided for, arising from changes in government policy (for example, new environmental objectives);
- in addition large scale plantations, water harvesting schemes, tree planting schemes for salinity or biodiversity reasons and other uses which intercept water before it enters ground

or surface water systems will have to meet the water costs, just as they would if they were pumping from aquifers or rivers;

- water-sharing plans based on best-practice system modelling developed through transparent processes involving all stakeholders, subject to review when necessary, and with regular reporting on progress; and
- best practice specification of the responsibilities of water users.

The National Water Initiative will also establish new arrangements dedicated to the management of water at a basin, aquifer or catchment scale to deliver agreed environmental outcomes.

For example, in the Murray-Darling Basin, a basin-wide system of mechanisms will be established to enable environmental water management, including through the market.

A flexible trading model has the advantage of being able to purchase water for the environment when its needed, and selling or leasing water back to other water users at other times.

Often the best thing for environmental outcomes is to top up floods – and that usually comes at a low cost to irrigators.

If our hopes for the National Water Initiative and the Living Murray project are borne out we will see a gain in the economic outcomes from every litre of water used.

At the same time we expect an economical but effective use of water to support nominated environmental outcomes.

This will be delivered by an effective system of environmental managers who can play an active role in trading and investment markets to meet their nominated environmental objectives in the least cost way.

Conclusion

There are lots of uncertainties in applying markets to environmental problems. They are not a panacea, and often we are on the frontier of knowledge.

We need to learn by doing:

- National MBI pilots Program experience can link-in to specific policy processes; and
- The National Water Initiative is a critical national experiment that must succeed.

And it is to you that we in Government look for new solutions, new experiments and warnings about pitfalls.

So it is with pleasure that I declare the symposium open and wish you well in your deliberations over the next two days in anticipation that, collectively, we will continue to meet and overcome the challenges of using MBIs for environmental outcomes.

Thank you.

Day 1

Session 1: Setting the scene: What are market-based tools and why use them?

An overview of market-based instruments and environmental policy in Australia

Stuart Whitten, Martin van Bueren and Drew Collins[1]

Abstract

Market-based instruments for environmental management are relatively new mechanisms in both an Australian and international policy context. However, they are increasingly being considered for the management of natural resources and the environment. This is particularly so where regulatory approaches have failed to arrest on-going degradation or where the cost of traditional policy tools is proving prohibitive to government or society in general. . In this context we address four issues in this paper:

1. What is the historical policy context that has led to the emergence of market-based policy instruments in Australia?
2. What are market-based instruments and why are they useful as a policy tool? More specifically, what theoretical and practical advantages do they offer over more traditional instruments?
3. What schemes are in operation in Australia and how successful have they been? and,
4. Are there any lessons to date for their future application?

1. Introduction

Market-based instruments (MBIs) are gaining acceptance as important policy mechanisms for achieving environmental protection goals. However, their application in Australia and internationally is still in the embryonic phase. Around the world a variety of MBIs are being tested and applied to different environmental problems. In some instances, putting the theory into practice involves some hurdles and practical difficulties. Consequently, there is debate as to whether the benefits of market-based instruments justify the costs involved in their establishment.

Adoption of MBIs is based on the premise that these instruments offer the potential to achieve efficiency gains over more traditional regulatory instruments. Achieving these gains requires attention to detail and overcoming a range of potential obstacles including: aligning instruments and policy options; concurrent or prior removal of perverse incentives; addressing diffuse, or non-point, source problems; and, ensuring instruments are performance based rather than overly prescriptive. Hence, MBIs are often context specific in the sense that their application requires detail to both the existing policy and biophysical environment.

This paper provides an introduction to the potential role of market instruments and some early applications. As such the paper sets the scene for a more in-depth examination of the strengths and weaknesses of these instruments in the papers that follow in this volume. The focus in this paper is

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[1] The authors' affiliations are respectively: CSIRO Sustainable Ecosystems, The Centre for International Economics, and BDA Group. This paper draws on the presentations made by Drew Collins and Martin van Bueren at the 2003 AARES Symposium. The authors would like to acknowledge the assistance of Mandy Yialeloglou in preparing the paper.

on the policy context in which MBIs are emerging, what MBIs and their advantages are, and, some broad principles that are important in their application. These points are illustrated by reference to the application of MBIs to date in Australia and, to a lesser extent, overseas. The paper concludes with a brief discussion of the lessons to date for future MBI development and application.

2. The evolution of environmental policy in Australia

Environmental issues have gained increasing attention in the public arena in Australia over the last twenty or more years. At the national level consider the debates; for example, over land and water degradation that resulted in policy initiatives such as The National Heritage Trust (NHT), The National Action Plan for Salinity and Water Quality (NAPSWQ) and the Council of Australian Government's (COAG) renewed focus on water reforms. At the state level, at which much of the practical responsibility lies, these debates have played out in legislative changes to water allocation and management, pollution management issues and biodiversity conservation. The core motivating force behind these policy reforms is the changing attitudes of the Australian community to environmental issues together with increasing scarcity of environmental goods and services.

Part of the reason for people's changing attitude towards environmental protection is due to improving incomes, education and standard of living. It is common for developed countries to display a greater preparedness to invest in environmental management than developing nations. Indeed, a survey undertaken by the Australian Bureau of Statistics has shown that people with a high income and/or education level are more likely to express concern about the environment than those with lower incomes and/or education (ABS 2001). Other reasons behind changing environmental attitudes and values include the increasing scarcity of untouched wilderness areas, a better scientific understanding of the impacts of man's disturbance on the ecosystem and more advanced methods for communicating environmental issues quickly and to a large audience.

Governments have tended to respond to community demands for better environmental outcomes via regulatory responses. For example, the Australian Petroleum Production and Exploration Association have identified almost eighty Acts that potentially affect the oil and gas industry (APPEA 2004). The regulatory approach often prescribes conditions for resource access and usage such as various conservation acts that restrict the uses to which land covered with native vegetation can be put by limiting clearing. Similarly, many mining regulations specify the maximum allowable level of pollution, minimum requirements for mine-site rehabilitation and the type of management processes that should be used to prevent environmental damage.

In many cases the regulatory approach has failed to achieve the goals set, or has proved to be very expensive. As a result governments are starting to look for more effective and cheaper ways of achieving environmental outcomes. Efforts are being made to develop systems that satisfy government and community aspirations for higher environmental standards whilst also being flexible and amenable to the running of businesses. Increasingly these efforts are focusing on the potential of MBIs to meet the multiple criteria of effectiveness, efficiency and flexibility. For example, reforms to water resources, pollution management and biodiversity conservation have in part drawn on the use of MBIs such as water markets, pollution taxes and charges as well as 'bubble markets'[2] and auctions for biodiversity.

3. Market-based instruments

3.1 What are market-based instruments

MBIs are broadly defined as 'instruments or regulations that encourage behaviour through market signals rather than through explicit directives' (Stavins 2000, p. 1)[3]. Stavins further describes these

[2] A 'bubble market' is where multiple pollution sources are regulated as a single source allowing a firm or group of firms to seek the least cost way of complying with the regulation.

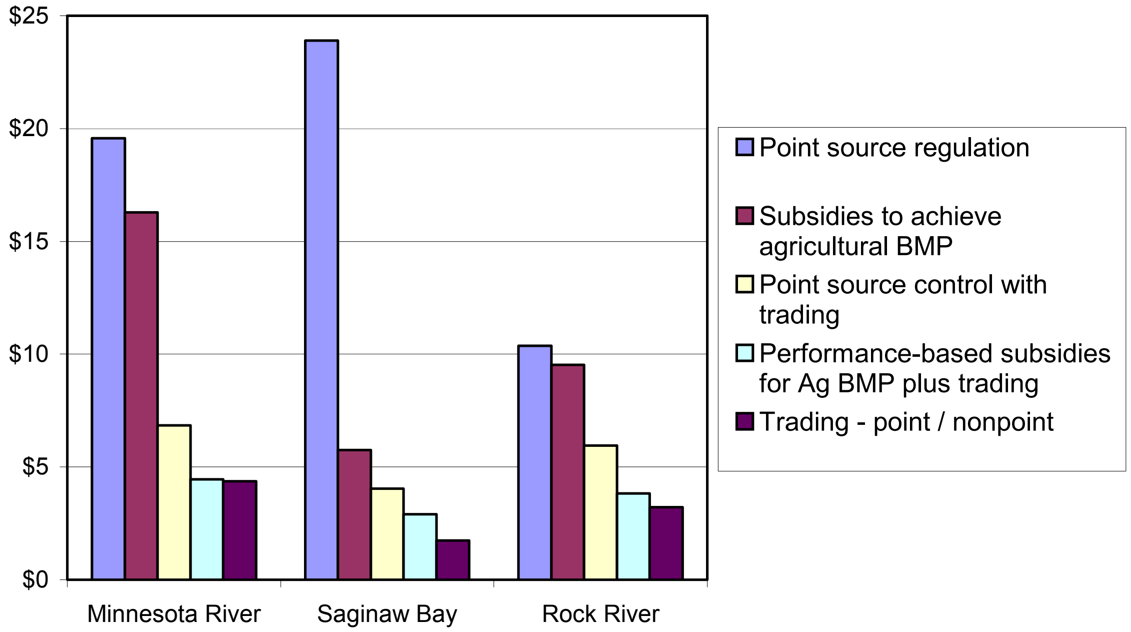
[3] Much of the discussion in this section is based on Stavins (2000), Hockenstein, Stavins and Whitehead (1998).

instruments as 'harnessing market forces' because of their potential to redefine the agenda of firms and individuals such that the improved environmental outcomes are in their own interest. The focus in applying MBIs is on achieving outcomes through the self-interest of the firms and individuals. While the key interest in MBI application is achieving policy targets at reduced cost, other interests such as risk may also be targeted (Pannell 2001). MBIs have two potential cost advantages over more traditional instruments.

First, MBIs allow different firms to make different adjustments in response to their unique business structures and opportunities. Second, incentives to discover cheaper ways to achieve outcomes provide dynamic ways of reducing the future costs of achieving targets.

As a way of illustrating the potential cost advantages of MBIs consider how a standard command and control measure operates. Under a command and control instrument firms are required to achieve specified outcomes regardless of their individual cost structures. For example, two neighbouring firms producing similar amounts of pollution may face widely differing costs to reduce their pollution (due to processes employed, input mixes, type of goods produced or other reasons). A command and control instrument would lead to each reducing their pollution by an identical amount whereas an MBI with the same target would encourage differential reductions in pollution. That is, firms with high control costs undertake a smaller share of achieving environmental targets in a physical sense but a similar share in a monetary sense. A practical example of the potential cost savings resulting from progressively allowing greater flexibility in adjustment is shown in Figure 3.1. In this example, increasing flexibility by facilitating point-non-point source nutrient trading to manage pollutants in streams produces increasing cost savings in each case.

Figure 3.1: Potential cost savings from trading versus alternative mechanisms



Notes: Costs saved are $US per pound of Phosphorus removed. BMP is 'best management practices'.
Source: Adapted from Faeth (2000) Table 8.

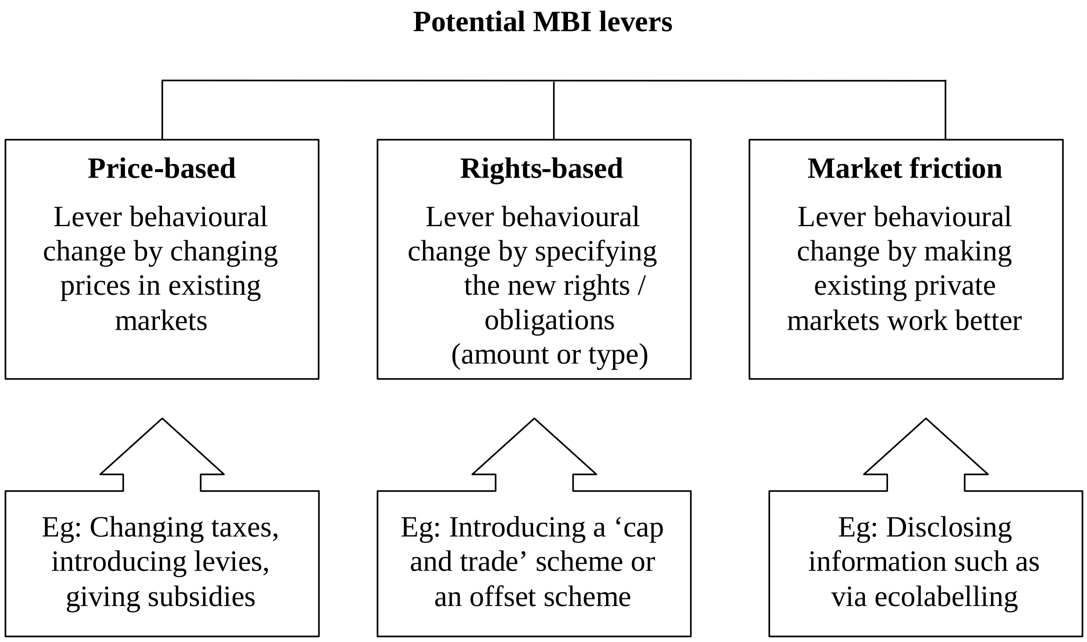
The dynamic incentives to find and adopt innovative solutions are driven by similar factors to those driving cost savings. Command and control simply require the target to be achieved. There are few incentives to reduce pollution beyond the target. Furthermore, many command and control instruments specify technologies that must be used thus reducing the incentive to search for cheaper or more effective technologies. Stavins (2001) and Hockenstein, Stavins and Whitehead (1998) refer to this as 'freezing the development of technologies'.

3.2 Types of market-based instruments

The key reason for MBI adoption is their theoretical potential to deliver the same outcome as a command and control mechanism but generally at lower financial cost to industry and at lower overall net social cost. Consider the three potential levers that MBIs are able to employ. Each lever shown in Figure 3.2 generates a range of possible MBIs. Price-based instruments alter the prices of goods and services to reflect their relative impact. They provide certainty to industry as to the compliance costs of achieving an outcome but the environmental outcome generated to the broader community is uncertain.

Rights-based instruments can be designed to control the quantity of the environmental good or service (or a suitable proxy) to the socially desired level. These instruments provide certainty as to the environmental outcome but not as to the cost to industry of achieving that outcome. Instruments designed to reduce market friction are less common. They aim to stimulate a market to produce a desired environmental outcome through improving the workings of existing markets by reducing transaction costs or improving information flows. Responses to market friction tend to be less certain and longer term.

Figure 3.2: Range of levers employed by MBIs



Within these categories it is not always clear which one a specific MBI should fall into. For example, a 'rights based' scheme (such as the Renewable Energy Certificate Scheme) could also be described as a 'price-based' scheme as a non-punitive penalty caps non-compliance costs, and in turn if set too low would have a greater bearing on the level of performance than that sought by the created 'rights'.

Whilst MBIs generally reduce the compliance costs faced by operators, especially at an industry level, as noted earlier the overall cost to society may also be significantly less – where MBIs are appropriately applied. In many instances, MBIs will not be the most efficient policy response. There are a number of reasons why, including the relative homogeneity of sources or costs or measurement and monitoring issues, and these are discussed in Section 3.3.

Despite the challenges and modest application of market instruments to date, an impressive range of MBIs has been employed in Australia and other OECD countries. Key instrument types are shown in Table 3.1.

Table 3.1: Market-based instruments by type

Price-based	Rights-based	Market friction
• Emission charges • User charges • Product charges • Performance bonds • Non-compliance fees • Subsidies (materials and financial) • Removal of perverse subsidies/taxes • Deposit-refund systems	• Tradeable permits, rights or quotas • Offset schemes	• Reducing market barriers • Extension / education programs • Research programs designed to facilitate market exchanges • Labelling • Information disclosure

3.3 What characteristics underpin effective MBIs?

Despite the potential advantages of MBIs there are a number of design issues and preconditions that are important to their success. Design issues relate to the regulatory and enforcement aspects of MBIs. Preconditions for effective outcomes relate to the nature of the industries that are impacting or generating the environmental outcome of importance and the broader institutional environment.

3.3.1 Regulatory design issues

MBIs are based on the principle of voluntary actions in response to price signals. Use of the price mechanism to convey incentives is attractive to governments as the market performs the detailed allocative task of identifying who shall reduce pollutant discharges or increase the provision of ecosystem services. However, actions in response to price signals in traditional markets are conditional on ownership of the rights or responsibility, ability to measure the response and sanctions where promised actions are not undertaken. In addition to these more traditional problems there is often a fear that environmental rules and regulations will change through time discounting the significant investment involved in changing behaviour and outcomes by government and industry. These are aspects of regulatory design in market-based instruments.

The rights and responsibilities underpinning MBIs determine who pays and who benefits. For many environmental goods and services these rights and responsibilities are not well defined. Hence, regulations stating definition and allocation may need to accompany and support the MBI. For example, allocating responsibility to firms for their emissions facilitates emissions charges and taxes. Similarly, allocating a right to emit is necessary to implement a rights-based mechanism. Definition of the rights and responsibilities sets up an inherent tension in the application of MBIs. Regulations are often necessary to codify rights or responsibilities but are resented or feared by firms. Where stakeholders are cautious or even oppose MBIs the problem can be compounded (Hockenstein, Stavins and Whitehead 1998).

Hockenstein, Stavins and Whitehead (1998) and Stavins (2000) contend that because most MBIs are 'bolted onto' existing legislation they are often limited in their potential to create cost advantages over existing instruments. However, this is not always the case, and for political or other reasons an evolution of MBIs from existing institutions and regulatory platforms may prove to be the most effective approach. Of course, design tradeoffs made in order to ensure political acceptability can undermine the potential effectiveness of MBIs or any policy tool.

Hockenstein, Stavins and Whitehead (1998) also contend that government agencies with responsibilities for environmental management often have little experience in designing MBIs (as opposed to regulatory approaches) and few incentives for their adoption. In practice there clearly are areas of excellence in government (often with greater experience than outside researchers and commentators). But MBI expertise is not widespread, and those areas without the skills are increasingly looking to transfer instrument designs without rigorous assessment of their applicability in the alternative setting. In a similar vein, the skill-base of firms is often structured around technological compliance with prescriptive regulatory settings rather than those needed to capitalise on the flexibility offered by MBIs.

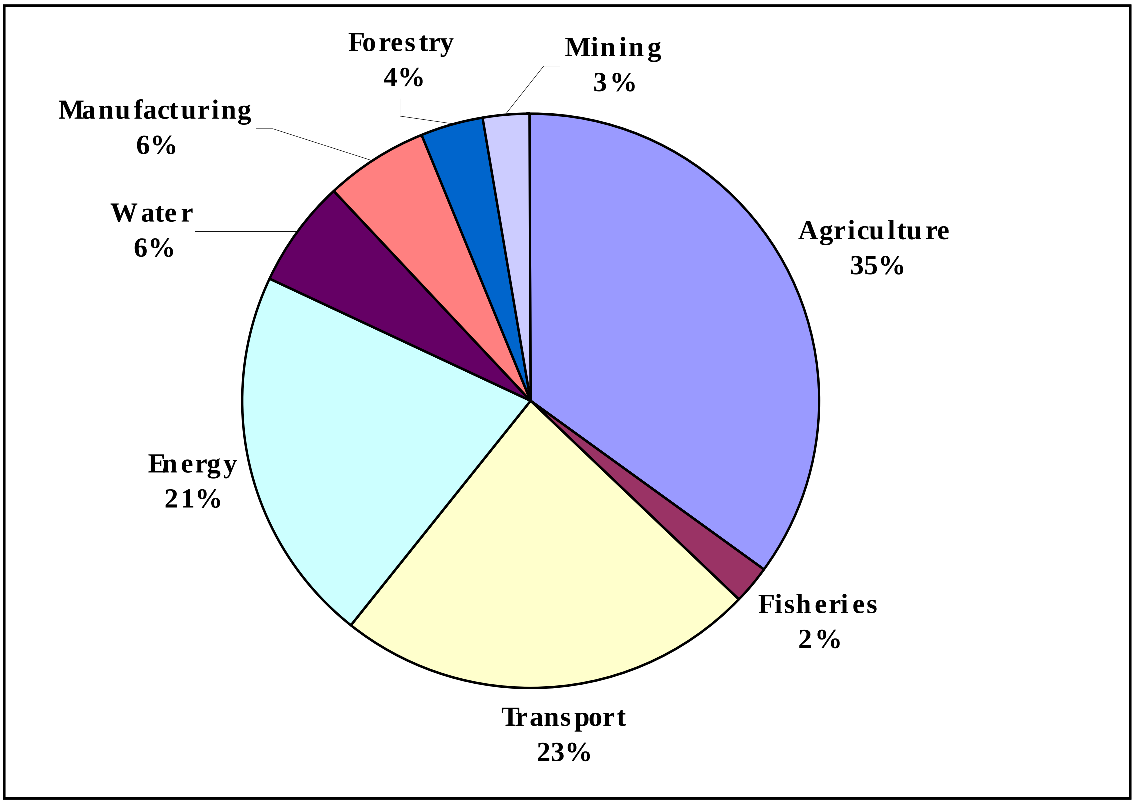
Rights and responsibilities necessary for MBIs will only be credible where there is a clear and demonstrable link between the rights specified and environmental outcomes sought. The allocation of rights, trading of rights, and the monitoring and enforcement of performance, are all dependent on sound metrics. That is, physical measures of the environmental outcome, or a suitable proxy for the outcome. For example, an emissions permit may have a 'performance basis' defined in terms of the annual quantity of allowable emissions. Alternatively, the basis may be specified in terms of a pollution 'process' – such as the expected recharge of a groundwater aquifer, which has a functional relationship to the level of dryland salinity in a catchment. In some cases an 'input basis', such as the permissible use of a polluting input, may be used when there is a clear quantifiable link between the quantities of input used and consequent pollution levels.

Generally an instrument will be more efficient if applied closest to the point of environmental damage. However this needs to be balanced with the technical capability and costs involved in establishing workable metrics. Some MBIs have been introduced that are applied to inputs or processes when a more efficient outcome metric could have been used.

3.3.2 Preconditions for effective MBIs

A critical factor in MBI success is a supportive broader institutional environment. Worldwide $950 billion dollars US, or 3.6% of world GDP is consumed in international price-based instruments (van Beers and van den Bergh 2001). The sectoral breakdown of these instruments is shown in Figure 3.3. While many of these subsidies are in sectors with potentially significant environmental impacts such as forestry, water and agriculture, most are targeted towards resource exploitation and industry development rather than towards environmental management. Where these subsidies actively promote environmental externalities they are referred to as 'perverse subsidies'. In recent times there has been an increasing shift towards reducing the 'perverse' impacts of broader subsidy programs, particularly within the US farm program and related instruments and within the Common Agricultural Policy in Europe. At the same time there has been a shift towards environmentally beneficial subsidies such as those offered in Australia through state and federal aspects of the National Heritage Trust and National Action Plan on Salinity and Water Quality Australia and the Conservation Reserve Program in the US.

Figure 3.3: Breakdown of world subsidies by sector



Source: van Beers and van den Bergh (2001) and Steenblik and Munro (1998).

The structure and variation in the firms that impact (positively or negatively) on the desired environmental outcome is also important to the effectiveness of potential MBIs. A number of characteristics can be used to effectively design MBIs:

1. the greater the degree of heterogeneity amongst firms generally the greater the gains relative to traditional command and control regulations (Newell and Stavins 1999; Stavins 2000);
2. the less site specific the impacts of pollution (that is, the less likely it is that hot-spots will develop) the more likely an MBI will be cost-effective (Stavins 2000);
3. if outcomes are critical (for example due to threshold or irreversibility) then rights based methods are preferred (see for example Stoneham, Lansdell and Strappazzon in this volume);
4. rights-based instruments work best when the firms using these have experience with similar tools (such as trading in water markets) and there are low cost mechanisms for exchange (Stavins 2000).

Other exogenous factors can also impact on the effectiveness of MBIs. Stavins (2000) notes for example that economic growth and inflation tend to erode effectiveness of performance-based taxes and charges while technological changes tend to increase the effectiveness of these instruments.

4. Australian and international experience with MBIs

In this section we provide a broad overview of Australian and international experience with MBIs. The number of MBIs that have been implemented has been steadily increasing over recent years, and a new generation of Australian MBIs are now under development as part of the National Market-Based Instruments Pilot Program under the National Action Plan for Salinity and Water Quality. A list of the range of MBIs currently in operation in Australia is shown in Table 4.1 with potentially many more operating at pilot or local scale that are not included in this list.

Table 4.1: Examples of Australian market-based instruments

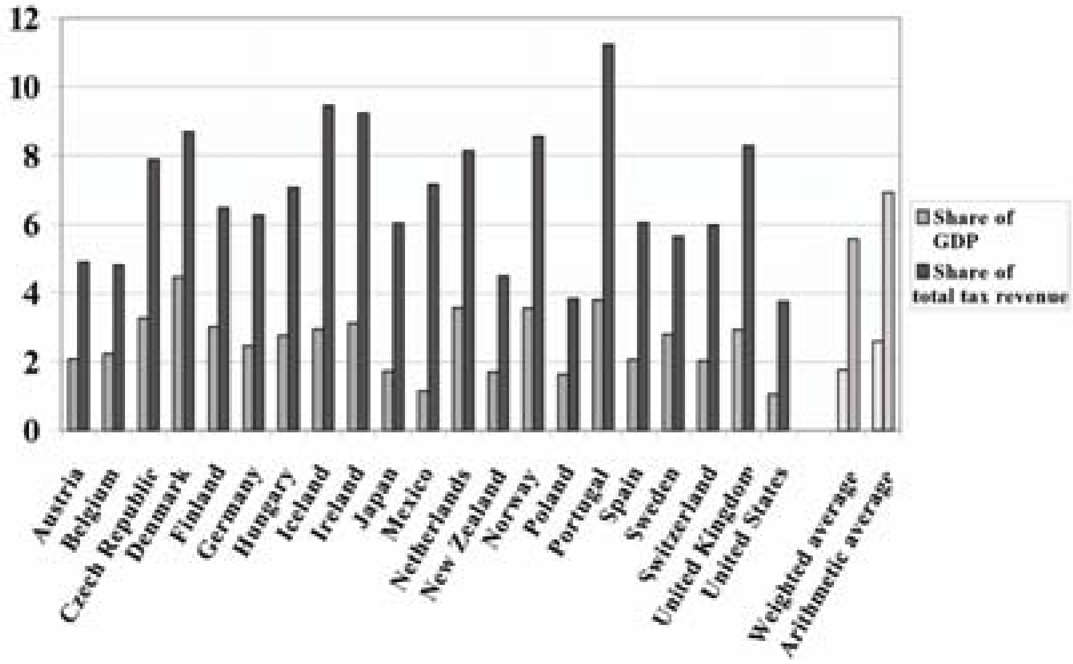
Lever	Instrument
Price-based	• Licence fee for use of marine waters • Aircraft noise levy (Sydney) • Ozone depletion fee • Waste effluent charges (Load based licensing) • Mine site rehabilitation performance bond • Greenhouse challenge subsidy • South Australian beverage container deposit scheme • Bushtender in Victoria
Rights-based	• Hunter river salinity scheme • Tradable Renewable Energy Certificates (RECs) • Nutrient offset scheme in South Creek, Sydney • Carbon legislation (see for example NSW, QLD or Vic) • Development offsets (local and state levels)
Market friction	• Banrock Station Wines environmental labelling • Revolving funds for nature conservation • Eco Certification Program (Tourism)

Sources: OECD (1999), National Action Plan on Salinity and Water Quality (2002), Van Bueren (2002).

4.1 Price-based MBIs

The main price-based mechanisms in use internationally are ‘eco-taxes’ and subsidies. Across the OECD there has been increasing use of ‘eco-taxes’ and similar instruments. These taxes amount to around 2% of GDP and about 5.5% of total tax revenue across the OECD. They are primarily imposed on energy in the transport and heating sectors (60% and 5% respectively) as well as vehicles (30%) and electricity (4%) (OECD 1999). The revenues from environmentally related taxes in OECD countries are shown in Figure 4.1.

Figure 4.1: Revenues from environmentally related taxes in percent of GDP and total tax revenue, 1995



Source: OECD (1999, p. 60)

There is also strong Australian experience with price-based MBIs, though not generally with 'eco-tax' arrangements. Many Australian state and local governments have imposed pollution, development and waste management fees. Further product taxes are imposed on lubricating oils and used tyres to pay for product recycling. Other common price-based mechanisms designed in part with an environmental outcome in mind include parking and toll charges as well as noise levies (such as that imposed on landings at the Kingsford-Smith Airport in Sydney). Subsidies are also prevalent in Australia including those through tax concessions for Landcare management, NHT and NAPSWQ grants and numerous water and energy related programs such as that shown in Figure 4.2.

A well known price-based MBI is pollution taxes under the 'Load-Based Licensing' scheme (LBL) in NSW. Under LBL polluters are charged a fee that is based on the mass and relative impact potential of the pollutants emitted. The key factor is that the charge is performance based. If polluters are able to reduce their emissions then their LBL fee will fall. Firms are required to submit an annual return to the NSW EPA detailing their emissions. Firms may also be audited by the NSW EPA to ensure that returns are accurate. In order to reduce the potential for hot-spots developing the pollutant potential can also include the geographic location of the emission.

Figure 4.2: Example of a price-based MBI – water efficiency rebates

4.2 Rights-based MBIs

Rights-based MBIs have been used extensively in Australia to manage resource over-allocation in fisheries and water. They have also been used to cap emissions contributing to environmental damage. Three examples are caps placed on salinity in the Murray-Darling Basin and in the Hunter River, and on nutrients from a group of wastewater treatment plants in the Hawkesbury-Nepean system. More recently rights-based MBIs have also been employed to promote the uptake of environmentally positive activities such as low greenhouse gas energy under the Tradable Renewable Energy Certificates (RECs) program

4.2.1 Rights-based MBIs and renewable energy

The RECs program in Australia is an innovative rights-based program intended to encourage generation of electricity from renewable sources.[4] In April 2001 the Federal Government introduced a mandated target that requires electricity retailers to generate an additional 9500 Giga-watt hours of electricity from renewable sources by 2010. The measure applies nationally, with all electricity retailers and wholesale buyers contributing proportionately to the achievement of the target. The target would increase the renewable share of electricity generation from 0.24 per cent in 2001to about four per cent by 2010. The target will be phased in via interim targets over the period 2001 to 2010.

Individual firms will be proportionately liable for meeting their share of the target. For example, if a retailer purchases 10 per cent of the nation's electricity it will need to meet 10 per cent of the interim target for that year. A system of tradeable renewable certificates (RECs) has been developed to assist firms in meeting their obligations. Each REC is equal to one Mega-watt hour of renewable electricity. Electricity retailers can purchase these certificates to make up any shortfall in physical purchases of renewable electricity. Certificates can be acquired directly from renewable energy generators or purchased off the market. Each year liable parties must surrender RECs to the Regulator to cover their share of the target, with certificates subsequently expiring as a result of this process. A central registry of RECs has been established to support this requirement.

The RECs trading scheme has been designed to improve the cost-effectiveness of achieving the target. If renewable electricity is expensive in some locations then electricity retailers in those regions can purchase REC's generated in lower cost regions to minimise the cost of meeting the target. The certificates remain valid until surrendered and can be banked for use in future periods, although borrowing certificates will not be permitted. As with all such schemes a penalty for non-compliance is incorporated into the MBI design. The RECs penalty is set at a fine of $40 per mega-watt hour that is not surrendered, which sets an upper limit on the price of RECs. However, this amount is estimated to be greater than the expected marginal cost of obtaining renewable energy – implying that the penalty is not expected to constrain certificate prices (ABARE 2001b). The compliance mechanism is a soft penalty regime as penalties will be redeemable if compliance is achieved within three years.

4.2.2 Rights-based MBIs and air quality

A number of different rights-based MBIs have been effectively used to improve air quality in the US as shown in Table 4.2. These programs have been used to address lead, nitrous oxides, sulphur dioxide and chlorofluorocarbon (CFC) emissions. The most notable of these programs, in terms of its size and success, is the US Acid Rain Program. The Acid Rain Program is a cap-and-trade system that regulates sulphur dioxide (SO_2) emissions, the primary precursor of acid rain. The first phase of SO_2 emissions reductions was started in 1995, followed by a second phase in 2000. Now almost all electric power-generating units have been issued with allowances and brought within the system. Emission allowances were 'grandfathered' to industry participants, which helped to make the scheme more palatable to industry. Electric utilities must have adequate allowances to cover their emissions with high penalties for non-compliance (US$2000 per tonne plus a requirement that excess emissions be offset the following year). A robust market of SO_2 permit trading has emerged resulting in estimated cost savings of approximately US$1 billion per annum relative to the costs under command and control regulation (Stavins 2000).

[4] Detailed information on the RECs program can be found on the Office of Renewable Energy Regulator website: http://www.orer.gov.au/

Table 4.2: United States air quality trading programs

Baseline and credit programs	
Lead trading	Introduced in 1982 to allow gasoline refiners greater flexibility in meeting reduction targets for lead content in fuel
Heavy duty motor vehicle engine emissions trading	Introduced in 1990 to meet standards for particulate matter, nitrous oxides and other emissions from heavy duty truck engines
Gasoline constituents program	Established in 1992 to meet minimum oxygen concentrations in fuel
Cap and trade programs	
Acid Rain Program	Established in 1995 to control sulphur dioxide emissions
CFC Trading Program	Established in 1986 to help comply with the Montreal Protocol, which called for reductions in the use of chlorofluorocarbons (CFC).
RECLAIM Program	The Regional Clean Air Incentives Market Program (RECLAIM) was launched in 1994 to reduce nitrogen oxide and sulphur dioxide emissions in the Los Angeles area
Other US state programs	In addition to RECLAIM, emission trading programs are in various stages of development in several US states
NOx Regional Ozone Program	A national program introduced in 1999 to meet reduction targets for nitrous oxides

Source: United States EPA (2001)

4.2.3 Rights-based MBIs and water quality

Another apparent MBI success story has been water quality. The United States is at the forefront in developing trading programs for controlling the discharge of effluent into waterways. There has been strong experience and success in Australia as well with the Hunter River Salinity Trading Scheme and Pilot Pollution Trading in the Lower Hawkesbury Nepean systems. The main forms of effluent being regulated in this way are nutrients, salts and pesticides from point sources – including sewage treatment plants, piggeries and industrial plants. More recently, efforts are being made to incorporate non-point sources into the regulatory framework although the success has been mixed. These sources primarily constitute broad-acre farms.

Compared to air emissions trading, the application of trading to manage water quality is significantly more complicated. Water pollutants do not necessarily mix uniformly throughout a drainage system[5]. That is, the environmental impact of a unit of discharge entering the waterway at one location is different to the impact of an equivalent unit discharged at another point along the waterway. This problem can sometimes be overcome with trading ratios but these must be founded on a solid understanding of the biophysical relationships involved. A related risk is that trading could induce these so called ‘hotspots' if market rules are not carefully crafted. The source of water pollutants also differs. Non-point sources – such as agricultural runoff and stormwater – often contribute a large proportion to the total effluent load in waterways. Non-point sources are difficult to incorporate into a trading program because, by definition, discharge from these sources is dispersed and often unobservable. Thus, proxies for the amount of effluent being discharged by individual sources may need to be used, subject to the robustness of assumed relationships. This may require a functional

[5] Air and other pollutant “hot spots” also exist but are less common

relationship to be established between land use practices and the quantity of discharge. Even if these functional relationships are established, it can be costly to monitor non-point sources because they are dispersed across a wide geographic area.

An Australian example: The Hunter River Salinity Trading Scheme

The NSW Environmental Protection Agency (EPA) operates the Hunter River Salinity Trading Scheme. This cap-and-trade scheme regulates discharges of saline water from coalmines and power stations in the Hunter River catchment above Singleton. The program was introduced as a trial scheme in 1995 after extensive consultation with the NSW Department of Land and Water Conservation[6] (DLWC), the Coal Industry Association, the Hunter Catchment Management Trust and Pacific Power.

The objective of the scheme is to manage saline water discharges so as to minimise impacts on irrigation, other water users and on the aquatic ecosystem. The scheme manages salinity by restricting discharges to a share of that which can be safely diluted within a high flow event. The total salt that can be discharged during the high flow event is calculated according to the ambient salinity in the Hunter River and concentration targets at key points in the river (Denman and Singleton). A comprehensive system of real time monitoring is used to ensure that participants do not exceed their pollution entitlement. Monitoring is the responsibility of permit holder, with the EPA and DLWC conducting regular audits to verify the accuracy of the monitoring data. It is estimated that the scheme costs between $150 000 and $200 000 per annum to administer (ABARE 2001a). This cost is covered through a fee levied on participants based on credit holdings.

The scheme was introduced as a pilot scheme. The environmental targets were achieved during the pilot period despite a series of seasons with low flows that made it harder for participants to manage their discharges (ABARE 2001a). The evolution of the scheme shows how MBIs can evolve from traditional command and control regulation. Initially the scheme was managed through EPA licensing with ‘credits’ allocated to coalmines and power stations in the region and including a reserve held by the EPA. More recently, the pilot has moved to a permanent footing under separate legislation. A number of innovations have accompanied introduction of the permanent scheme, including extending the life of credits to 10 years and allowing third party ownership. In order to maximise the potential benefits from trade and facilitate new entrants, twenty percent of credits expire every two-years and are reallocated via auction.

A US example: The Lower Boise River Trading Program

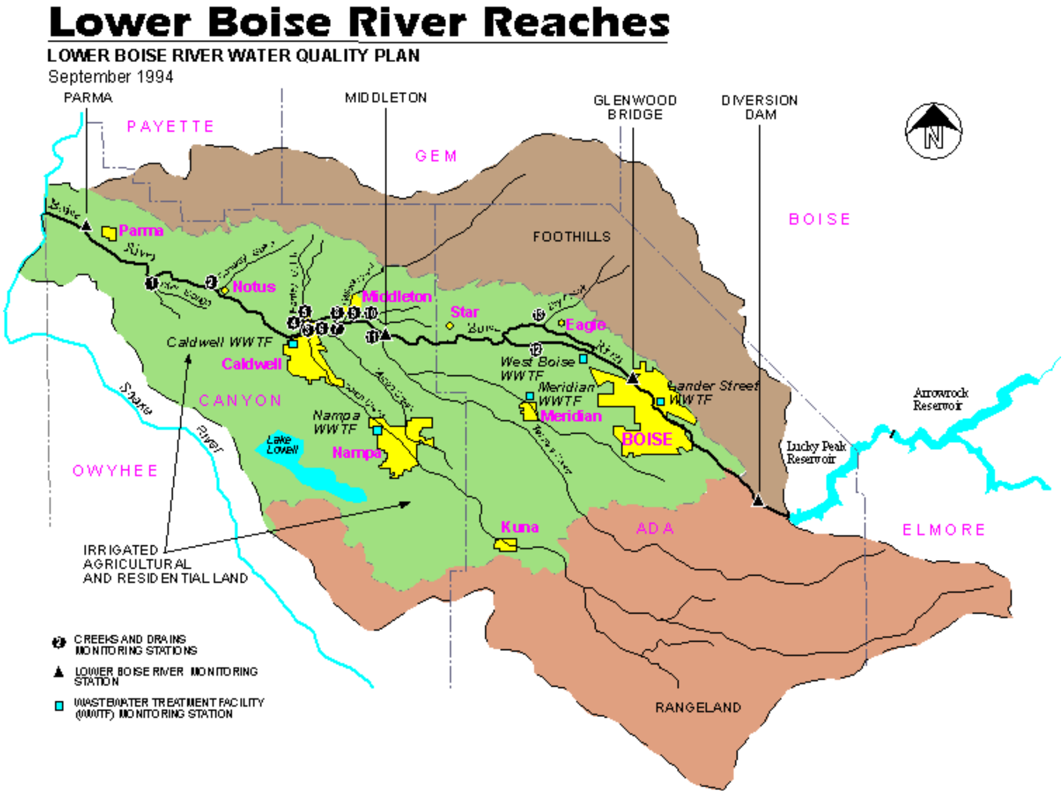
The Lower Boise River Trading Program is one of the prototype schemes being developed by the US EPA. The Boise River catchment is located in southwest Idaho and is subject to discharges from sewage treatment plants, factories and agricultural producers of which the primary concern is the amount of phosphorous entering the Boise River (see Figure 4.3). In 1997 the US EPA, in partnership with stakeholders in the watershed, began to examine the potential for setting up a trading program as a means of reducing the costs of meeting new water quality standards to be introduced in 2001. While existing regulations under the National Pollutant Discharge Elimination System (NPDES) regulate point source discharge limits these are expected to become more stringent and subject to ‘total maximum daily loads’ (TDMLs) from all pollutant sources. It was decided to develop a demonstration program for trading phosphorous reduction credits because initial investigations suggested the costs for nutrient reductions range widely among sources yielding potential benefits from trade.

The objective of the TDML plan is to meet a water quality target measured at the mouth of the Boise River. However, the sources of pollution are distributed unevenly through the catchment. Furthermore, non-point sources in particular are complex and costly to measure. In order to incorporate non-point nutrient pollutants the impact of many BMPs is estimated using a generalised

6 In 2003 DLWC was merged with Planning NSW to create The Department of Infrastructure, Planning and Natural Resources (NSW)

model. The uncertainty about the actual impact is then incorporated via an 'uncertainty discount'. To take account of the spatial differences in pollution generation trading ratios between different locations in the catchment have been devised. These trading ratios are used as conversion factors to ensure that the market does not create or exacerbate 'hot spot' problems.

Figure 4.3: The Lower Boise River



Point and non-point sources are incorporated using a 'baseline and credit' MBI format. Point sources will need to meet their discharge limits by either reducing their discharge or purchasing 'offset credits'. 'Offset credits' may be purchased from other point sources (point-to-point trading) or from the agricultural sector (point-to-non-point trading). The agricultural sector is not subject to an enforceable baseline level of discharge, but farmers can generate credits for sale to point sources by adopting approved 'best management practices' (BMPs). For example, BMPs include buffer strips, wetland construction, irrigation control systems, and tillage systems. 'Offset credits' will only be issued in circumstances where a farmer has changed his management practices in adopting a BMP. That is, credits will not be issued retrospectively.

An innovative aspect of the Boise River trading scheme is the proposed establishment of a private 'Trading Association'. The purpose of the Trading Association is to facilitate trades via a single source of information about trade types and location and potential buyers and sellers. The World Resources Institute is developing a similar Internet based scheme across catchments (see: www.nutrientnet.org).

4.3 MBIs designed to reduce market friction

Relatively few MBIs have been specifically targeted towards reducing market friction in a way that stimulates a market to emerge thus ensuring environmental outcomes are met. This is because the impacts of such measures are generally less certain and may take considerably longer to occur than either price-based or rights-based measures. Furthermore, many instruments that may ultimately serve this purpose are not specifically directed towards reducing market frictions. For example, extension schemes directed at better biodiversity management might reduce the set-up costs of farm-based tourism with a biodiversity component. Despite this constraint, government, industry groupings and the private sector have developed MBIs that effectively reduce market friction. In this section we briefly discuss an example of eco-labelling as an information tool and revolving funds as a market facilitation tool.

4.3.1 Banrock Station wine eco-labelling

Banrock Station Wines has 2070 hectares of vineyards amongst 1600 hectares of native vegetation. The vineyards are managed to minimise their impacts on the Ramsar listed wetlands. Marketing campaigns for Banrock Station Wines feature the environmental management of the property with a portion of each sale being returned to wetland conservation in the projects around the world including Australia, New Zealand, the Netherlands, Sweden, Finland, Denmark, the United States, Canada, and the United Kingdom.[7] The marketing aims to inform wine consumers that some revenues are being notionally committed to purchasing a positive environmental outcome at the vineyard or for wetlands in their own neighbourhood. The BRL Hardy owned venture, Banrock Station Wines has been extremely successful reaching sales targets well in advance of forecasts.

The success of eco-labelling approaches relies on consumers responding to marketing and advertising campaigns that link the sale of the product with a positive environmental outcome. Such ‘product branding’ usually requires some form of assurance (for example, accreditation) for consumers to know that the claims related to the branding are being carried out. In the case of Banrock Station Wines, this accreditation is provided by linking the purchase to a donation to a reputable conservation organisation such as Landcare Australia and the Swedish Wetland Fund. These organisations then permit the use of their logos on Banrock Station products. Broader eco-labelling schemes are also under consideration in Australia (for example, Blackwood Environmental Stewardship Trial - BEST Farms in the Blackwood Basin in WA).

4.3.2 Victorian Trust for Nature revolving fund

The Victorian Trust for Nature has operated a revolving fund since 1989. Revolving funds commit a pool of funds to purchasing properties with significant native habitat or of cultural value, and then reselling the land to conservation-minded people wishing to own a native habitat property. The advantage of a revolving fund is the ability to recycle the funds many times over as lands are progressively purchased and resold. For example, the Victorian Trust for Nature fund had purchased and resold 14 properties by 2000 with a further 8 awaiting sale. Properties are often resold with a conservation covenant attached to further protect the natural values.

The revolving fund essentially works by matching buyers and sellers that would not otherwise occur due to information constraints or time-of-sale mismatches in a highly specialised market. In the US revolving funds are often used to make quick purchases that are then on-sold to governments due to the much slower way in which government funds would be approved for such purchases. Revolving funds may also purchase properties to allow community or non-profit organisations time to raise funds for their purchase as community assets.

Revolving funds usually require that the land purchased must be of a specified conservation importance. Such lands may have threatened plants or animals, or be one of the last remaining areas of native vegetation in the region. The land may also form part of an important riparian or wildlife corridor or contribute important functions for landscape ‘health’. Important factors include: degree of disturbance; diversity of flora and fauna; presence of threatened or endangered species; value as a buffer or wildlife corridor; size and shape of area; and, management input required to maintain the ecological integrity of the site. Eligible sites are often brought to the attention of the fund by Trust for Nature supporters or property vendors.

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[7] See www.banrockstation.com.au

5. Discussion

As more is learnt about the requirements for successful MBI establishment, the range of policy contexts to which trading is being applied continues to broaden. During the coming decade it is likely that trading instruments will become increasingly common in Australia and overseas as a means of managing domestic and international environmental problems. Consequently, it will be important for Australian industry sectors to keep abreast of developments so that it can actively engage in the MBI design and implementation.

A number of factors have been responsible for the heightened interest by Australian and international governments in environmental markets. Firstly, the overwhelming success of the US Acid Rain Program – which used a trading scheme to reduce the emissions of sulphur dioxide emissions – has convinced many governments and prominent environmental groups of the merits of trading. Since its establishment in 1995 the Program has surpassed expectations, with firms exceeding the reduction target at less than one-half the forecast cost (Ellerman, 2000). A robust market of sulphur dioxide trading has emerged, resulting in cost savings in the order of US$1 billion annually compared to the costs under some command and control regulatory alternatives (Stavins, 2001). The cost savings are mainly a consequence of tremendous technological change in the electricity generation sector, and opportunistic use of low-sulphur coal that has become more economic with rail reforms in the 1990s. The profile and prospects of similar emissions trading schemes has been significantly increased under the terms of the Kyoto Protocol.

Second, the philosophy of environmental trading is consistent with micro-economic reforms introduced by successive state and federal Australian governments over the last fifteen years or so. For example, sweeping market reforms have been made to the banking, transport and electricity sectors. There has also been a noticeable paradigm shift in the way natural resources are being managed. The shift has been away from centralised 'command and control' regulations and towards market-based schemes. For instance, Australia now has a tradable property rights framework for controlling the extraction and use of irrigation water (tradeable water entitlements). Similar frameworks have been developed for managing Commonwealth and State fisheries.

In another development, Australian resource management agencies have embraced the concept of commercialising 'environmental services' because it is perceived that this could attract private investment in natural resource management. Environmental services include the services of nature that society often takes for granted - such as the pollination of agricultural crops by bees, water purification by forests and the salinity control benefits of trees. Many of the MBI pilot projects funded under the National Market-Based Instruments Pilots Program focus on such environmental services.

A fourth reason for the growing interest in environmental trading is the ongoing and rapid improvements in information technology and computer processing. These advances are revolutionising our abilities to monitor the environment. Simultaneously, the cost of remote sensing and 'real time' monitoring is continuing to fall. The Internet has also reduced the transaction costs of trading, because it allows buyers to locate sellers quickly and easily. These developments are expected to improve the economic feasibility of environmental markets. A related development is the advances being made in modelling complex biophysical relationships between land use change and ecosystem impacts. Reliable scientific information on the nature of these relationships is critical for the functioning of environmental markets.

Despite these encouraging signs for the development and adoption of MBIs some caution should be exercised. Poorly defined environmental goals are not conducive to efficient market instruments. As an example consider the issue of solid waste management.

Government interests in waste management have moved away from that of focussing primarily on managing post-consumer disposal impacts to promoting perceived upstream benefits associated with reducing waste generation and increasing recycling and reuse of waste materials (such as resource conservation and industrial emissions). While such upstream benefits will vary markedly between different waste materials and recycling processes, little attention has been focussed on identifying which actions will deliver what benefits. Rather, driving down waste disposal *volumes* to landfill has become the policy metric. Accordingly, MBIs have focussed on volumetric landfill taxes and recycling subsidies.

By using an indirect metric where environmental outcomes associated with the subsequent behavioural changes are poorly understood, environmental benefits may be small, even perverse. The key issue is that the market failure and therefore the policy objective must be clearly defined prior to instrument selection and then every effort made to apply policy instruments closest to the point of the market failure (environmental damage), not at some distant point in product supply chains. .

A third concern is that reforming current and perverse incentives may be the most effective way of addressing policy goals rather than immediately considering new MBIs. As is the case overseas there are potentially significant perverse incentives in the energy, transport and agricultural sectors in Australia. For example, there has been a recent shift in emphasis in the agricultural sector from supporting production and prices to natural resource management issues. But this shift remains incomplete with significant concerns remaining over the direction of drought policy and the prevalence of industry 'rescue' packages, such as the latest assistance package for the sugar industry.

Finally, many MBIs to date have been narrowly applied. These instruments limit community responses as much as prescriptive regulations that seek to 'pick winners'. For example, consider the range of water conservation incentives applicable to appliances (see Figure 4.2), water tanks and irrigation technology. The ACT water efficient showerhead scheme for example is estimated to cost approximately $1,700 per mega-litre of water saved[8] whereas the opportunity cost of irrigation water in the Southern Murray Darling Basin (that incorporates the ACT) ranges between $500 - $1,000 per mega-litre.[9] The piecemeal application of instruments for narrowly defined outcomes is a poor surrogate for fundamental property right and institutional reforms. Generally the gains from MBIs increases with the volume of trade, and the potential for trade in turn will be greater where market boundaries are broader – looking to capture as many low cost opportunities for reform as possible.

6. Conclusions

MBIs are becoming a 'mainstream' policy instrument for managing a wide range of environmental problems. Australia's uptake of MBIs for environmental management has so far been modest compared to other OECD countries (OECD 2001). However, recent government reforms in natural resource management policy – both at Federal and State level – suggest that MBIs will play a greater role in the future. Governments appear to be undergoing a paradigm shift in their views on what constitutes good environmental policy, with greater emphasis being placed on the role of decentralised instruments to achieve change within industry. Just as the 1990's saw great advances in microeconomic reform in transport, electricity supply and water, so too it is likely that significant reforms will be made in NRM.

This new era of environmental policy presents both opportunities and challenges. Environmental awareness and the growing demands placed on businesses to be accountable for their environmental performance is an international phenomenon. In general, the traditional response by government has been to instigate 'command and control' regulation. Environmental markets are a departure from these unnecessarily prescriptive regulations with potential benefits from the greater flexibility and certainty. If designed well, these instruments offer the potential to drive down environmental compliance costs.

On the other side of the ledger, environmental trading poses future challenges. First, there is a risk that environmental targets will be set by government without a comprehensive assessment of all the costs and benefits implied by the target. Ideally, what is needed is a consultative process that is not

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[8] Derived from Energy Strategies (2003), AAA Showerhead rebate program: audit and evaluation

[9] Marsden Jacob Associates (2002), *Improving water use efficiency in water conveyancing systems*. Report to Land and Water Australia

open to abuse by interest groups or being gazumped by impatient politicians. All too often, environmental targets are implemented without full consideration of the economic and social trade offs involved or of the fundamental property right reforms that may be necessary.

A second, related, risk is the erosion of MBI gains via arbitrary reallocation of rights or resources within these instruments. The legal basis of the MBI must be soundly specified if they are to function successfully. Thirdly, poorly designed trading programs can impose high transaction costs, particularly where the responsibility of monitoring and verification is also devolved. A fourth is to work with government to develop MBIs that are unambiguous in their operation and that have simple, transparent rules that are not open to manipulation. In some applications, such as biodiversity and salinity management, there is a need for good quality science to underpin any MBI. Finally, the advent of environmental trading will require new management skills and stakeholders will need to undergo a period of 'learning'. In the industrial sector many firms were ill-equipped to fully utilise the opportunities created by trading instruments and this may well be the case in the rural sector.

To sum up, the papers at this symposium will showcase a variety of MBIs that have gained widespread acceptance by the majority of stakeholders. In most cases this has been achieved through extensive consultation and pilot testing, the development of fair and unambiguous rules, and the provision of secure tenure. But poor instruments also exist, generally reflecting poor design, ambiguous policy goals or governments implicitly still 'picking winners'. Greater use of market instruments as environmental 'band-aids' should not be at the expense of fundamental property right reforms.

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Market based instruments and NRM: Back to basics

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1. Introduction

The observation that environmental policy necessitates action on both public and private lands is the genesis of much recent policy reform agendas in the environmental domain. In particular, there has been recognition of both the multiple benefits associated with land scape intervention, a consequence of the connectedness of the environmental landscape, as well as the myriad of different costs (public and private) that are imposed on agents in the economy by such interventions. At the heart of the problem then, in evaluating the efficacy of financial commitments by governments to environmental reforms, is establishing how to get the ‘right’ intervention at the ‘right’ location at the ‘least’ cost. This paper contributes to this discussion on appropriate and effective means for achieving land-use change on private lands. While the focus is on delineating the frameworks for effective implementation of market-based instruments, there is also a discussion of the relative merits of different policy instruments and the need to consider a portfolio approach to policy implementation.

2. Understanding the complexities of natural resource management[2]

In order to assess the state of current environmental policy, and to posit changes in that policy, we must start with an understanding of the genesis of the environmental problems themselves. In particular, it is important to recognise why natural resource management (NRM) can not be viewed in isolation from other parts of the economy. At a macro level, economic growth and population growth lead to an increase in demand for most resources. Furthermore, environmental goods appear to be mostly normal goods (i.e. the value people place on them rises with income and education), which are in fixed or limited supply. As such, it is likely that the social value of environmental resources will continue to rise rapidly.

Many goods are effectively priced and marketed in the economy, but many are not. The economic (or social) value of marketed goods is generally reflected in their market value, and with some exceptions that are well understood by economists, market mechanisms allocate resources efficiently. Of course this does not apply to non-marketed resources. There are many environmental resources that are not adequately valued through the market system. Further complexity arises when it is acknowledged that the utilisation of natural resources often yields multiple outcomes, some of which are valued by the market while others are not. For example, land can be used to produce crop and livestock commodities, which have readily observable prices, but this same land could be used to sustain populations of native plants and animals which are not valued in the market place.[3]

It is generally acknowledged that existing markets and institutions misallocate resources to environmental goods and services. Markets are generally efficient in allocating resources to ‘exploitation activities’ but may be ineffective with respect to investment in environmental conservation. Commodity markets, for example, provide clear signals to individual landholders about the value of clearing land for agricultural production, yet markets for conservation actions are missing or inefficient. The social value of non-marketed outputs may be rising (or falling, in the case of bads like greenhouse emissions) even more rapidly, but the values do not have a voice in the marketed part of the economy. In particular, when making tradeoffs across different activities, people only observe those underlying values that are priced through the market. It is this incompleteness of

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[2] Much of this section borrows heavily from Bardsley et.al.[2002].

[3] Environmental goods also include inputs to marketed services such as eco-tourism and some forms of commercial outdoor recreation activities.

markets that results in a distortion of resource allocation from the efficient, or value-maximizing outcome. The result is a squeeze on environmental resources.

There exist two broad policy approaches to dealing with this problem. One is to delineate a clear boundary around the marketed part of the economy. This serves to protect the environment by mitigating the risks of exploitation. This is a natural reaction and the basis of much existing policy. The other is to change the boundary between the marketed and non-marketed part of the economy, curing the problem at its root. A combination of both approaches will probably always be optimal. This paper suggests that new developments in science, technology and economic theory allow us to shift the mix of policy instruments that define this boundary in ways that were not possible before.

3. Value creation and environmental reform

Economists generally contend that the over-riding objective of good economic policy is to maximize value creation. Of course political objectives, and social concerns may result in optimizing subject to some constraints, but the ability to deliver these other 'social' criteria is not always at odds with delivering value-maximising outcomes. Many of the social criteria are about the division of value often intertwined with notions of equity. Indeed, most economists would like to separate out efficiency from equity or other social criteria, and use first best schemes for redistributive purposes. Thus, value creation lies at the heart of all good economic policy. Value creation entails demand and supply side considerations. In particular, the foundation of all of demand analysis is the customer's willingness-to-pay (WTP). That is, the dollar amount that would leave a consumer indifferent between purchasing and not purchasing a product (or service) is the WTP. WTP is a well defined construct that can be influenced by objective and subjective considerations. Moreover it is decision contextual.

Similarly, on the supply side, the opportunity cost (OC) is the foundation of all supply analysis. It is the dollar amount that would leave a supplier indifferent between supplying or not supplying a product or service. Again, OC is a well defined construct that can be influenced by objective and subjective considerations. Moreover it too is decision contextual. Value creation is then the difference between the customer's WTP and the seller's OC.

As with any other sphere of economic analysis, when dealing with environmental policy issues we should begin by imposing this lens of value creation. At its core, this requires a considered understanding of the demand and supply of environmental goods and services. The first part of this story is to identify who the players are. The public goods nature of most environmental goods and services results in the customers typically being the government (in some, probably incomplete, sense, aggregating societal preferences over environmental assets), while suppliers can range from individual farmers to community groups or businesses.

In the realm of environmental resources, as detailed earlier, because much of the environmental values are not well defined, ascertaining the true WTP (from a societal perspective) or the OC (from that of the landholders, or whoever the relevant agent may be) is difficult. The complexity of the landscape adds to the heterogeneity of both demand and supplier types. In particular, notice that two adjacent tracts of land can hold very different environmental significance (from a societal/ scientific perspective) and hence the WTP associated with delivering some land-use change on those tracts would be quite different. Similarly, two adjacent landholders may be privy to different farming techniques, risk profiles, access to capital etc thus rendering there OC associated with identical land use change very different! It is this very heterogeneity that makes market-based instruments attractive as a new policy tool. Many existing policy mechanisms, such as regulation or voluntarism (at two ends of the policy spectrum) fail to fully exploit the heterogeneity of types, both on the demand and the supply side, that is at the heart of maximising value creation.

4. The environmental policy world

Environmental policy makers around the world have relied on a mix of policy mechanisms including command and control, market-based instruments, education and attitude change. In Australia, emphasis has been placed on policy mechanisms that foster voluntarism (for example, LandCare, Clean up Australia) and legislation (for example the *Planning and Environment Act 1987*). Concerns about the efficacy of the environmental policy mechanisms employed by governments in Australia are beginning to be raised. Despite significant progress made overseas, relatively little attention has been given in Australia to the application of changing market institutions to address environmental and natural resource management. In effect, Australia's approach to environmental policy has been to 'fence-off' the environment from the remainder of the economy, and hence, limit its exposure to the organizing influences of market processes.[4]

Governments around the world are wrestling with the changing issues associated with the use and degradation of natural resources and the environment. The broad gambit of concerns include, current and future viability of natural resources (sustainability), appropriate valuation methodologies for environmental assets, and transboundary degradation. An important common thread across these is that of opportunity cost. The environmental and natural resource issues associated with land illustrate this problem. Land can be used to provide agricultural commodities, biodiversity, carbon sequestration and other water and air quality services. When land is used to grow crops and livestock, it has an associated opportunity cost in terms of the viability of the future use of that land. There is much debate about the monetisation of these costs, as they require some weighting of current versus future use (in economic parlance there is no agreement on the appropriate 'discount rate'). Where land is cleared of native vegetation there is also a loss of biodiversity that involves an implicit opportunity cost. Finally, the transboundary concerns (where environmental impacts cross over different geographic boundaries), and the associated international trade policy discussions through the medium of bodies such as the WTO, highlight the fact that the opportunity cost of degradation is probably not internalized by nations, let alone individual landholders. Once again, the core issue is around maximising value creation by fully understanding, and hence exploiting, the heterogeneity in the demand for and supply of environmental services on private lands.

As stated earlier, value creation, as defined by the boundaries of the customers' WTP and the suppliers' OC, is an important lens by which to view the efficiency component of policy objectives. Difficulties arise because of changing consumer preferences over environmental goods with consequential implications for the willingness-to-pay for environmental assets vis-à-vis other assets. Difficulties also arise because of the complex spatial and temporal biophysical interactions associated with the environment that renders the other side of the value equation – the opportunity cost – ill defined. The connectedness of the environmental landscape, geographically and intertemporally, has implications for the valuation methodologies used to establish both WTP and OC.

Current environmental management policies suffer from three specific problems. Firstly, there is insufficient information on which to make reasonable choices, and there is often an implicit assumption that there are standard benefits from intervention across the landscape (ala duty of care and other command and control measures, totally missing the heterogeneity of types on both sides of the market). Secondly, policy directives have failed to take into account the incentives of individual agents and the way that policy influences behaviour. For example, the introduction of legislation to limit the clearing of vegetation on private land has often resulted in pre-emptive actions by landholders incorporating the future impact of such legislative change in their underlying costs. Finally, the absence of ex-post measurement and accountability processes has limited policy learning and evolution.

[4] See for example the various 'command and control' regulations used to manage the native vegetation and other environmental issues.

5. It's all about information

What ought to be clear from the preceding discussion is that information is at the heart of good economic policy formulation and implementation. We are seeking the "right" intervention at the "right" location at the "least" cost. This amounts to maximising value creation. But in order to rank possible environmental reform agendas we need information in many dimensions.[5] From a societal perspective what is required from our policy makers is a methodology for revealing site-specific information about the trade-offs associated with using natural resources and their impact on the environmental landscape. This amounts to tightening our understanding of the bounds of value creation (the WTP and OC) of landscape interventions that impact on environmental assets. We need mechanisms that reveal information about the connectedness of the environmental landscape (i.e. the multiple benefits associated with land use change at a particular site), and information about the opportunity costs of different agents. That is, in order to maximise value creation we need to exploit the heterogeneity on both the demand and the supply side, and moreover, we need to gather information on this heterogeneity.[6] Some of the information, such as the environmental impact of land use change across time and space, and the value we place on that impact will come from a mixture of scientific methods that explore the biophysical impacts of land use change and mechanisms aimed at accurately aggregating societal preferences over environmental assets. The political economy of establishing the relative weighting placed on biodiversity or salinity or carbon sequestration or any other environmental good seems quite blunt. We need to devise mechanisms to accurately reflect those societal preferences (and sadly contingent valuation tools are unlikely to deliver truthful revelation of consumer preferences). Similarly, on the supply side, information is needed on the opportunity costs of individual agents to deliver land use change, and its associated environmental outcomes. This is where market-based instruments can be particularly useful.

6. Using market-based instruments

Managing the environmental landscape and its implications for policy are in some respects similar to management of any capital asset. It is widely accepted that traditional markets are insufficient institutions where they fail to adequately reflect externalities and social costs. A coherent policy framework must begin with a diagnosis of environmental problems as economic problems. Economists have long recognised that the market process has implications for human behaviour. In redesigning the environmental policy framework we are suggesting recourse to scientific and economic theory to push out the boundary between the marketed and the non-marketed parts of the economy. If they are well designed and operating efficiently, markets provide a harmonization of values decisions and actions. This is the oft-cited discipline of the market process. It is unlikely, given the complex nature of the environment, that markets for environmental goods and services will resemble more familiar institutions such as commodity markets.[7] Markets in the environment, no matter how well designed, will not completely correct the complex issues that underpin missing or incomplete environmental markets. Too frequently, rhetoric about the potential for developing

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[5] A reviewer notes that these dimensions include: (1) Information for setting environmental targets. This requires information on community preferences/values for environmental goods and estimates of the cost imposed by reallocating resources to the environment. (2) Sufficient scientific information to establish the basic relationships between changing environmental quality and how this translates to 'macro' outcomes that matter to society. (3) Information to allow environmental credits/debits to be adequately defined, and (4) Information yielded from monitoring of actual observed changes against a suitable baseline of environmental quality.

[6] The policy maker need only know that there is significant heterogeneity in marginal cost rather than exact costs. Once a scheme is implemented, the market price will indicate the industry marginal cost of meeting the environmental target.

[7] For example, it is inherently difficult for market participants to appraise the quality of the goods (credits) they are buying/selling. Instead, this function is often undertaken through a regulatory process such as a certification or verification scheme.

environmental markets has been simplified and idealized, unduly raising expectations and diminishing the difficulties of the task. This point is made by Pannell [2001].

7. Information may matter, but incomplete property rights are a deal breaker

Markets for environmental assets are replete with issues of informational asymmetries and transaction costs. Thus, not only are there problems around the revelation of information, but that information about parts of the value problem lies in the hands of different agents puts us in the realm of the world of asymmetric information. This complicates, but does not a priori invalidate the use of market-based instruments to deliver the sought after environmental policy objectives. An important precondition for any market-based instrument is a well defined property right. Where such property rights are well defined, such as with point source pollution, there are now many examples of tradeable emission schemes. Tradeable pollution permits allocate the pollution control burden across firms or individuals by using the market as the information exchange mechanism. In this sense, individual firms, not government, make the decision to reduce environmental damage based on the marginal cost of abatement.[8] Some firms will make no change, while others will be able to reduce environmental damage in very cost effective ways and gain by selling pollution credits. These different responses by different firms simply reflect the fact that there is considerable variation in the cost of abatement between firms. Put differently, the tradeable emission market maximizes value creation (relative to say a uniform pollution charge on each firm) by exploiting the heterogeneity of the firms' opportunity costs of abatement and allowing the market to serve as an information exchange mechanism. The tradeable emission market is constructed to allow the economy to discover these differences in abatement costs and take advantage of abatement actions that are low cost. There are now many other examples of such cap and trade schemes.[9]

We need to be careful in overstating the ability to define property rights and trade in them at some future date. The Vegetation Bank proposed by the MDBC may suffer from this. It is not clear that the costs associated with setting up such a scheme would ever be recouped in salinity trading in the future. Not only are the property rights hard to define, the proposed method entails using government funds to top up salinity credits that would then be used to encourage private forestry to make investments in activities that currently do not warrant a commercial return. We noted earlier that missing markets are at the heart of many environmental policy issues. To propose market-based instruments to correct for these missing markets requires an understanding of why those markets are missing in the first place. While it is certainly true that in some contexts developing a mechanism, such as a market of some sort, will yield better environmental outcomes, as with any market, we need to understand the incentives and objectives of the participants in the market. Once again, we need to look at the problem through the lens of value creation. In the case of some proposals, such as Vegetation Bank, we are simply using a subsidy to achieve environmental objectives at a cost that is likely to far outweigh the benefits. Understanding the objectives and incentives of market participants is a cornerstone to effective implementation of market-based instruments. Poorly designed market-based instruments are as worrisome as any other poorly designed policy tool!

The design and public policy issues associated with eco-labelling is now seen as a problem of informational asymmetry between producers and consumers where the impact of production processes on the environment has credence attributes (that is, attributes that cannot be discerned by

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[8] See Tietenberg[1985] for a detailed discussion on emission trading.

[9] As noted by a review another important advantage of permit or tax systems is that they provide a stimulus for technological innovation - which will end up reducing the marginal cost of meeting the environmental targets. Furthermore, off-set schemes, whereby credits can be generated off-site to 'neutralise' the environmental damage caused at a particular site, also have flexibility advantages and can allow economies of scale in the generation of environmental credits.

consumers even after experiencing the good).[10] In such markets, certification schemes can be used to overcome the asymmetric information problem that might otherwise render the market incomplete.

Auctioning of conservation contracts is another example of the practical application of an information perspective to previously intractable environmental management problems. In Victoria, for example, a pilot auction of biodiversity conservation, BushTender, has proven to be an efficient and popular policy mechanism for engaging private landholders in biodiversity conservation. Latacz-Lohmann and Van der Hamsvoort[1997] explain how there is an 'information problem' with respect to the market for environmental goods and services associated with private land. In essence, the relevant set of information with regard to the opportunity cost of land use change rests with farmers, while the willingness-to-pay for that land use change depends on the value ascribed to those environmental assets from a scientific and public policy perspective. Auctions, as with other market mechanisms, can be designed to efficiently reveal and aggregate this diverse information. Note that the success of the BushTender trial hinged critically on attaining and revealing appropriate information. The auction for biodiversity conservation was designed to reveal specific information from the agency responsible for increasing biodiversity conservation and from landholders. As part of the auction, the agency revealed information about the improvement in biodiversity associated with changes in land management (the Habitat Services Score), and the agency revealed some information about the relative conservation status of different areas of vegetation (the Biodiversity Significance Score). This information would significantly improve priority setting for biodiversity conservation, whatever the mechanism employed. The other key factor contributing to the cost-effectiveness of the auction based approach is that it enables an agency to take advantage of the heterogeneity in landholder's opportunity costs. As mentioned earlier, differences may arise because of different preferences, risk profiles, demographics etc.

8. Mechanism design is non-trivial

With all auctions, or indeed any other market-based instrument, attention to design and contract specification is of paramount importance. Klemperer[2002] notes that 'auction design is a matter of horses for courses, not one size fits all'. Efficient auction formats will reflect the objectives of the seller, the nature of the assets, and the specifics of bidder characteristics. For example, avoidance of collusion, the heterogeneity of parcels of land, and bid aggregation issues all impact on agreements that extend over time as is the case with contracts for NRM. It may be unknown, for example, whether the contracted actions have been undertaken. This can be addressed through monitoring and the use of Environmental Management Systems as well as introducing an output based component to compensation. The balance between rewarding on the basis of inputs and outcomes would depend on the relative difficulties of monitoring and measuring these, as well as the risk burden on the supplier. Since the causal links betweens actions and outcomes are not properly understood, scientific research and recourse to detailed Environmental Management Systems may prove useful.

9. Market-based instruments augment, not replace, existing policy mechanisms

That environmental policymakers in the past concentrated on using the extremes of command and control mechanisms and volunteerism to achieve environmental objectives is largely a result of the limited opportunities to expand that policy toolkit. Recent advances in economics, game theory and environmental science have led to the recognition that there may be many other policy tools that help us to solve the question of how to get the right intervention at the right location at the least cost. The key is of course information. Information about the multiple benefits associated with land use change and information about landholders' opportunity costs. Markets, or market-based instruments will often be ideal mechanisms to reveal this information in a relatively parsimonious way. It is important to recognise that the 'optimal' policy approach is almost always going to entail a combination of

[10] See Emons[1997] for a more detailed discussion.

policy tools. Command and control mechanisms, whether the onus for reform lies with the regulator or the regulated (ala duty of care) is important for delineating the boundary of the non-marketed part of the economy. EMS is equally important in establishing credibility in environmental goods and services where the asymmetric information problem due to the credence attributes may otherwise render a market non-existent. Using market-based instruments for pollution trading entailed creating a market in pollution credits, while the market-based instrument of auctions for conservation contracts, is actually trading in actions (or interventions) that landholders take on private lands. The appropriateness of different tools will always be context specific, and in large part will depend on how best information can be revealed in the economy, and how heterogeneity of land and consumer types can be exploited. In some circumstances, such as where land use change has multiple benefits, defining property rights over environmental assets and allowing trading is likely to be far too complex to be workable. However, identifying the multiple benefits, through good science, and allowing an auction to run over well defined actions (such as weed control, fencing, crop rotation etc.) is far more tenable. There may also be circumstances in which the perceived gain from exploiting the heterogeneity of consumer types is outweighed by the cost of constructing a market. In such circumstances, it may make more sense to have a fixed payment scheme for certain actions. Good environmental policy is likely to require a portfolio approach to adopting different policy tools to address the specifics of the environmental problem at hand.

10. Where to from here…

Moving from the command and control world of past environmental policy regimes to one of creating markets for environmental assets is a considerable shift. It is worth noting that the appropriate policy approach for environmental reform is likely to be a portfolio of different mechanisms. Regulation and legislation has an important role to play in clearly delineating the boundaries of the environmental landscape. The thesis of this paper is that we can do better than just drawing such a boundary. Mechanisms such as ‘duty of care’ are useful in not just changing the onus from government to private landholders for environmental management, but in also allowing some flexibility in where the boundary gets drawn under legislative frameworks. This comes with two serious flaws. First, it means that ascertaining where the true boundary lies is subject to interpretation in the courts, and as such makes the property rights of landholders fuzzier. Ill defined property rights, as noted earlier, are a major impediment to value creation because of the large transaction costs associated with their exchange in all parts of the economy. Secondly, and perhaps more seriously, it fails to take advantage of the potential heterogeneity of landholder types in delivering environmental outcomes. Defining a site-specific duty of care is likely to be prohibitively onerous. Duty of care will serve as an effective tool for defining some minimum environmental management standards (based potentially on the precautionary principle) but is unlikely to yield effective outcomes beyond that.

The first step towards market-based instruments for environmental outcomes is the cap and trade process as applied to pollution permits. This is an effective mechanism for exploiting the heterogeneity of opportunity costs of agents so as to achieve a stated cap at the least possible cost. Such a mechanism is predicated on clearly defined property rights and a market institution that allows the trading in such rights. It does not, however, allow for heterogeneity of demand types (or, in the context of land use, the observation that adjacent tracts of land have very different environmental values from a scientific perspective) nor the spatial and intertemporal complexity of land-use change (unlike clearly identifiable point-source emissions). Moreover, it leaves unaddressed the appropriateness of the stated cap.

Using auctions to achieve land use change is a relatively new environmental policy tool. The basic problem of incomplete and asymmetric information that plagues most environmental policy discussions is at the heart of auction theory. In particular, this mechanism, if appropriately designed, exploits both the heterogeneity of landholders’ opportunity costs and forces policy makers to seek information about the different willingness-to-pay for land use change from a scientific and societal perspective. As such, it moves us a long way down the road of maximizing value creation, and changing the boundary between the marketed and the non-marketed part of the economy. The complexity of design, however, should not be understated. Understanding how all the parts of an auction process fit together requires a considered approach to the nature of the assets, the bidders and the way the rules of the auction are designed. An important consideration in any environmental policy mechanism is the ability to evaluate and monitor actions and outcomes, and to see how they stack up relative to the stated efficacy. Market-based instruments provide a great opportunity for not just implementing new policy tools today, but to empirically validate the efficacy of these tools and to adapt them as new information (from science, or consumer preferences) becomes available. In order to do this effectively, recourse to detailed and well defined Environmental Management Systems will be invaluable as a monitoring and evaluating process. The evolution of the use of markets in the environmental policy toolkit requires sufficient flexibility to adapt as new information becomes available. Because such markets are likely to run frequently, they can be continually redesigned in the light of past failures and successes, as well as new opportunities or threats.

Finally, we conclude on a cautionary note. There has been much discussion on the potential use of markets to encourage private sector involvement in environmental management.[11] There are some serious reservations with such policy recommendations. First, and foremost, the premise of this paper and much of the work on using markets for environmental management, is that such markets are currently missing and that trying to create such markets to accurately reflect environmental values that are currently not incorporated in decision making will yield better outcomes. What such discussions presuppose is that the reason such markets are missing is that it is not currently in the interest of any of the agents in the economy to try and establish such market institutions (primarily because property rights over many of the environmental assets are not defined). In advocating auctions for conservation contracts, or land use change more generally, we essentially form a mechanism that enables the value of environmental assets to be established through a market process. The participants in this process are the landholders, and the agency representing the government. These are the players that are at the heart of the value creation story in this realm. Involvement by any other players, such as private sector corporations, will only eventuate from substantial subsidies that enable their participation. The question to ask is how does involvement in environmental management enable private sector corporations to meet their fiduciary duty of maximizing shareholder wealth? If consumer preferences are changing towards environmental assets then a company seen to be 'green' would certainly be interested in being involved in some capacity. Eco-labelling is clearly one policy mechanism that enables governments to try and capture some of the value associated with corporate Australia's interests in appeasing its increasingly green populace. However, if involvement from private sector corporations is merely through a tax-break or some other subsidy payment, then despite the claimed leveraging, we are not at the point where private sector involvement is necessarily a good thing. That is not to say that as markets for environmental assets evolve there won't be a role for private sector corporations, and indeed that in some instances (with well defined property rights) there might well be many companies seeking involvement in environmental management without the lure of lucrative subsidy packages. But let's be careful in what kinds of markets we really think can be created…markets for biodiversity credits, probably not!

[11] See *Repairing the Country: Leveraging Private Sector Investment*, Allen Consulting Group and, *Landscape Change in the Goulburn Broken Catchment*, Alexandra and Associates

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Session 2a: Australian MBI case studies – what can we learn from them?

Auctioning conservation contracts: evaluating Victoria's BushTender Trial

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Abstract

In this paper we provide an analysis of Victoria's BushTender Trial. BushTender is an auction-based approach to allocating conservation contracts that is currently being trialed in two Victorian regions. We analyse the bids provided by landholders. We compare the discriminative price auction to a one-price auction—which is analogous to a fixed-price scheme. We also comment on anecdotal evidence about the likely indirect benefits of BushTender.

1. Introduction

State and Commonwealth governments in Australia collectively allocate significant resources to natural resource and environmental management. Programs such as the Natural Heritage Trust ($1.25 billion over five years), and the National Action Plan for Salinity and Water Quality ($1.4 billion over seven years) demonstrate a substantial and on-going commitment of public organisations to environmental management. These organisations have employed a range of mechanisms, including legislation, planning, market-based approaches, research and development programs and community programs to allocate funds between competing activities.

While many reports have advocated greater use of market-based approaches for environmental management, these have mostly been theoretical rather than practical propositions. This paper reports on the performance of a market-based approach to the problem of allocating funds to biodiversity conservation. The BushTender Trial is an auction-based approach aimed at securing biodiversity conservation contracts on private land.

The following sections of the paper provide a brief overview of the biodiversity conservation problem on private land in Victoria, the rationale for applying auctions to this problem and a summary of key design features for the BushTender Trial. Results from the implementation of the first year of the trial and analysis of the performance of the auction-approach are presented in the final sections.

2. Conservation of biodiversity on private land

There is over one million hectares of native vegetation remaining on private land in Victoria. Much of it is of high conservation significance and it is important for salinity control, water quality, land protection, greenhouse and landscape reasons. Approximately 15 per cent of Victoria's threatened

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[2] Acknowledgments: We wish to thank James Todd, Michael Crowe, Peter Bardsley, Mark Eigenraam, and David Parkes for their ongoing advice.

Disclaimer: The opinion herein is that of the authors, and not the Department of Natural Resources and Environment, nor the Government of Victoria.

vegetation types are reliant *solely* on private land for their survival while another 35 per cent of threatened vegetation types occur *largely* on private land. Biodiversity conservation is dependent upon these private land areas and conserving and enhancing this vegetation requires a permanent change in the way landholders use and manage the remnants on their land.

Even though an important component of the state's biodiversity assets are on private land, NRE (2000) argues that some of the mechanisms used in the past have not adequately addressed the problem of biodiversity decline:

> *'The current set of mechanisms needs to be strengthened to engage larger more commercially oriented farms. A survey across northern Victoria found that up to 80 per cent of the remnant vegetation in the region occurs on these properties but the landholders tend not to be engaged in existing voluntary programs. A new approach is now needed to encourage effective management of native vegetation on these properties. The key objective in this situation is to encourage long-term changes in the use of management of existing remnants on these properties and to support complementary revegetation. In these circumstances, the mechanism most likely to be effective is the establishment of funded management agreements'*

The auction mechanism is being considered as an additional approach to Government-funded intervention in native vegetation management on private land because it has the potential to:

- encourage NRE to more objectively quantify outcomes, including multiple benefits;
- provide landholders with more flexibility in identifying acceptable cost-sharing arrangements;
- maximise cost-effectiveness through market-based procedures; and
- broaden the spectrum of landholders that participate in these activities.

In common with existing programs, this additional approach must also be mindful of how it can most positively influence other issues, for example:

- long-term attitudinal change to conservation management practices;
- balancing community involvement and individual involvement in decision making; and
- balancing the value of Government intervention against the risk of increasing reliance on this intervention.

3. Auctions for biodiversity conservation contracts

Myerson (1999) argues that many of the important issues facing modern economies can be represented as applications of game theory, or more specifically as problems of sharing information in economic systems. This approach has resulted in the introduction of new policy instruments that promise to extend the policy maker's tool-kit for addressing environmental and natural resource management problems. The key insight that differentiates these new tools - from those that are commonly in use - is the realisation that private and hidden information is often the main constraint on policy making, just as it is a constraint on the free and efficient operation of markets for many environmental goods and services. Joseph Stiglitz, in his 2001 Nobel Prize lecture, explains that information is now understood to be fundamentally different from other "commodities." Asymmetric information creates problems that cannot be treated as just another application of general Chicago school principles, using only traditional concepts such as transaction costs, failure of property rights, and marginal costs and benefits of acquiring information. New tools are now available, augmenting the traditional tool-kit, and they are ready to be used in policy design.

Asymmetric information problems are potentially important in many environmental management problems. For example, landholders make decisions using private information that affect environmental outcomes in different areas such as remnant vegetation, dryland salinity, and waterway quality. Government and departments often have information about the relative priority of these areas. However, landholders may not know government priorities, or may understand them only imperfectly.

In addition to the problem of asymmetric information, an environmental agency will often face the problem of imperfect information: the benefits of a policy change will often come in the form of public, or 'non-market' goods. Hence, there are at least three steps that an agency often needs to take in sorting through an environmental issue:

- determine the importance or likely benefits of the policy change using the political process, or some sort of non-market valuation;
- decide on what they can achieve with the different instruments available (the cost-effectiveness of different instruments);
- decide if the cost of the best policy instrument (from step 2) is greater than the implied benefits (from step 1).

Interest in applying auctions to land-use problems has grown because the auction mechanism may help reveal the information needed (by an agency and landholders) to make efficient environmental management choices. Recent applications of economic theory and experimental economics techniques to auction design have improved the performance of auctions, and expanded their application to a broader range of problems. Hence, given the right context, auctions should prove to be a relatively cost-effective option - in step 2 above - if the information problem is critical.

Latacz-Lohmann and Van der Hamsvoot (1998) identified two advantages of employing auctions to environmental management problems involving land-use change. The first is that - as discussed above - auctions reveal information to decision makers. The second advantage of an auction of conservation contracts is that these contracts can be designed to accommodate variable environmental benefits from location to location. Stoneham and Chaudhri (2000) note that each unit of land-use change could deliver different environmental benefits such as unique habitats for plants and animals, carbon sequestration, nutrient interception and individual land management agreements, or contracts, between each landholder and government (society) would be needed to accommodate this diversity.

3.1 Auction design

The use of auctions for addressing environmental management problems has been successful where their designs reflect both the nature of the object in question (eg. homogeneous objective or prize, multiple units, heterogeneous parcels of land) and the objectives of the auction (eg. revenue raising, environmental goals, fostering competition, heterogenous environmental objectives)[3]. Klemperer (2002) notes that "auction design is a matter of horses for courses, not one size fits all".

[3] We apply this theory to the design of the BushTender Trial below.

Formal analysis of auctions in the economic literature is relatively new. Early work on auctions stems from the seminal papers of Friedman (1956) for the case of a single strategic bidder, and Vickrey (1961) for the equilibrium game theoretic approach. The development of appropriate game theoretic tools has made auction theory an increasingly researched topic. The three broad models studied are: the independent private value model of Vickrey (1961), the symmetric common value model of Rothkopf (1969) and Wilson (1969, 1977) and the asymmetric common value model of Wilson (1967).

In auction models, economists use a variety of assumptions. For example, in an auction with many sellers and one buyer, an economist would usually make some assumptions about:

- the set of potential sellers;
- the joint distribution of valuations of these potential sellers;
- the reservation price rule used by the buyer (if relevant);
- bidder uncertainty regarding: the value of the object being auctioned; the strategies likely to be employed by other players; and the characteristics of the other players; and
- the distribution of information across sellers and the buyer.

An understanding of the auction theory (the assumptions of different models and their implications) can assist policy makers design and implement a successful auction. Several important issues that policy makers need to consider include:

- choosing the most relevant model of bidder valuations for use (independent private valuations, symmetric common valuations, or asymmetric common valuations);
- the number; size and distribution of potential bidders, either from a strategic point of view, or from a political point of view;
- the scope for collusion; and
- the scope for secondary markets to change the optimal auction design, reservation price policy, default rules (for penalising false bids), and auction format.

Klemperer argues that we need to take account of an auction’s context, so we can counter several potential inefficiencies due to strategic bidder behaviour, collusion, predatory pricing, and other forms of entry-deterrence.

The key elements of auction design adopted for the BushTender Trial are summarised in the Table 3.1. A more detailed discussion of the rationale for these design features can be found in Latacz-Lohmann and Van der Hamsvoort (1997) and Stoneham and Chaudhri (2000).

Table 3.1: Design features and economic theory

Design element	Rationale
Competitive bidding	Truthful revelation of on-site costs of land-use change.
Price minimisation objective	Competition between bidders facilitates cost-effective outcomes.
Sealed-bid	Repeated open, ascending and uniform-price auctions are generally more susceptible to collusion than are repeated sealed-bid (see Klemperer 2002). Also reduced admin/running costs associated with single/sealed bid approach. Sealed-bid format reduces overall costs where participants are risk-averse (see Riley and Samuelson 1981).
Price discrimination	Where asymmetric information between bidders is evident (independent private values model), the optimal auction system is one where the item on offer is assigned to the lowest bidder (see Myerson 1981). Where heterogenous items are on offer ranking outputs will improve auction efficiency over a uniform-price approach (see Baneth 1994 and Latacz-Lohmann and Van der Hamsvoort 1997).
Individual Management Agreements	Where there are non-standard benefits (ie, benefits that vary from site to stie), individual management agreements, or contracts, developed with landholders will improve auction efficiency (Latacz Lohmann and Van der Hamsvoort 1997).
Progress payments	Normally payments are assumed to be a function of bids only. However, conditional payments will improve auction performance where contracts extend over time (see McAfee and McMillan 1987). Progress auction payments could be perceived by landholders as a more reliable form of income than commodities, and this could conceivably increase participation (also see Price Discrimination, above)
Single round of bidding	When landholders are assumed to have 'independent private value' then each bidder knows precisely the cost of implementing his conservation contract. Each individual bidder is unaware of the value placed on the item by competing bidders but assumes those valuations will be drawn from the same probability function. A landholder who learns about other landholders' valuations would not, generally, change his bid. In this situation, multiple rounds of bidding would not alter individual bids markedly. BushTender is a single round auction.

Design element	Rationale
Sequential or multiple round auction	If the assumption of independent private value is incorrect, then the auction could be improved through sequential or multiple rounds. Stoneham and Chaudhri (2000) have argued that repeated, sequential auctions should be considered for the context under which BushTender operates. However, this additional design feature was not pursued for the pilot, where simplicity for the landholders was considered paramount. If a more expansive version of BushTender were used in the future, then NRE may consider additional auction design features such as sequential or multiple rounds.
Reserve price	A reserve price strategy is less important where there is a budget constraint (see Myerson 1981, Riley and Samuelson 1981). BushTender has a severe budget constraint and (hence) NRE did not use a reserve price.
Limited Information Revelation	Cason et al. (2002) use experimental economics methods to test the impact of full, verses partial, disclosure of information by the environmental agency. They find that partial disclosure generally improves cost-effectiveness of the auction. These findings were incorporated into the BushTender design.

3.2 Implementation of the pilot auction of biodiversity conservation contracts

The Victorian Government allocated a total of $600,000 to BushTender in June 2001. $400,000 of this was earmarked for landholder payments. The rest was used to fund, *inter alia*, project development and management, regional officer visits to properties, communication, and evaluation.

In addition NRE accessed fencing money, that was available via a fencing scheme operating in the trial area, where landholders proposed activities that were consistent with the scheme. This raised the total *potential* budget for BushTender, but the magnitude of additional funding was dependent upon the number of successful bids that contained fencing as part of their management strategy[4].

NRE conducted BushTender in two trial regions, namely parts of the North East and North Central Catchment Management areas (Figures 3.1 and 3.2).

Figure 3.1: North Central trial area

Figure 3.2: North East trial area

The process involved landholders from within the trial areas registering an expression interest in response to NRE's information campaign. NRE responded to expressions of interest by mailing out further information on the scheme and subsequently contacting registered landholders to arrange a property visit. During each visit, field officers assessed the quality and significance of the native vegetation on the site and discussed management options with the landholder.

Landholders then identified the actions they proposed to undertake on the site and with the field officer, prepared an agreed management plan as the basis of their bid. Following the site visit, landholders received a printed draft management plan, a summary of the relative conservation value of their site and their Habitat Service Score as determined by the quality and size of their site and their proposed management commitments.

Each landholder had 14 days from the date they received their draft plan in which to submit their bid. All bids were assessed on the basis of the:

- current conservation value of the site (measured through the 'biodiversity significance score', or BSS);
- amount of service offered by the landholder (measured through the 'habitat services score' or HSS); and
- cost as provided in the landholder bid.

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[4] The constraint on NRE funds is: total payments < $400,000. Hence, the actual budget paid is less than $400,000 due to the 'lumpiness' of total bid amounts, see Section 4.

This information was used to calculate a Biodiversity Benefits Index (BBI) for each site according to the following formula:

$$BBI = \frac{BSS \times HSS}{bid} \qquad (1)$$

Table 3.2 provides some summary statistics about participation in each of the two trial regions. In total there were 126 expressions of interest from within the trial regions. Field officers assessed 116 properties containing 223 sites. Landholders with more than one site on their property were given the option of submitting individual bids for each site or a single bid for all the sites in combination. In total 98 landholders submitted bids.

Table 3.2: Summary statistics of participation in the two trial regions

	North Central	**North East**
Expressions of interest:	63 (in trial area)	63 (in trial area)
Properties assessed:	62	54
Number of sites assessed	104	119
Average sites per property:	1.7	2.2
Total hectares offered:	1,834 ha.	2,011 ha
Number of vegetation types identified/assessed:	20 (out of a possible 25)	18 (out of a possible 25)
Vegetation quality range (score out of 100):	17 - 73	13 - 79
Largest site:	294 hectares	218 hectares
Number of remnant vegetation management proposals:	100	108
Number of revegetation proposals:	4	11

4. Results

Figure 4.1 shows the marginal cost or supply curve for biodiversity from the BushTender Trial[5]. On the horizontal axis is the total quantity of biodiversity in terms of what we have labelled biodiversity quality adjusted (BQ) units. These are the numerator of the BBI as given in (1): the conservation value score times the habitat services score. If an agency were to use a more expansive (spatial and temporal) auction approach then the information in the marginal cost curve could be very valuable: it would enable the agency to efficiently allocate its funds across auction rounds. An agency would perceive those bids on the steep-rising segment of the marginal cost curve as relatively lower ‘value for money’. From this, an agency could more clearly identify the cut-off point from each auction round, presumably by using the equi-marginal principle.

[5] For reasons of confidentiality, we have altered all graphs in this section by doing two things: removing all outliers; and re-scaling the axes.

Figure 4.1: Marginal cost curve

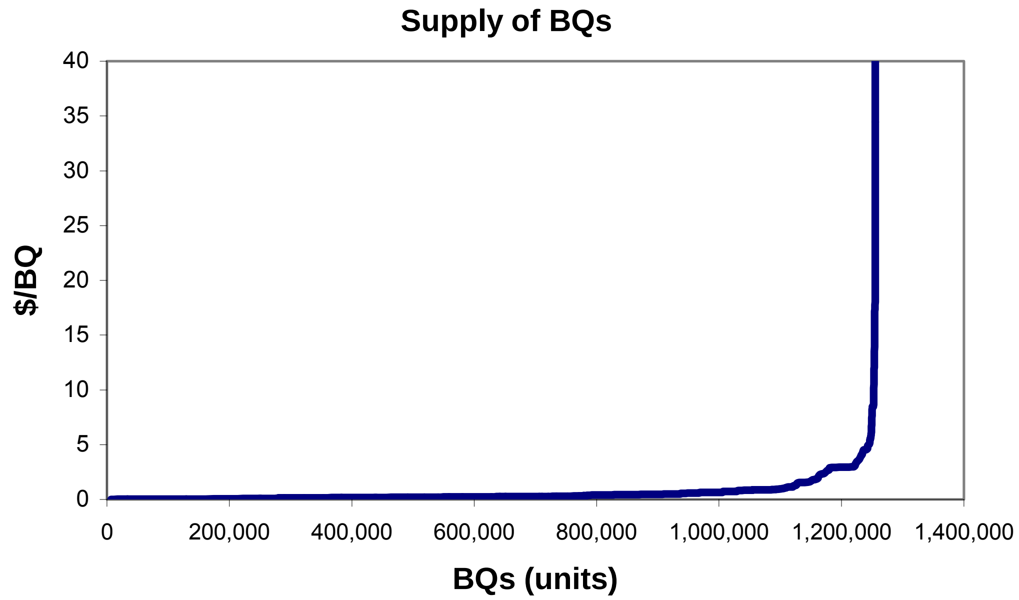

Figure 4.2 shows a scatter of bids, with the threshold-BBI curve (the solid curve). The threshold BBI is the value of the marginal bidder's BBI. The threshold BBI curve shows combinations of HSS/bid and BSS which - when multiplied by each other - equal the threshold-BBI. Bids at the top-right of the figure are high value and low price; they are preferred bids. All those bid points to the right of the threshold-BBI curve are 'successful' bids. NRE currently expects to allocate a total of (approximately) $411,000[6]. The horizontal distance between each bid point, and the threshold-BBI curve, represents NRE's surplus from the contract.

Figure 4.3 shows the natural log of BBI, versus the natural log of its components: HSS, BSS and bid. Since the formula for the BBI - given in (1) - is multiplicative, the log transformation turns the formula into an additive one: the log BBI can be interpreted as log BSS plus log HSS less log bid.

Figure 4.3 illustrates that there is relatively little variability in the BSS, and relatively more variability in HSS and the bids. Hence the BBI is strongly influenced by a landholder's HSS, and his bid: landholders have control over those aspects of the index that highly influence their success in the auction, or otherwise.

[6] This is at 4/2/2002.

Figure 4.2: Threshold-BBI and bid data

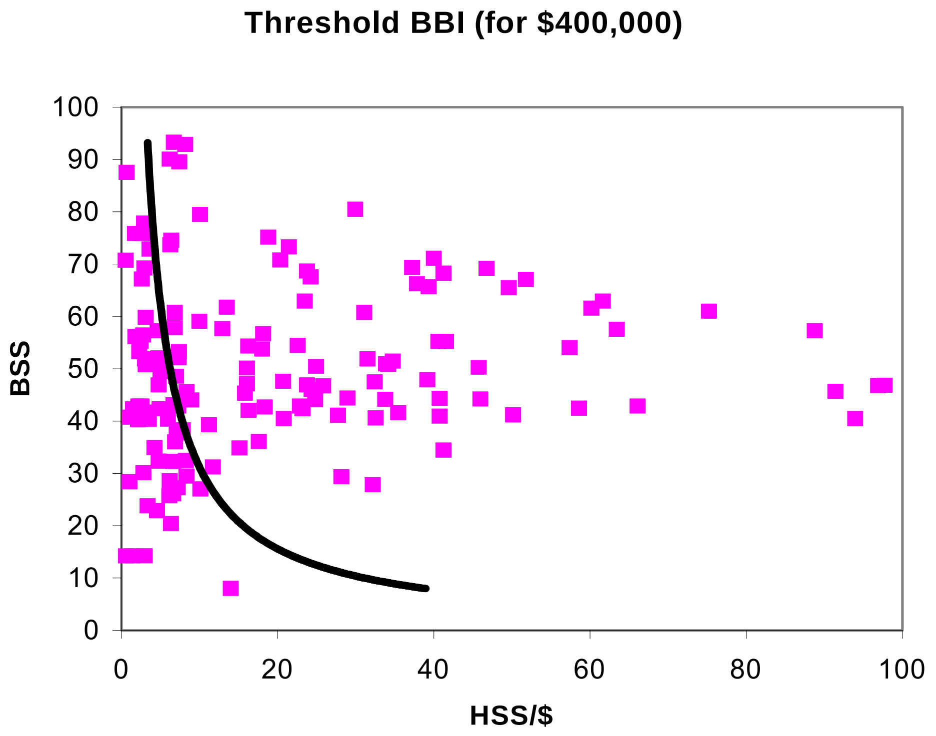

Figure 4.3: Scatter plot of BBI, BSS, HSS, and Bids (all in natural logs)

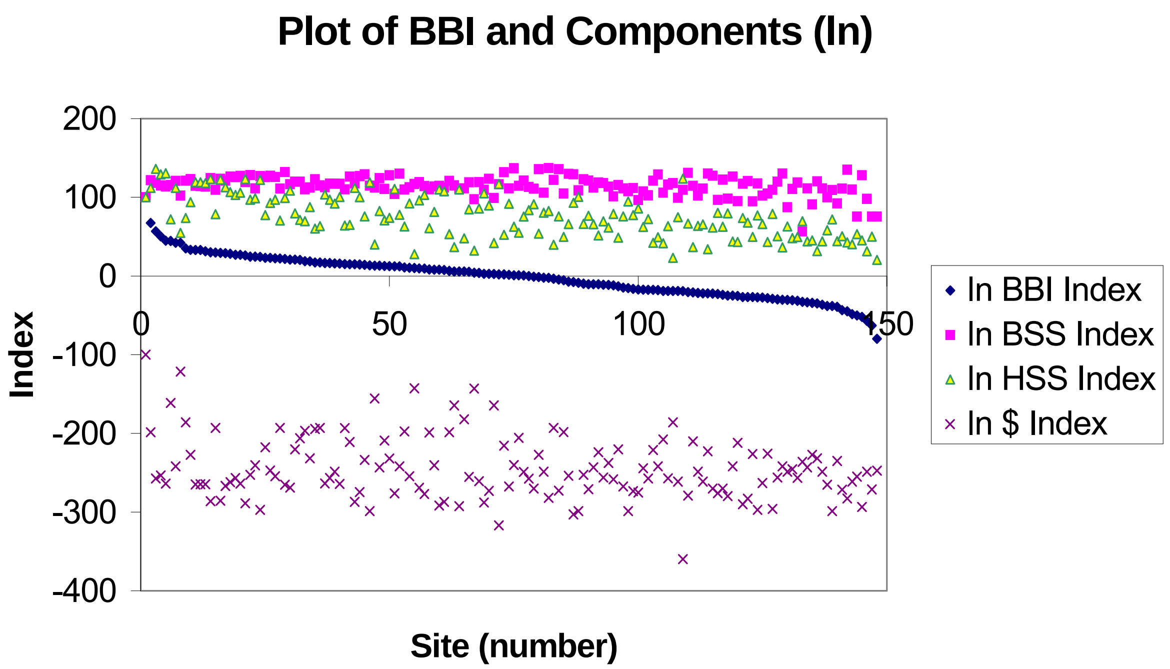

Figure 4.4: Comparison on one-price versus discriminative price auction

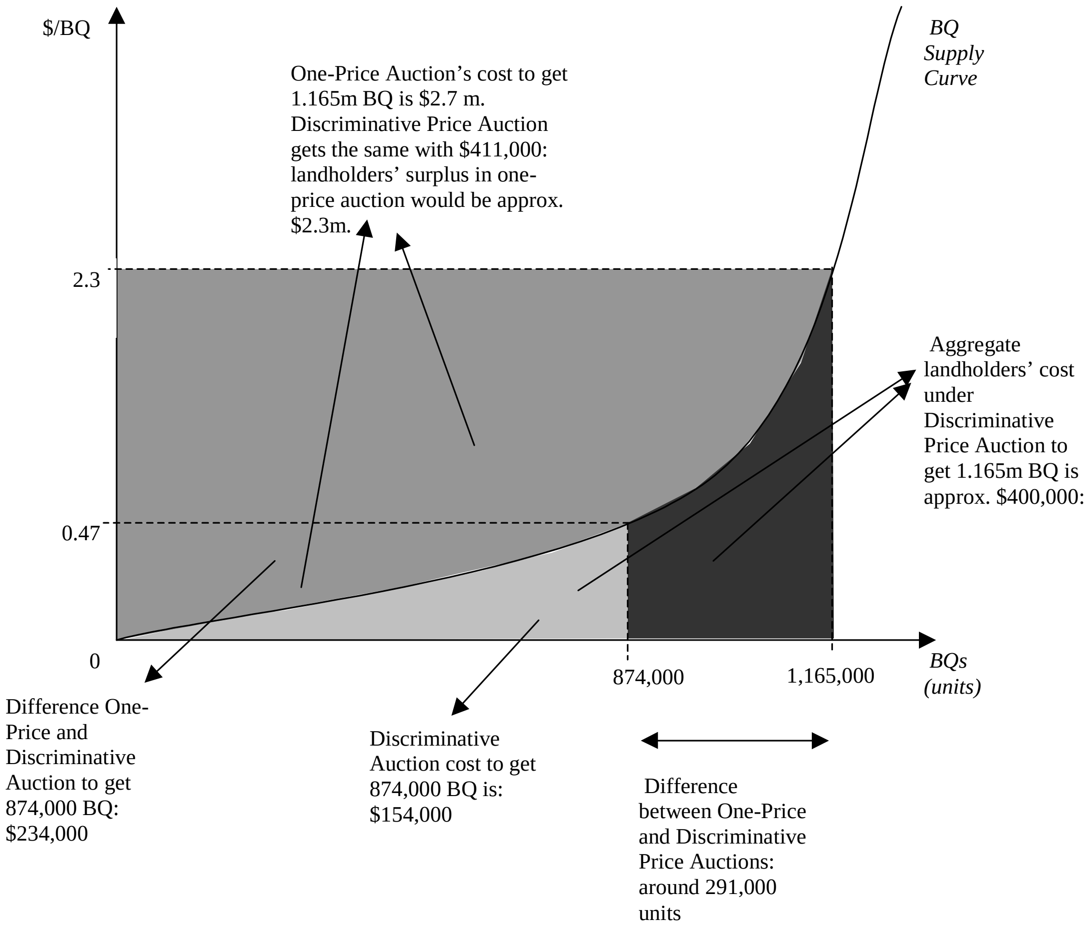

Figure 4.4 is a comparison of the discriminative price auction with a hypothetical one-price auction[7]. In a one-price auction, an agency would pay each successful landholder the same price: the price of the marginal offer[8]. The one-price auction is analogous to a fixed-price scheme.

Figure 4.4 shows that - for the same budget of around $400,000 - a one-price auction give an agency approximately 25 per cent less biodiversity (from 1,165,000 to 874,000 BQ units) than a discriminative price auction. Looked at another way, a one-price auction would require a budget of approximately $2.7 million (almost seven times more than the actual budget) to get the same quantity of BQ units as the discriminative price auction.

5. Discussion

The BushTender Trial has been useful because it has enabled analysis of both the design and implementation of an auction-based approach to biodiversity conservation. The advantages of an auction-based approach such as BushTender to biodiversity conservation arise from both direct and indirect sources.

[7] This comparison is not strictly correct because bidder behaviour would probably be affected by auction design.

[8] 'Price' here is dollars per BQ.

5.1 Direct benefits of BushTender approach

Direct benefits refer to the static economic efficiency gains that arise from more efficient and effective mechanism design (see Table 3.1). We *expect* economic efficiency gains in three areas: information revelation, cost minimisation and contract specification.

5.1.1 Information revelation

The main advantage of the auction is that information is revealed from the relevant parties involved in biodiversity conservation. This approach contrasts with fixed-price offers, where, potentially the wrong information is solicited from the wrong parties: these require the landholder to reveal the actions that they believe will improve the environment (when this information is perhaps held by environmental agencies); and agencies reveal the price that will be paid for these actions (when this information is often held by landholders). The BushTender auction, on the other hand, allows an environmental agency to use information it has to determine the relative biodiversity outcomes of actions proposed by a landholder on any particular site; and it allows landholders to reveal the on-site costs of these actions. This change in the information revelation processes should allow an agency to make better resource allocation decisions, thereby improving economic efficiency and targeting of highest priorities.

During the BushTender Trial, the conservation value of a site (and hence the chance of a bid succeeding) was improved by the presence of any rare/threatened species recorded for the area. Landholders were invited to sign species disclosure agreements if any such records were verified by the field officer. As such, there was an incentive for landholders to disclose the presence of rare species inhabiting their land. In the past landholders may have been reluctant to reveal this information because they feared that this might precipitate future restrictions on the use of this land. Under BushTender, landholders are rewarded (and not penalised) for disclosing information about rare and threatened species and such populations become assets rather than liabilities. Site assessments during the trial revealed a number newly discovered rare plant species populations that, with the landholder's permission, have been entered on the public record. This has provided better information to NRE about biodiversity assets on private land in the two trial areas.

5.1.2 Cost minimisation

BushTender specifically incorporates cost minimisation as the basis of ranking bids. The bid curve presented above is in effect a supply curve for biodiversity on private land. Like supply curves for commodities, the biodiversity supply curve has been derived within a competitive environment, with attention paid to minimising collusive and gaming behaviour of landholders, and maximising the advantage of variation in landholders' opportunity costs.

5.1.3 Contract specification

Recognising that biodiversity services provided by different landholders have non-standard benefits and that landholders have different opportunity costs, individual management plans were completed for potential bidders. NRE has included periodic landholder reporting, random monitoring of sites and sanctions (cessation of payment) in these contracts to ensure landholder compliance.

Auctioning conservation contracts reveals information needed for efficient allocation of resources and facilitates deals between landholders and government. With resources allocated on the basis of better information, and within a competitive environment, an agency should be able to improve the cost-effectiveness of its environmental expenditure.

5.2 Indirect benefits of BushTender approach

The following observations during the trial indicate that - in addition to the direct benefits listed above - indirect benefits could also be an important spin-off from the BushTender approach.

5.2.1 Public decision making

One important observation from the pilot thus far has been the prospect of using information revealed from the auction. Public sector decision-makers anticipate that information about the marginal cost of biodiversity conservation for private land will be able to be compared with the marginal cost of alternative supplies of biodiversity, eg. public land. This will assist public management and resource allocation decisions. Good quality information is being introduced into the economy.

In addition, BushTender has identified the need for Government to determine its conservation preferences 'up front' and to identify and quantify the outcomes of any proposed changed land use according to an objective and repeatable assessment process. This in turn has ensured that agency funding of landholder contracts is relatively visible, defensible and auditable[9].

5.2.2 Trading and off-sets

In limited instances, it may be possible to introduce more flexibility into the economy by allowing degradation of one area of habitat to be offset by purchased habitat improvement through the auction system. Urban development, mines, infrastructure projects such as roads and transmission systems could all benefit from increased flexibility. These behaviours imply value creation because this segment of the economy is now part of the economy that is "marketed".

5.2.3 Education

The amount and type of information provided to landholders during the trial was quite sophisticated. Each participating landholder in the trial was provided with a plan of their proposed site identifying the different vegetation types and management zones, a summary of the site conservation values and a three-year management plan. All landholders also had the opportunity to discuss the quality and management of their site with the field officer during the site assessment. Rarely, has such specific and targeted information been provided through other incentive or extension programs and it is possible that even 'unsuccessful' bidders initiate some of the actions as proposed in their management plan as a result of having learned more about the conservation values of their site.

6. Concluding comments

The following observation can be made about the pilot auction of biodiversity conservation contracts:

Improvements in economic theory - particularly the economics of information and game theory - have developed, and will continue to develop, new policy mechanisms. These mechanisms should allow an environmental agency to shift more environmental problems from the non-marketed to marketed zones of the economy .

The BushTender trial allows NRE to examine the use of one particular mechanism - an auction approach - to the problem of biodiversity on private land. This application adds to the increasing experience of environmental agencies, around the world, who are using mechanisms that take account of the information context of a policy problem. We expect direct efficiency gains from an auction mechanism in this context because it allows an environmental agency and landholders to exchange information that is vital to efficient decision making (by both parties).

In our context, a key aspect of realising such potential efficiency gains is auction design. In this paper we have related auction theory to practical design of the BushTender trial. Taking account of auction theory can help policy makers achieve their aims: auction design theory allows policy makers to tailor an auction to their circumstances. The discriminative-price auction system used in BushTender would seem far superior to a similar scheme that used fixed-price offers.

The BushTender trial potentially provides *indirect* efficiency gains to NRE for several reasons: it allows more flexibility in other policy decisions (such as offsets for infrastructure development); it

[9] Notwithstanding the selective revelation of information by NRE to ensure the auction's cost-effectiveness.

provides education to landholders that may affect their general attitudes towards conservation; and it alters landholders' perceptions about whether rare species on their land are an asset, or a liability.

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What have we learnt from the Hunter River Salinity Trading Scheme?

Simon Smith[1]

1. Introduction

The Hunter River Salinity Trading Scheme (HRSTS) is a tradeable emissions scheme that manages discharges of saline water from coal mines and electricity generators to the Hunter River. Salt levels in the river have improved dramatically since the Scheme's inception. The Scheme's success is built upon achieving conservative water quality objectives while allowing participants to maximise opportunities to discharge salt to the river in a way that minimises environmental management costs. Practical lessons about the implementation of trading schemes have been learned on conceptual design, credit allocation, operating rules and stakeholder involvement. The Scheme is recognised nationally and internationally as a leading edge approach to dealing with an environmental problem, utilising a market-based framework, setting clear environmental targets, tradeable credits and real-time response.

2. The Hunter River and salt

The Hunter River drains the largest coastal catchment in New South Wales, covering some 22,000 square kilometres. The catchment supports a diverse and productive economy, with total annual output from its rural areas exceeding A$4 billion. Known internationally for the quality of its wines, the Hunter also supports a range of other agricultural activities including dairying, vegetables, fodder, beef and horse breeding. Also located in the valley are over 20 of the world's largest coal mines and three power stations including Australia's largest electricity generator. Newcastle, at the river mouth, is the world's largest coal export port.

Salt occurs naturally in many of the rocks and soils of the Hunter Valley. Some of this salt is leached into groundwater and nearby rivers. Salt levels in the river have a critical impact on water quality and agriculture[2].

Human activities have an impact on the saltiness of water in the Hunter Valley. During coal mining, salty water collects in mine pits and shafts and has to be pumped out to allow mining operations to continue. Although much of this water is recycled, in some cases the excess cannot be stored on site. Electricity generation uses large volumes of river water for cooling. As this water evaporates in use, natural salt is concentrated in what remains. Excessive clearing of deep-rooted vegetation and over-application in irrigation can also cause salty groundwater to flow to the surface.

3. The salinity problem

As a result of human activity, salinity in the Hunter River increased significantly through the 1970s and 1980s. Salinity levels were particularly high during periods of dry weather and low river flows.

By the early 1990s there was significant conflict between primary producers and mining operators. Discharges from industry increased salt levels in the river at times making the water unsuitable for irrigation. Up until then, the EPA and its predecessor had regulated industrial salt discharges (e.g. mines and power stations) by issuing 'trickle' discharge licences. Under this traditional licensing approach each polluter could emit a limited amount of pollution defined in the licence and expressed

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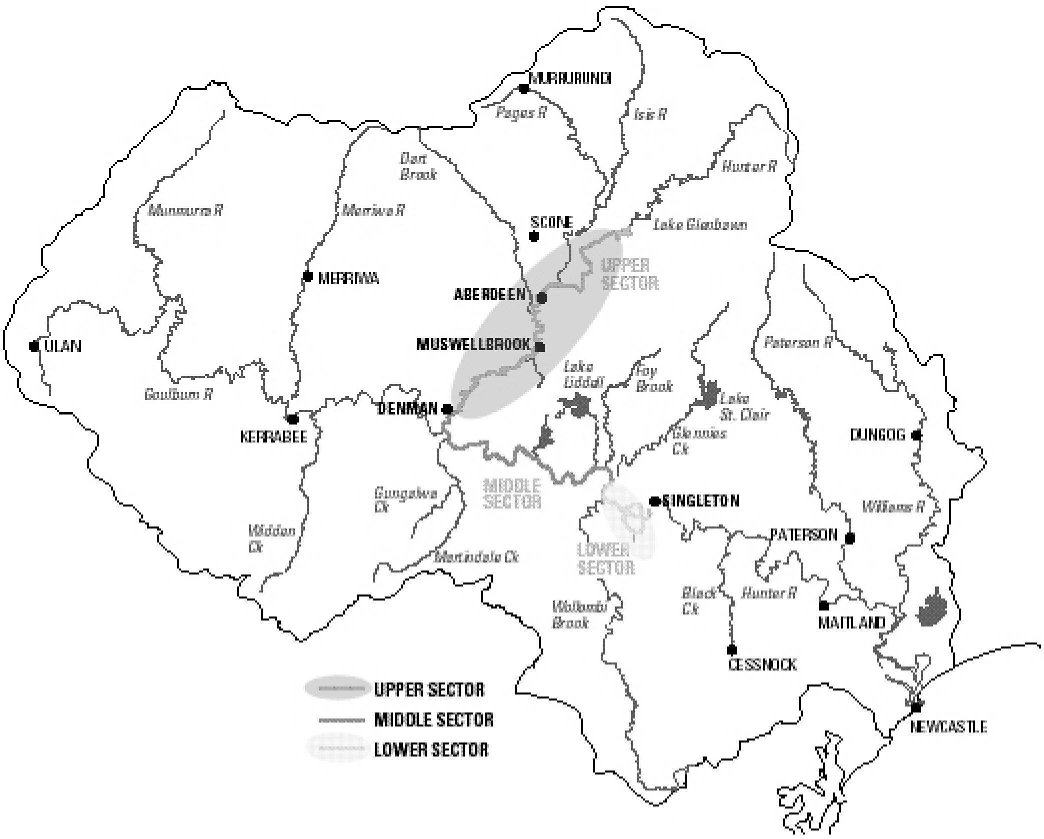
[1] Simon AY Smith, Executive Director - Policy, Economics and Environmental Reporting, NSW Environment Protection Authority

[2] Water salinity is estimated by measuring electrical conductivity (EC). The more salty the water is, the more it conducts electricity. Electrical conductivity is measured in microsiemens per centimetre (μS/cm). Drinking water quality measures between 600EC and 1200EC.

as a concentration limit. Small discharges were allowed at anytime regardless of the salt concentrations in the river. In dry times the river became very salty, and unusable for irrigation when it was needed most. In wet periods with higher water volumes, the river could handle more salt than it was receiving. The end result was high variability in salinity, with no guarantees that acceptable salinity levels could be achieved. Primary producers responded by seeking tighter regulation of emissions. It became almost impossible to open a new mine because controlling salt would have become very costly.

Figure 1. Hunter River catchment



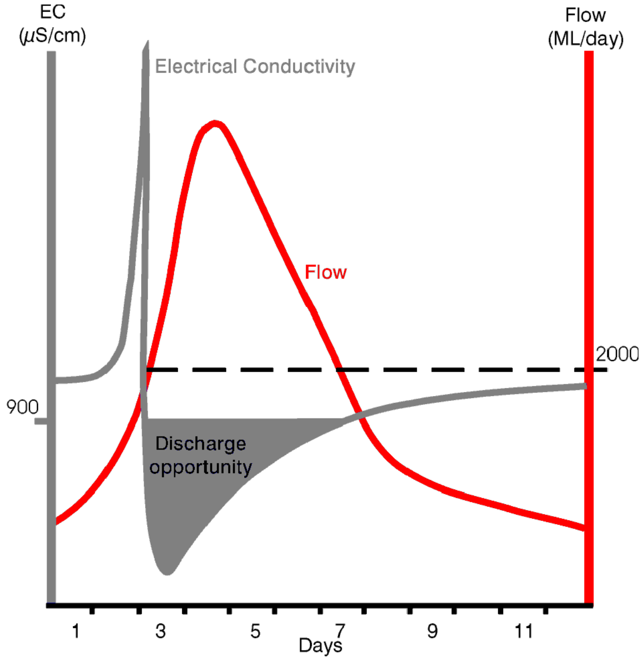
4. Researchers identify an opportunity

As a first step, the then Department of Water Resources (now Department of Infrastructure, Planning and Natural Resources (DIPNR)) began to establish what is now an extensive network of real-time conductivity monitoring stations in the river. At first, the data suggested only that the system was highly variable and complex, with a generally inverse relationship between salinity and river flow.

However, after hydrographers collected and analysed an extensive data set, a clear pattern became evident. During high flows, there is an initial 'spike' of very salty water, usually for around a few hours. This is caused by rising water levels picking up residual salt and salty groundwater left behind after the previous high flow.

After each spike has passed, a period of hours or days of very low salinity was observed as the increased flow diluted the salt concentration. The spike/fresh dynamic ("freshes") in the river is shown in Figure 2. Researchers realised that if discharges of saline water were to be allowed, they would be best to occur in these low salinity periods when their impacts would be minimised.

Figure 2: Structure of a river 'fresh' – optimal time to discharge



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5. Community worked together to develop solution

In attempting to address the community's concerns, a range of options had been investigated for dealing with excess saline water by the then Coal Association (now the NSW Minerals Council). These options included a pipeline to the sea, desalination, storage and evaporation systems and deep well injections. Building on the hydrographers' new information, the Coal Association developed a proposal for a trial of managed discharges, timed to coincide with river 'freshes'.

Mines, power stations and farmers put years of mistrust and conflict behind them to trial this new approach. For its part, the industry agreed that it would greatly step up its accountability and transparency to the community by installing real-time salinity and discharge monitors at each discharge point and making the data available to the community.

One of the positive features of the emerging consensus was that the parties agreed to a quantitative environmental goal - that discharges from industry should never be allowed to cause the river to exceed 900EC. This goal was accepted because it would ensure that river water could be safely used by everyone while at the same time protecting the river. (900EC is fresher than most bottled mineral water.)

The first managed discharge occurred during January and February 1993. As a precaution, irrigators agreed to cease abstractions during the trial, and the EPA allowed much larger than normal discharges to occur. Dischargers agreed to purchase additional dilution flows from the reservoir to keep the river fresh and to flush the system after the discharges. Both the river and the discharges were intensively monitored by DIPNR, which also prepared a report describing what had happened.

Although rain complicated evaluation of the trial's success, the community agreed to develop a permanent solution, and a pilot scheme of managed discharges operated from 1995 to 2002. The EPA adopted an entirely new regulatory approach to implement the pilot, removing pre-existing entitlements that permitted relatively small discharges to occur at any time ('trickle' discharge licences). After several years of success of stabilising salinity levels in the river below 900EC, the Scheme was legally formalised in 2002 through the *Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002.*

6. How the scheme works

The principal idea of the Scheme is to only discharge salt when there is a large quantity of water in the river. This is when the river can best handle it because:

- large amounts of fresh water dilute the salty discharge so the impact on the river is not as great; and
- the increased flow of the river transports salt more quickly to the sea.

6.1 Discharges only allowed in high flows

The River is notionally divided into three sectors, the Upper, Middle and Lower sectors (refer to Figure 1). This reflects the different volumes of water that flow through each sector, and the lower salt tolerance of the Upper sector where flows are the lowest. For example, a high flow in the Upper sector is a flow of more than 1000 megalitres of water per day, whereas it is more than 1800 and more than 2000 megalitres per day for the Middle and Lower sectors, respectively.

Monitoring points along the river measure whether the river is in low flow, high flow or flood flow. When the river is in:

- low flow - no discharges are allowed;
- high flow - limited discharge is allowed. Participants can discharge subject to holding sufficient 'salt credits'; and,
- flood flow - credits are not required for discharging as the high degree of dilution should mean that water quality is not compromised. However, the industry must still ensure that the river salinity targets are met.

The 'Total Allowable Discharge' is the amount of salt that may be added on any given day. This is calculated so that the salt concentration on any day never goes above 900EC in the middle and lower sectors of the river, and never above 600EC in the upper sector. When the river is in flood, unlimited discharges are allowed as long as the salt concentration does not go above 900EC. Members of the Scheme coordinate their discharges so that this goal is achieved.

6.2 River divided into blocks of water

The water in the river is divided into numbered blocks. A block is a section of water that flows past Singleton in a day. For example, block 2003-198 is the block of water that will flow past Singleton on the 198th day of 2003 (17 July). This block of water will flow past other points on the river on different days. For each block, the Scheme operators continually monitor the flow level and the ambient salinity then calculate how much salt can be added to the block (the Total Allowable Discharge) so that salinity stays under the target.

6.3 Credits control salt discharges

All participants in the Scheme are licensed by the Environment Protection Authority (EPA)[3]. There are a total of 1000 salt discharge credits in the Scheme held by participants - different licence holders have different numbers of credits. Licence holders can only discharge salt into a river block in proportion to the credits they hold - 1 credit allows a discharge of 0.1% of the total allowed.

For example, assume that the Total Allowable Discharge for block 2003-198 is 112 tonnes of salt (this ensures 900EC is not exceeded when that block passes Singleton). A licence holder with 20 credits could discharge 2.24 tonnes of salt (112 x 20 x 0.1%), and a licence holder with 45 credits could discharge 5.04 tonnes of salt (112 x 45 x 0.1%) into that block.

[3] Environment Protection Licences are issued to participants under the Protection of the Environment Operations Act 1997, see www.epa.nsw.gov.au

The River Register[4] lists the times when individual licence holders are allowed discharge. Licence holders need to discharge different amounts of salt at different times. Credit trading gives each licence holder the flexibility to increase or decrease their allowable discharge to suit their operating conditions while limiting the combined amount of salt discharged. Therefore, if a licensee needs to discharge more salt at a particular time than they hold credits for, they can purchase additional credits from another licence holder who does not need to use their credits at that time.

The trading system is online, allowing licence holders to trade quickly and simply. The trades can be for one or many blocks (i.e. a single day or longer periods), and the terms of the trade are negotiated privately by the parties involved[5].

7. What underpins the scheme's success

7.1 Setting the environmental goal

The amount of pollution emissions allowed to be emitted in traditional licensing approaches is usually based on 'best available technology'. Older mine facilities could discharge more because the technology available when they started was not as advanced as that available for newer mines. The cost of 'best available technology' meant starting a new mine became prohibitively expensive, limiting the opportunity for more jobs in the region.

Focusing on the environmental goal - keeping salinity under 900EC - gives licence holders flexibility when developing their saline water management strategies. They can choose to combine pollution abatement technologies with salt credits in the most cost effective manner for their organisation. Each licence holder may choose a different strategy, but the combined discharge will not compromise river salinity levels.

7.2 Regulatory framework, monitoring and review

The Environment Protection Licence held by participants defines the discharge points, the maximum amount of discharge and the monitoring and reporting requirements. Any licence holder discharging outside the limits of the Scheme is violating their licence conditions, and penalties apply. The Regulation contains additional safety measures, such as discounting the value of credits if too many are traded into the one river sector.

A Services Coordinator (DIPNR) manages information that underpins the Scheme. Twenty-one monitoring gauges collect information along the length of the river. Every ten minutes measures of river flow and salinity are collated then sent by radio or phone to the central data warehouse. River modeling experts use this information to calculate the Total Allowable Discharge in response to changing river flow and rainfall within the catchment area. The daily River Register (accessible over the internet) notifies each credit holder about the amount of salt that can be discharged, and the start and end times for each release. Participants need to hold sufficient credits to meet their discharge needs.

The Hunter Catchment Management Trust is the Chair of the Scheme's Operations Committee. It brings stakeholders together regularly to review Scheme performance. The Operations Committee includes water users, mining, electricity generation, government and community representatives.

8. Allocating credits

Credits were first allocated free of charge to existing licence holders, based on a formula that took into account the environmental performance, salty water byproduct, employment and economic

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[4] The River Register is accessible for scheme members through scheme's website. The website also provides the credit exchange as well as general access to the credit register and other information on the trading scheme.

[5] The website for online trading is located at www.epa.nsw.gov.au/hrsts

output of each licence holder (credits issued based on existing entitlements is known as 'grandfathering'). Credits were then reissued when the Regulation was introduced.

The credits, issued under the Regulation, have different life spans:

- 200 expire on 30 June 2004;
- 200 expire on 30 June 2006;
- 200 expire on 30 June 2008;
- 200 expire on 30 June 2010; and,
- 200 expire on 30 June 2012.

Every two years 200 new credits will be created to replace those that have expired. These new credits will all have a lifespan of 10 years. For example, the first 200 credits auctioned will span block 2004/183 (1 July 2004) to block 2014/181 (30 June 2014). This arrangement means that 200 new credits will be available every two years into the future, but the total number of active credits is limited to 1000. The new credits will be sold by public auction. The advantage of a public auction is that it can reveal the market value of credits.

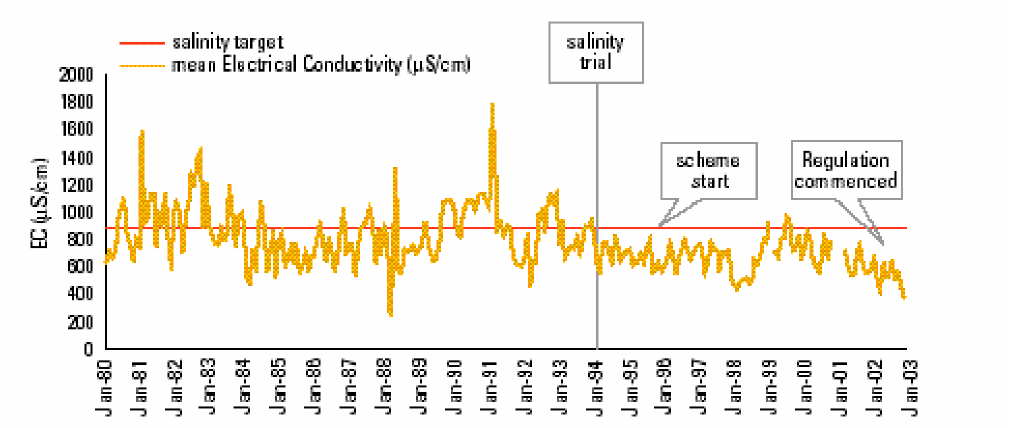
New industry can enter the Scheme by buying credits at auction, or by acquiring credits directly from other Scheme participants. New entrants will also be able to apply to the EPA for allocation of 85 residual credits that have been retained by the EPA.

Licence holders can choose the most cost-effective strategy for their operation. They can either

- buy more credits; or.
- implement cleaner technology or practices so that they need fewer credits.

The long life span of credits allows industry to plan ahead and adjust their processes over time. The result is that environmental outcomes are achieved at least cost to the community.

Figure 3. Electrical conductivity at Singleton 1980 to 2002 (monthly means)



9. Success of the scheme

Figure 3 shows that the target of 900 EC has been achieved. Between 1995 and 2001, credit holders have discharged the equivalent of over 59,203 tonnes of salt while the water quality goal has been met.

This improvement in salinity levels has occurred despite the drier than average weather pattern in the first few years of the Scheme's operation. The figure shows that in previous dry spells (early 1980s and again in the early 1990s) salinity levels were very high. These have not been repeated while the Scheme has been in operation (which has been similarly dry except for some of 1998/99). While occasional local and short-term exceedences do still occur, these are caused by diffuse sources of saline runoff other than industry.

Importantly, new mines can readily be granted discharge licences without compromising environmental outcomes, with significant economic and employment benefits for the valley.

10. Recent improvements

Protection has been given to the river environment under recent improvements to the Scheme introduced through the Regulation. In the Upper sector of the river, where new development is most likely to occur, the river flow threshold for low flows has been increased from 600 megalitres per day (ML/day) to 1000 ML/day, preventing industry from discharging when irrigation is most likely and river conditions are most critical. The flood flow threshold for the Upper sector has also been increased from 2000 ML/day to 4000 ML/day, so that credits are required to manage discharge on more days than under the pilot scheme.

Protection has also been given to all river sectors during flood flows by requiring industry to co-ordinate discharges during these flows to meet the salinity targets in all river sectors. If the targets during flood flows are not met due to industry discharges, under the Scheme's rules the EPA can extend credit trading to cover all discharges (this would include flood flow discharges).

The Scheme is now operating on a full-cost recovery basis. Participants are paying an annual contribution for the services provided in conjunction with the Scheme, such as river monitoring, modeling and reporting, and maintaining the river register. Total Scheme costs are to be split between discharge licence holders and credit holders (credit holders do not necessarily have a licence as credits can be purchased by the public through the auctions). Proceeds from credits sold to participants at auction will be deducted from the total annual contributions payable by participants.

11. Key lessons learned

The Hunter River Salinity Trading Scheme demonstrates that when environmental goals are clearly defined, a well-designed economic instrument within a supporting regulatory framework, can very effectively achieve those goals. Key lessons learned from the Scheme are:

- Clear definition of the environment goal or output of the scheme is paramount.
- The scheme's rules must be carefully defined so as not to undermine achievement of this goal.
- A regulatory framework is essential to underpin the integrity of such a scheme.
- Effective consultation and stakeholder involvement is important to get industry ownership of the scheme and a good level of satisfaction amongst all stakeholders.
- The EPA developed an on-line credit exchange facility system to ensure fast, efficient, 24-hour credit transfers. This allows participants to respond to discharge opportunities even when discharge events occur outside business hours. An unforeseen benefit of this tool has been that participants now have a better understanding of the Scheme rules.
- An extended pilot period was necessary to demonstrate that the Scheme would work. Based on the experience of the pilot it was possible to improve and finalise the Scheme.
- It was necessary to gradually remove the grandfathered entitlements of the original licence holders to enable new industry and development to participate in the Scheme. Grandfathered credits are being progressively withdrawn and reallocated by auction over 8 years.

Session 2b: New MBIs: Short papers from poster paper prize winners

Experience with market-based approaches to climate change regulation in the Australian electricity industry

Iain MacGill, Hugh Outhred and Karel Nolles[1]

Abstract

There is growing worldwide interest in the use of market-based instruments to achieve environmental policy objectives. To date there is only limited experience with their practical application. Australia, however, has been an early and enthusiastic adopter of market-based instruments for climate change regulation of its electricity industry. In this paper we outline some of these recent developments. In particular, we consider the policy objectives, design and experience to date with market-based electricity industry restructuring, the Federal Mandatory Renewable Energy Target (MRET), the NSW Greenhouse Benchmarks and Government accredited Greenpower. The mixed performance of these Australian schemes to date illustrates the need for great care in designing such market-based approaches.

1. Introduction

The last three decades has seen growing interest in the implementation of environmental policy through market-based instruments that take advantage of the efficiency of the market process in order to deliver desired environmental outcomes (Montgomery, 1972; IEA, 2002).

Such approaches would seem to offer important efficiency and flexibility advantages over traditional *technical* ‘command and control’ regulation, and non-tradeable *financial* mechanisms such as pollution taxes. Their use has been proposed, and in a relatively small number of cases implemented, for a diverse range of environmental problems including regional air pollution from SOx and NOx, greenhouse gas emissions, water pollutants such as phosphorus and salt, and a range of land-use management challenges that include biodiversity conservation and dry-land salinity.

However, there is only limited experience with market-based instruments to date, and serious questions for policy makers to consider when designing and implementing such schemes. Australia’s early and enthusiastic adoption of market-based approaches to climate change regulation in the Australian electricity industry is of interest in these regards. In this paper, we outline some of these recent policy developments, and their outcomes to date.

We first consider the restructuring of the Australian electricity industry over the last decade from state-owned monopoly utilities towards a competitive National Electricity Market. Whilst this restructuring was not driven by environmental objectives, it is relevant for a number of reasons. First, there was an expectation by at least some key policy makers that it would improve the greenhouse performance of the Australian electricity industry. Also, electricity is not a natural fit to commodity style markets – as such, it requires a ‘designer’ market and there are parallels between this and the design of environmental markets. Finally, this electricity industry restructuring sets the context

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within which market-based instruments have been implemented and has been a major driver for their use.

We then outline three recent Australian policy measures where market-based instruments are being used to regulate or influence the greenhouse performance of the electricity industry. These are the Federal Mandatory Renewable Energy Target (MRET), the NSW Greenhouse Benchmarks Scheme and Government accredited Greenpower. The policy objectives, instrument design and experiences to date with each of these measures are described.

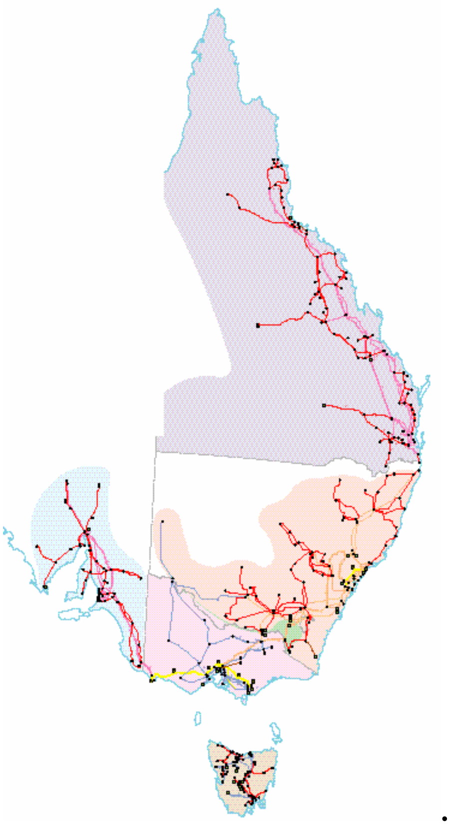
We conclude by presenting some of the key design lessons that have been identified so far from the implementation and performance of electricity industry restructuring and these three market-based instruments.

2. Electricity industry restructuring

Mitigating climate change is one of three nationally agreed energy policy objectives (COAG, 2002). Restructuring of the electricity industry has, however, been primarily driven by economic reform objectives; for example, the Code for Australia's National Electricity Market (NEM) has no specific environmental objectives. This NEM now covers five states and territories home to around 90% of the Australian population, as shown in Figure 1.

There was, nevertheless, some expectation that restructuring would also help reduce greenhouse emissions through competition and more rational energy investment (Commonwealth of Australia, 1997). Unfortunately, projections now suggest this will not be achieved for reasons including low coal generation costs, excess generating capacity, reduced energy efficiency efforts because of lower prices, the failure to price environmental externalities, a market design that favours incumbents and the supply-side orientation of reforms to date (MacGill et al, 2003).

Figure 1. The Australian National Electricity Market (NEM). (Taken from www.nemmco.com.au)



International experience with restructuring has also highlighted the impacts of pre-existing circumstances and resource endowments on environmental outcomes (IPCC, 2001). However, some of the reasons for the failure of Australian restructuring to deliver greenhouse emission reductions appear to be a more fundamental outcome of the market design process itself.

Electricity is an 'unusual' commodity. Supply must exactly match demand at all times and all locations within the power network, even though large-scale storage is not available. The value of electricity can therefore vary greatly by location and time. Electricity markets are 'designer' markets in attempting to match a reasonable commercial model to the complex physical realities of power system operation. In the case of restructuring in Australia, designers would seem to have been guided more by historical arrangements and the preferences of the incumbents, than the importance of creating a level playing field for new entrants and generation technologies.

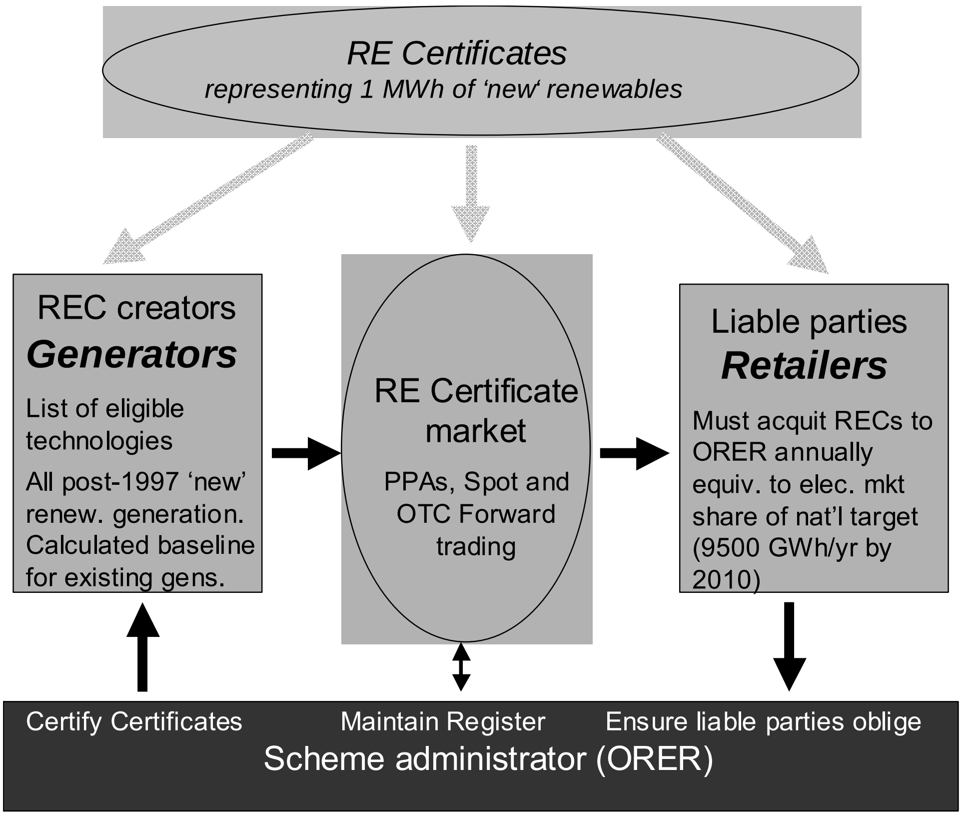
Thus, electricity restructuring does not, in itself guarantee environmental improvements. It may, however, improve responsiveness to price signals from market-based regulation (IPCC, 2001)

3. Federal Mandatory Renewable Energy Target (MRET)

The MRET scheme requires all Australian electricity retailers and wholesale customers to source an increasing amount of their electricity from 'new' renewable generation. Its stated objectives are to encourage additional renewable generation, reduce greenhouse emissions and ensure that renewable energy sources are ecologically sustainable (ORER, 2003).

This 'baseline and credit' scheme is designed around Renewable Energy Certificates (RECs) representing 1 MWh from 'new' renewables, as shown in Figure 2. This generation can come from either new (post January 1997) generators or by increasing the output from existing generators above a calculated annual baseline. Eligible sources include hydro, biomass, wind, solar thermal generation, photovoltaics and solar hot water systems.

Figure 2. Scheme design for the Australian Mandatory Renewable Energy Target (MRET).



The original target of an additional 2% from renewable sources by 2010 was translated to a fixed national target of 9500GWh in 2010. This target is divided across electricity retailers and wholesale market customers according to their share of overall Australian electricity sales. A penalty of A$40/MWh is charged to liable parties who fail to meet their individual annual target beyond an allowable buffer that can be carried forward to next year. MRET is therefore a hybrid trading and taxation instrument.

The scheme is administered by the Office of the Renewable Energy Regulator (ORER). This regulator runs the REC registry but doesn't formally provide any trading arrangements. Power Purchase Agreements (PPAs) and OTC trading between generators and liable parties are both used – an internet-based spot market, the Green Electricity Market (GEM) was established by some of the major Australian energy companies but has recently ceased operation.

MRET has been operating for over two years. Liable parties have comfortably met the targets to date, and the scheme has driven development of a number of new renewable projects. There is certainly competition between project proposals that should help drive down costs, and a viable forward market would also seem to be developing.

The technology 'neutrality' of the scheme has also proved valuable. Some early projections of the likely generation mix driven by the scheme suggested a very major role for biomass. In practice, numerous proposed biomass projects have encountered difficulties, and the market has redirected its attention towards wind projects.

However, a range of problems have also emerged, including (MacGill, 2003):

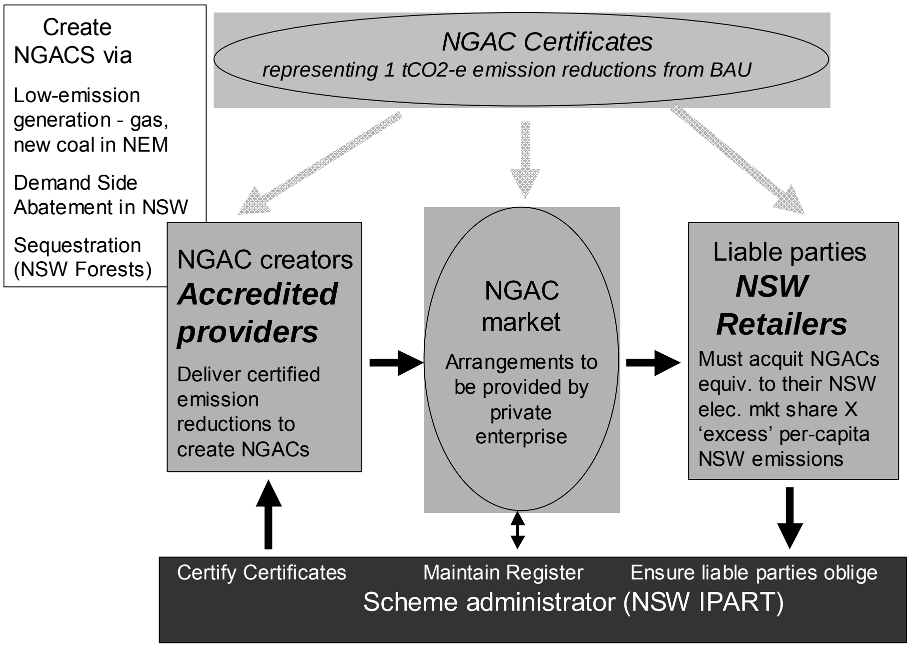
- a view by some key stakeholders that the 9500GWh target for 2010 is too low to meet the objectives of the scheme;
- the likelihood that the total electricity demand projections used for translating the 2% target to 9500GWh under-estimated demand growth. This means that MRET will not deliver an additional 2% of renewable energy as intended;
- concerns by some stakeholders that MRET provides no significant market impetus for important, yet currently high cost, photovoltaic technologies;
- opposition to the classification of biomass from native forests as a renewable energy source;
- baselines for some existing large-scale hydro appear to have been set below their long-run average system yields. They may therefore be able to earn RECs without making additional investment. They also benefit from natural annual variability, earning RECs in years when output is above baseline, yet not 'losing' them when output falls below. Some 35% of the MRET target may be met this way according to the Australian Business Council for Sustainable Energy (BCSE, 2002);
- price uncertainty from only a single annual acquittal of RECs to ORER. Also generators are permitted to register RECs at any time after their creation – this information asymmetry could advantage some large suppliers; and,
- investment uncertainty with the recent COAG Review recommendation to scrap the scheme (Outhred et al, 2002). This has damaged the prospects of numerous proposed renewable projects.

4. The NSW Benchmarks Scheme

This scheme sets greenhouse reductions benchmarks for NSW electricity retailers based on an 'imputed' per-capita electricity related emissions target for the State. Its stated policy intent is to reduce "greenhouse gas emissions created through NSW electricity consumption" (NSW Government, 2001).

The tradeable instruments are NSW Greenhouse Abatement Certificates (NGACs) representing a notional 'avoided' tCO_2-e emissions, as shown in Figure 3. Abatement activities include certified low-emission generation, energy efficiency and sequestration. All of these activities require the establishment of business-as-usual (BAU) baselines from which emission reductions can then be calculated. Retailers and large customers who elect to participate directly in the scheme are given NGAC obligations according to their share of electricity sales in NSW.

Figure 3: Scheme design for the NSW Electricity Retailer Benchmarks.



The scheme only commenced operation in January 2003 and work still continues on some aspects of scheme design and implementation. It certainly represents an ambitious attempt to introduce a Statewide pricing signal for the electricity, and related, sectors. There is already some early market activity in forward trading of NGACs, even though the scheme's measurement and verification methodologies are not yet all in place.

However, there are some serious concerns about the likely performance of the NSW Benchmarks for reasons including (MacGill et al, 2003):

- its use of 'imputed' rather than physical emissions – the two may diverge;
- the very different activities – low emission generation, demand side abatement and sequestration – that can generate NGACs. This assumes that all activities are measurable and fungible (tradeable);
- baselines have to be estimated for this wide range of possible activities. It is difficult to ensure that only activities additional to BAU progress will be credited, particularly with demand side abatement actions;
- double counting across policy measures may allow the scheme to 'free-ride' off other existing policy measures; for example, NSW retailer's MRET obligations can be counted towards their benchmark targets;
- the unwieldy complexity of 'imputed' emissions and baselines; and,
- jurisdictional overreach –the scheme allows low emission generation anywhere in the NEM to be counted as contributing to NSW abatement.

5. Greenpower

Greenpower schemes allow consumers to voluntarily pay a premium for electricity from ‘green’ sources. Because networks ‘mix’ all generation, green power can’t be physically delivered to the purchaser. Instead, these schemes are generally designed so that retailers contract with ‘green’ generators to cover the volume sold to customers. This necessary abstraction creates a challenge in counting and certifying premium price green power from different types of new and existing green sources. In particular, most electricity industries already have some renewable generation in place, typically large hydro, while Greenpower customers are motivated by the desire to support *increased* renewables.

External auditing can increase consumer confidence in such arrangements. Australia has a State government backed accreditation scheme with the stated policy objective of “..promot[ing] the installation of new green electricity generators by increasing consumer demand and confidence in Greenpower products” (Greenpower, 2003).

The scheme requires an increasing amount of greenpower to be sourced from ‘new’ (post 1997) generators. Biomass generation from native forests is not accepted. Forward trading of renewable power between accredited generators and retailers with Greenpower schemes has emerged.

Over 95% of Australian electricity consumers now have access to accredited Greenpower. Schemes vary amongst retailers in terms of the proportion of Greenpower that customers can choose to buy, and the types of renewable generation that is sourced. Premiums can be some 60% higher than usual tariffs for 100% Greenpower products.

The main challenge appears to be limited customer interest. Less than 1% of Australian customers have chosen Greenpower products, and it accounts for less than half of one percent of total electricity sales.

6. Key lessons to date

A number of important market design lessons would seem to have emerged from these experiences to date with Australia’s electricity industry restructuring and market-based environmental instruments for climate change. These include:

- restructured electricity industries will not necessarily deliver improved environmental performance, and market designs must take care not to favour the incumbent participants and technologies against new entrants and alternative, largely distributed and environmentally superior, technologies;
- numerous abstractions and design choices are required when implementing market-based tools, and these can have a marked impact on scheme effectiveness and efficiency;
- setting appropriate baselines in ‘baseline and credit’ schemes to ensure additionality is particularly problematic, and moral hazards arise for policy makers during this process;
- the broad reach of some market-based tools increases the potential for them to interact with other policy measures in ways that reduce their environmental effectiveness;
- there are serious ‘market for lemons’ risks with tradable instruments that have measurement, verification and additionality difficulties – ‘poor quality’ yet low-cost projects can crowd out more expensive yet ‘high quality’ activities,
- creating transparent, liquid markets for these schemes that allow efficient price discovery and risk management by participants can be challenging; and,
- these market-based instruments represent an environmental policy intent that may change over time. This regulatory uncertainty creates risks for participants that can have a chilling effect on the effectiveness and efficiency of such markets.

In conclusion, and as the IEA (2002) has also observed, it is proving harder to effectively design and implement these market-based tools than many had expected because of the complex framework required to effectively exploit their flexibility and efficiency.

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Conservation Auctions and Land Management Tenders

Di Bentely, and Warwick Moss[1]

1. Introduction

The Liverpool Plains, on the Upper Namoi River in North-West New South Wales, is a diverse and highly productive agricultural region of 1.2 million hectares. However the clearing of native vegetation and changes in land management have resulted in significant changes to the structure and function of ecosystems in the catchment.

The Liverpool Plains Land Management Committee (LPLMC) is an autonomous, community based organization formed in 1992 to promote sustainable natural resource management. The early work of the Committee focused on encouraging and facilitating scientific research and because of this, the Liverpool Plains is one of the best researched and understood catchments in Australia. This scientific knowledge and understanding, together with landholder expertise, has now been incorporated into a catchment plan – the Liverpool Plains Catchment Investment Strategy (LPCIS).

The LPCIS recommends management actions to overcome the six major natural resource issues identified by the local community. These issues are soil conservation, dryland salinity, water quality and quantity, riparian zone management, floodplain management and biodiversity.

The effective management of these problems frequently requires action to be taken some distance away – sometimes on different properties. That is, many farmers are asked to take action and incur expense for the benefit of other farmers or for the broader community. In effect, these farmers are providing a service – sometimes called an Ecosystem Service. In implementing its Strategy, the LPLMC is exploring different methods of paying farmers for this service including Devolved Grants and, for the first time in New South Wales, Natural Resource Auctions. The Committee is also investigating the application of accredited Environmental Management Systems (EMS) which were identified by LPLMC in 1998 as having the potential, through product differentiation, to give farmers access to consumer markets demanding sustainably produced goods.

This work parallels the search by government and land management agencies for cost-effective tools to implement a range of strategies and plans and the subsequent increasing utilisation of market-based instruments (MBIs). These involve market creation or market correction through, for example, tradable permits, differential fees and rates, tax incentives, investment vehicles and ecosystem service auctions. The MBI approach stems from clearly established market failure in environmental and land management problems and the belief that a market-based approach is more likely to lead to economically efficient and cost effective outcomes.

This paper focuses on Natural Resource Auctions, called Land Management Tenders (LMTs), and their use by the LPLMC. The approach is to auction contracts, which are funded and binding, to land managers who agree to change their land management or land use to be consistent with the aims of the LPCIS.

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2. Land Management Tenders

The trial of LMTs in the Liverpool Plains was the culmination of negotiations between the World Wide Fund for Nature (WWF) and the LPLMC, its inspiration being the United States Conservation Reserve Program (CRP) and the Victorian BushTender trial. Funding was provided by the WWF, the NSW State Salinity Strategy and the Commonwealth's Natural Heritage Trust.

The reason for choosing tenders was that they possess a number of characteristics which provide opportunities to overcome some of the traditional problems limiting the effectiveness of funding for natural resource management. For example, tenders are seen to have the ability to reveal information that is otherwise too difficult or too expensive to obtain, but necessary to an efficient and effective funding program. Funding bodies (the buyers) and landholders (the sellers) each hold quite different sets of information about strategic goals and the real costs of achieving them but, in the past, have had no mechanism to reconcile these sets of information to establish appropriate levels of funding. Tenders overcome this problem by allowing required outcomes to be clearly articulated by buyers and an informed price to be set by sellers.

The tender system also allows for multiple benefits (the same land use change can impact on a number of different natural resource issues) and non-standard values (the same unit of work can result in different outcomes – depending on where in the landscape it is undertaken). Two rounds of tenders have been conducted to date and both have dealt with multiple benefits. The first round focused on dryland salinity amelioration and biodiversity conservation, while the second included water quality in addition to the first two issues.

As mentioned, this type of auction has been used in the United States of America and Victoria, as well as this trial in the Liverpool Plains. The conservation auction system has been used in quite different ways in each of these, which makes the lessons learnt from each very useful to future auction work. The CRP focused on erosion and cropping land whereas the BushTender focused on remnant vegetation. In contrast the Liverpool Plains has taken a multiple land use, whole of landscape approach. The broadening of application and eligibility criteria and particularly the inclusion of multiple issues differentiates the Land Management Tenders from the other examples. This adds significant complexity to the auction system and the task of effective comparison between projects becomes more difficult as their aims, locations and activities become more varied.

Although the literature on auction theory is extensive, the application of this theory by a community group and at a regional level is constrained by many factors and presents a number of challenges. The most important of these are staff numbers and capacity, the availability of appropriate scientific, biophysical data – even in a well researched catchment – and the short term nature of available funding and other resources.

Funding projects is easy, funding the right projects is fundamentally more difficult! A significant challenge is to compare a range of projects varying, amongst other factors, in their position in the landscape, the relative importance of their natural resource issues, the size and extent of the project and the planned project activities. The auction process relies heavily on knowing what activities are required where in a catchment to lead to environmental improvement. Projects applying good or improved practice in high priority areas will be seen as providing benefits.

Consequently, it is important to develop an assessment methodology which provides confidence that it will lead to well developed projects likely to deliver the required outcomes, will provide for effective, objective assessment and be as efficient as possible.

3. The Environmental Benefits Index

In order to assess the benefits provided by the projects, the LPLMC developed and applied an Environmental Benefits Index (EBI). The basic purpose of the EBI is to provide a relative measure of the contribution of a project to the achievement of pre-determined objectives for the auction. The index is supported by assessments which classify biophysical states using relative numbers which allow the calculation of index scores. It is this transformation of often qualitative information to quantitative values which is crucial to the implementation of the EBI. It is also important to understand that the EBI and the auction itself is merely a tool for expressing priorities for action on the ground. It allows projects submitted in the auction to be assessed independently and objectively and to be immediately comparable despite potentially large structural, spatial and temporal differences.

There are several criteria that will determine the effective and equitable function of an EBI:

- Each assessment should be rigorous and appropriate to the aims of the auction and the science that lies behind the prioritisation of an issue.
- The EBI provides relative, rather than absolute rankings, however differing results should represent real and important differences between projects and their ability to deliver the outcomes required by the funding organization.
- The criteria for scoring should be appropriately documented prior to assessment and strategies for dealing with assessment grey-areas established.
- Individual assessment scores should be combined by calculations that give weight to projects that adhere to the transparent priorities of the funding organisation
- The effect of using additive or multiplicative calculations needs to be carefully assessed and understood, as does the impact of including unbounded factors (such as area) among bounded ones (e.g. a scale rating of 1-20).
- The EBI needs to allow all types of acceptable projects an equal opportunity to gain equivalent benefit points.

The satisfaction of these criteria is important for transparency of the process, equity amongst participants and adherence to the priorities for action that the organisation sets down prior to embarking on the auction. A project which obtains a higher score from the EBI assessment than another project should do so only because it more effectively targets important issues in improving land management and/or does this in a way that is more closely aligned with the accepted superior methods for managing land. The EBI at its most basic level is simply a process of differentiation between projects.

There is a constant tension between over-simplifying and over-complicating. The Liverpool Plains approach to designing the EBI is based on a simple and common structure for each issue (biodiversity, salinity and water quality). For each project, individual benefit scores are calculated for each issue and added together to give the total environmental benefit. This score is then divided by the bid price to give the final Environmental Benefit Index score used to rank the bids. The final figure is therefore a reflection of the ratio of environmental benefit gained for dollar investment supplied.

4. Results

Round 1 attracted 25 bids of which 17 were funded out of a budget of $300,000. In round 2, 26 landholders submitted bids and 18 were funded from a budget of $500,000. Projects varied widely in area and cost. In round 1 the median bid price was $16,000 with a median accepted bid price of $12,000. In round 2 the median bid price was $28,250 with a median accepted price of approximately $25,460. Project sites were distributed throughout the catchment and included landholders on large, medium and small properties. On average, participants are contributing at least $3 for every $1 public dollar received.

Each of the successful tenderers participated in the development of a Management Program specifying how and when the project works would be undertaken – mostly over the next three years. Milestones were agreed and incorporated into the Management Agreement which was then attached as a Schedule to a Common Law Contract signed by the LPLMC and the tenderer.

To ensure accountability, participants received 30% of the total payment on signing the contract while the remaining payments are linked to the achievement of milestones.

5. Discussion

In evaluating the LMTs, it is important to assess economic outcomes and the implications of the process for conservation auctions as a policy tool. Conservation auctions are claimed to be a highly cost-effective system however, of particular note in this context is the LPLMC trade-off between economic efficiency and other objectives. There are essentially two options. One is to produce the most efficient outcome possible, and then deal with equity effects through some distribution afterwards. The other is to seek to find a workable balance between efficiency and equity through the implementation of the mechanism itself. Conventional economics would prefer the former, whereas the trial has favoured the latter.

Without going into the detail of the economic assessment which will be published elsewhere, the analysis suggests that the EBI, although not perfect, did satisfy the design criteria and produce a ranking reflecting the variation inherent in the projects themselves as opposed to favouring a certain type of project. Projects that ranked highly did so because they scored well (relative to other projects) across many parts of the EBI and projects that achieved lower ranks did so because they scored poorly across many categories and were relatively expensive compared to other projects.

Despite this outcome however, the complexity of the auction with its many components necessarily requires consideration of the applicability of the auction mechanism to the multi-issue format. This is not necessarily related only to the design and operation of the EBI. Asking landholders to consider multiple issues during design, particularly where this requires knowledge outside their existing experience may contribute to the problem. The related difficulty of communicating information on several issues during the extension effort may be a contributing factor. These issues need to be balanced with the advantages of incorporating the reality of multiple benefits, the inclusion of a greater range of landholders with diverse interests and the potential cost-savings from multiple benefits from single actions.

Questions of equity – or, more accurately, the lack of equity – which must apply to the efficient investment of public funds in natural resource management, are little understood. It is to be expected that as such concepts gain wider appreciation, the EBI can be applied with more stringency without discouraging broader participation in the process. This trade-off between equity and efficiency has been raised several times, and presents one of the key challenges and lessons learnt out of this process.

Despite the importance of the revelation of specific supply information, the picture of the market as it is currently defined remains rather incomplete. An important question is whether the buyer is appropriately defining their own demand via funding limitations. As external bodies with external decision-making criteria (e.g. the NHT funding process) usually determine these limitations, the suppliers define the actual prices. Options which could be explored to improve on this situation could include determining a reserve price, or determining the cost under the best alternative funding method. Neither of these has been done in the LMT trial, however some ideas have emerged on how to do this.

A reserve price, expressed as a $/Benefit Point figure, could be determined independently of the auction. An ideal situation would occur if the EBI was designed so that the total benefits available in the catchment could be approximated along with the acceptable level of public investment in benefit provision. From this basis a price could theoretically be set at a price per benefit point that reflected the maximum acceptable investment. The problem with this theory is that there are significant informational gaps and difficulties in making catchment scale assessments strictly applicable at the farm scale. Also, following such an approach could result in the funding of much fewer bids and in the outlay of a significantly lower proportion of the funds available. This is not an optimal result in terms of encouraging community and landholder commitment to implementing change and engaging in the auction process, particularly if the costs involved in bid formulation born by the landholder is considered.

Another option might arise from the revelation of information regarding the best alternative method for achieving similar gains in land management in the outcome. In this situation the reserve price could be set at the level where the price paid per benefit point becomes equal to the price that would be paid for that project under the next best alternative scheme (e.g fixed grants).

The unfortunate truth is that improvements in the economic function of conservation auctions as a mechanism are inherently linked to improvements in our understanding of the landscape and community objectives for environmental sustainability and conservation. To do this the concepts of ideal states that underlie public pursuit of environmental benefits or the demand for environmental benefits need to be accounted for and defined in more detail. However, once a strategy such as the LPCIS has been developed, it is possible, in terms of looking at purely design imperatives for the tender process, to take these states as relatively well defined, valued and approved by way of a community based process.

6. Conclusion

Importantly, the tender process has demonstrated that there are many factors to be considered in analyzing the application of a new and complex process, and economics or science cannot be relied upon alone. The LPCIS recommends research based actions and, given social and economic constraints, the level at which it is possible to implement these actions is still being established. Land Management Tenders contribute to this establishing this level. The LPCIS can only be a guide, and given the economic and scientific assumptions within it, the EBI and ground-truthing processes can identify where those assumptions have broken down. It is of course important for the strategy to guide the EBI, however the EBI must be able to improve and inform the strategy. That said, this obviously complicates evaluation as the adaptivity of the process to some extent moves the goal posts.

Establishing east-west corridors in the Desert Uplands

John Rolfe[1] and Juliana McCosker[2]

1. Introduction

The National Market-Based Instruments (MBI) Pilot program was established in 2003 under the National Action Plan for Salinity and Water Quality. The MBI pilot program is a partnership between the Commonwealth and State Governments, with ten projects aimed at investigating better ways of encouraging improved land and water management. One of the successful projects under that program is focused on planning for the establishment of east-west landscape corridors through the southern Desert Uplands in central-western Queensland. The project will operate between July 2003 and December 2004, and is a partnership between four groups, being:

- Desert Uplands Buildup and Development Committee;
- Queensland Environmental Protection Agency;
- Central Queensland University; and
- CSIRO.

The key goal of the project is to determine how landholders may be voluntarily engaged to develop east-west linkage zones across the southern Desert Uplands. The project will establish the preferred options for developing agreements with landholders so that if funding is made available from other sources, the process of installing a linkage zone can begin. In the longer term it is possible that up to three linkage zones may be established.

A linkage zone would be different to a dedicated environmental reserve. It would involve areas of native vegetation on the cattle properties in the region being jointly managed for both cattle production and biodiversity outcomes. Landholders would receive some payment to reward them for managing part of their property in this fashion. Where possible, the vegetation zones would link up between properties so that an effective corridor (of varying widths) could be established across the region.

2. The issue to be addressed

The southern Desert Uplands is an area of eucalypt and acacia woodlands in Queensland where landholders have been clearing vegetation to improve pasture production for beef cattle. There are significant areas of remnant vegetation running north-south along low range systems, but clearing is beginning to fragment the east-west landscape. Clearing activity in the region has been high over the past decade, and could continue further, depending on the regulatory framework adopted by the Queensland Government.

Restrictions on vegetation clearing on leasehold and freehold land have been introduced by the Queensland Government over the past decade. These restrictions are imposed at the property level, so that landholders have some discretion about where clearing occurs and where remnant vegetation is maintained. Although there is widespread recognition that broad vegetation corridors have biodiversity and ecological values, there are no legislative mechanisms to ensure that vegetation conserved by landholders is linked strategically across property boundaries. It would be very difficult and costly to overlay a landscape planning process on the existing regulatory framework. For these reasons, the use of incentive mechanisms to voluntarily engage landholders in east-west corridor options is being reviewed in this project.

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3. Linkage zones

The southern Desert Uplands is about 40% of the size of Tasmania, and is about 150 kilometres across from east to west. Aramac and Barcaldine lie on the western edge of the region, and Alpha on the eastern side. The low productivity of the region means that property sizes are relatively large, so that about 10 to 12 properties might be involved in an east-west corridor across the region. Because there is a mosaic of remnant vegetation in the region, a number of options exist to establish corridors across the region. It may be desirable to have up to three east-west vegetation corridors across the region (about 40 – 70 kilometres apart).

The concept of a ‘vegetation corridor’ may be more appropriately thought of as a linkage zone. This is because it may involve blocks of remnant vegetation that are linked where possible with strips of vegetation. Ideally the strips should be at least 20% of the width of each block. In some cases it may be feasible to allow regrowth to become established in desired regrowth areas. While the blocks in a linkage zone may be about 10 kilometres or more wide, the connecting strips may be much narrower. In places there may be gaps in the linkage zone where it is crossed by roads, laneways or other infrastructure.

Where a linkage zone was established, landholders would still be able to run cattle. However, landholders would be expected to maintain the land in good ecological condition. This would involve the retention of a minimum level of pasture biomass on the land (approximately 1500 kgs/ha). It would be possible to burn the zones, but they should not then be stocked until the minimum biomass condition is reached. Weed species may also need to be controlled. Because there are some production and management tradeoffs for landholders, some incentive payments will be necessary to ensure that landholders will voluntarily enter into linkage zone agreements.

Institutional arrangements will also need to be made to ensure that protection of a linkage zone is maintained over time. Agreements with landholders may be for a varying number of years, although a consistent time frame would be preferable. Agreements may take several forms, with direct contracts, conservation covenants and Nature Refuge agreements being major options. Payments would normally be over the life of an agreement, although there may be a large initial component to make entry into an agreement more attractive.

4. A landscape tender process

The broad policy instrument to be explored in this project is the potential use of a tender system to allocate public funding for corridor options. Groups of landholders might tender for a corridor option, specifying the types of vegetation and area involved as well as the management inputs. The selection of the preferred corridor option would involve consideration of the biodiversity and management inputs together with the cost of each tender.

At a superficial level the corridor tender process would be very similar to the BushTender trials run in Victoria. However the nomination of a corridor that spans a number of properties introduces a number of additional factors that confound the design process.

5. Key corridor design issues

One major design issue is how to interest landholders in participating. Corridors are much more susceptible to non-participants and holdout bids than a simple BushTender process, so participation becomes a key issue. The use of coordinators may ease the burden on landholders in preparing bids, and help increase participation. Running a bid process through a regional body, and providing independent experts to help landholders with the bid process may also help to build trust and involvement. It is also likely that the structure of the incentive payment, the management requirements and the contractual arrangements will also be factors in potential involvement by landholders.

A second key design issue is how to encourage cooperation among landholders to develop corridor options without encouraging collusion or superinforming landholders about the potential benefits of holding out. These potential problems of collusion and holdouts distinguish corridor design from a standard BushTender process. Here, the issues in dealing with collusion and holdout issues are discussed separately.

Issues of potential collusion are largely related to mechanism adopted for forming corridor bids. Three major options for developing corridor bids have been identified in the project.

- The first of these is to for joint payments to be made to landholders, with one component related to the remnant vegetation conserved on a property, and the other component related to the overall viability of the linkage zone. This means that landholders would be directly rewarded for establishing linkage zones in strategic positions that enhance overall zone performance. Multiple rounds could be held of proposals from individual landholders. After each round, landholders can view the proposals put forward by their neighbours. They can revise their bids and resubmit, knowing that proposals that link more effectively across property boundaries will increase the reward to them. After several bidding rounds, linkage zones should move towards optimal locations.
- The second option is for landholders to form teams and submit corridor options. Each team may submit multiple options, especially by varying items such as contract period and landholder inputs. There are two issues that would make this option difficult to organise in practice. First, it may be very difficult for landholders to form and coordinate effective bidding groups, especially when group size is likely to be at least 10 – 12 members. Second, it may be very difficult for groups to apportion opportunity costs between members, and to negotiate bids where bid members have very diverse opportunity costs over similar vegetation types.
- The third option is where negotiators form teams and develop corridor bids. In this case landholders might deal individually with a negotiator rather than all other landholders. The use of a negotiator would help with the group coordination issue. Different negotiators may be involved with different corridor options to increase competition.

Collusion issues are largely irrelevant to the first option because landholders would act as individual bidders. However collusion is more of an issue with the second option because landholders with the highest opportunity costs may set the benchmark for all other bid group members (other group members may be reluctant to accept lower rates). This may also be an issue with the third option, depending on how much information the negotiator reveals to each group member.

Potential problems of holdout bids may be minimised in several ways. The use of a joint payment system as above in option 1 may help to reduce incentives for holdouts. Bids may be capped on a per hectare basis as a way of minimising potential gains from holdouts, and incentives offered to encourage early participation.

The third key corridor design issue is how to assess corridor options that may be tendered. Some evaluation process needs to be developed that will include an assessment of corridor viability along with the actual biodiversity features and the landholder management contributions.

6. The research program

The research project will involve four separate actions. One of these will be a desktop audit to review the literature on competitive tendering systems and assess the suitability of these for the Desert Uplands case study. A second action will be to assess the knowledge and preferences of landholders in the region so that the program design, incentive mechanisms and institutional arrangements will maximise participation. The third action will be to develop an appropriate methodology for the assessment of corridor bids.

The fourth action will be the use of some experimental economics sessions to test the different corridor bidding options. Approximately 12 landholders will be involved in each one-day session, where they will be each given a ‘dummy’ property described in terms of average land types and improvements in the region. Together, the 12 ‘dummy’ properties will form a block, so that several options exist to form corridor zones across the properties. In the sessions the different options to form corridors will be trialled and compared.

7. Results

The project will provide some clear recommendations of how to implement market-based incentives for the protection/maintenance of landscape values applicable to various scenarios in rural Queensland. The outcomes will help government agencies and regional natural resource management groups to design corridor protection options in ways that generate maximum efficiencies.

Session 3: New tools and new policy impetus

An overview of the ideas and information needed to develop and implement market-based instruments

Gary Stoneham[1]

Abstract

This paper examines the application of market-based instruments to environmental management. It is proposed that commodity-style markets are unlikely to be viable for environmental problems because information needed for meaningful transactions is hidden from the relevant agents. Applying ideas relevant to commodity markets will increase transaction costs because potential buyers and sellers of environmental services are poorly informed. Unlike markets, which evolved in many forms, environmental markets will need to be designed for each application under consideration. Three factors improve our ability to design mechanisms that discover prices and allocate environmental resources more efficiently than current approaches. Developments in economics, new information technology, and experimental economics techniques capable of "bench testing" new mechanisms should substantially improve our ability to design new environmental policy mechanisms that perform like markets. .

1. Introduction

Economic systems have emerged to meet our individual and collective needs and aspirations. Although this economic system involves complex and interacting processes, it can be reduced to two key elements: an economic environment and institutions. The economic environment consists of economic agents, who have private tastes, knowledge and skills; a set of production possibilities and an endowment of technology. The economic environment can be thought of as a set of initial circumstances that cannot be altered by the agents or the institutions who operate within the economic environment. The institutions developed in society define the rules of private property, the allocation processes and the language with which agents may communicate, exchange or transform goods and services (see Smith 1982).

Within the economic system, agents search for transactions that maximise their private or collective well-being. Whether acting in self-interest or in the interest of others, agents seek out ways of making transactions that create value. This evolutionary process winnows out inefficient ways of making transactions - those with high transaction costs. Different types of markets (forms of transactions) emerge from the economic system to facilitate the exchange of different goods and services. At one end of the spectrum, transactions are made in commodity markets where buyers and sellers have discovered that they can make meaningful transactions without inspecting the goods in question. Commodities can be traded on the basis of objective descriptions, such as protein content, fibre diameter, contaminant count etc. This style of transaction pervades the exchange of commodities because it offers lowers transaction costs. Different types of transactions have evolved to facilitate the exchange of other goods and services. In the real estate market, for example, buyers willingly incur substantial costs and effort to search, inspect, and check titles before they are willing to enter into transactions. For some other goods and services, transaction costs are so severe that transactions are more efficiently completed within firms rather than between firms. Caose (1937) notes that transaction costs define the boundaries of the firm. North (1990) expands on the processes that shape the structure and directions of economic development, arguing that "the incentives that are built into

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the institutional framework play the decisive role in shaping the kinds of skills and knowledge that pay off".

There are some goods and services, however, where transactions can not be made even within firms or organisations. In these cases, it is argued that markets fail to establish or at least are very inefficient. The environment is often one such case. It has not been possible for those interested in increasing the supply of environmental goods and services to routinely engage in transactions with those able to supply these goods and services. This partially explains the predominance of governments as the suppliers of environmental goods and services. National parks, for example, represent transactions made within the government rather than between government and private agents capable of supplying habitat conservation services.

In this framework it can be seen that competitive markets are just one amongst many institutions that could evolve through active selection by agents seeking value creation. For many modern policy and resource allocation problems, competitive markets will not evolve – they need to be designed. Roth (2002) notes that for these problems, "markets don't always grow like weeds - some of them are hothouse orchids". This paper examines the prospects for designing different institutions through which some environmental wants and needs could be meet. It examines why markets for the environment have not evolved naturally, and the tools and skills needed to design new institutions in the future.

2. Markets and the environment

Where markets for the environment are missing, resources are likely to be over-allocated to exploitative activities, such as land clearing (where there are clear signals to investors), and under-allocated to conservation activities. In these circumstances, society misses out on some welfare. Understanding why markets have not evolved to deal with the environment is an important step in designing mechanisms that will efficiently allocate the right level of resources to the conservation of environmental goods and services. In other words, why parties interested in exchanging rights relevant to the environment (individuals, governments, environmental interest groups etc) fail to do so.

Bardsley et al. (2002) note that ideas about why markets are missing or inefficient have changed over time. Coase (1960) argued that when property rights are clearly defined, market players will bargain to achieve an efficient solution (create a market), assuming that transaction costs are zero. While external costs and the specification of property rights are generally cited as reasons why markets are inefficient (see Productivity Commission 2002), information problems are argued to lie at the root of missing markets. Using the example of the “market for lemons”, Akerlof (1970) showed that asymmetric or hidden information problems can render some seemingly competitive markets inefficient. Asymmetric information refers to situations where one party to a transaction has information that places the other party at a disadvantage. In extreme cases, it becomes hazardous to do business with someone who has relevant but hidden information and these transactions will not be completed. This phenomenon can result in the non-existence of markets implying that society is missing out on value creation through mutually beneficial exchanges.

In general terms, environmental problems bear similarity with the “market for lemons”. For example, governments interested in improving the environment do not hold all of the information needed to make effective and efficient management decisions. Latacz-Lohmann and Van der Hamsvoort (1997) explain how information asymmetry affects the functioning of markets for environmental goods and services associated with private land. They note that there is a “clear presence of information asymmetry in that farmers know better than the program administrator about how participation (in conservation actions) would affect their production plans and profit”. Where economic systems do not include ways of resolving this information, Coasian transactions will not take place even though there may be value in such transactions. In other words, markets will fail to establish because the uninformed parties will be unwilling to participate even though the benefits of these transactions may be very high.

Latacz Lohmann and Van der Hamsvoort (1998) conclude “that some institution other than a conventional market is needed to stimulate the provision of public goods from agriculture”.

3. Designing markets for the environment

In the 1990’s, economists started to design artificial markets for complex resource allocation problems where markets had not evolved or were very inefficient. The important examples include: the Federal Communication Commission (FCC) auction of rights to use different parts of the radio spectrum needed for mobile phone operation (McAfee, R. P. and McMillan, J. 1996); the National Resident Matching Program (NRMP) which is a labour clearing house such as the one through which doctors are allocated to hospitals (Roth and Peranson 1997); and the allocation of landing rights (Plott et al.1981). In these cases, economists designed mechanisms through which agents engage in competitive and collaborative interactions and exchange rights. These artificial markets were implemented in the real economy and provide important insights into the skills needed to design environmental markets.

This section of the paper examines the skills and knowledge that can improve our ability to create efficient allocation mechanisms where markets have not emerged or are inefficient. Economic theory, experimental economics and pilots and developments in information technology are considered.

3.1 The role of economic theory

Economic theory provides insights into the conditions under which economic systems operate efficiently. However, economic theory may not always offer precise answers with respect to the design of artificial markets. In developing the FCC auctions, McAfee and McMillan (1996) note that the real value of theory in policy making is to show how people behave in various circumstances, and to identify tradeoffs involved in altering these circumstances. They also note that complex models become less useful than focused models that isolate a particular effect and build understanding. Economic theory provides general insights into the design of allocation mechanism and in contract design.

Allocation mechanisms - Although perfectly competitive markets do allocate resources efficiently, systematic analysis of resource allocation mechanisms (Hurwicz 1960) has lead to a general framework that treats competitive markets as just one amongst many institutions. In a further development, the Revelation Principle (Green and Laffont 1977), shows that, where information problems exist (adverse selection and moral hazard), any mechanism for organising society is equivalent to an incentive-compatible mechanism by which all informed agents reveal their private information (see Laffont and Martimort 2002). In these circumstances, agents will attempt to overcome their ignorance about some relevant information by taking decisions designed to acquire new information or to avoid some of the costs of their ignorance (Macho-Stadler and Perez-Castrillo (2001).

Game theory provides a unifying framework that allows policy analysts to identify and design new mechanisms that specifically address information problems where these prevent transactions from taking place. In this context, the policy design problem is viewed as a strategic game of interacting decision-makers, or players, each with a set of actions and preferences over the set of action profiles- the list of all players' actions. Each player interacts and is affected by the actions of all players. A wide range of situations can be represented within this framework as strategic games including: firms competing in business, political candidates competing for votes, jury members deciding on a verdict, animals fighting over prey, bidders competing in an auction, the evolution of siblings' behaviour towards each other, competing experts' incentives to provide correct diagnosis, legislators' voting behaviour under pressure from interest groups and the role of threats and punishment in long-term relationships (Osborne 1995). The pilot auction of conservation contracts (BushTender) is one of the Australian examples of the application of game theoretic ideas into practical design features and rules about how agents interact to reveal information needed to allocate resources to environmental conservation (see Stoneham et al. (2002).

Contract design - Contract design is an important area of economic theory relevant to the mechanism design problem. For some environmental problems, transaction costs will be minimised through transactions that involve modification of property rights (a contract) rather than an exchange of property rights as is the case with regular markets. Environmental problems associated with agricultural land-use are one such situation. Landholders hold a bundle of property rights that are not easily segregated for the purpose of exchange, yet there is scope to create value (environmental value) if transactions could be made to modify the property rights of relevant landholders - a contract. The main problems with contract design relate to incentives and asymmetric information. These problems are manifested as:

- Adverse selection - Situations where agents have private information on their types that would be valuable to the principal in terms of contract design;
- Moral hazard - Where agents can hide their actions leading to consideration of contracts that prevent agents taking advantage of asymmetric information to 'shirk' their commitments (Laffont and Martimort, 2002); and
- Observability - Even if contracts can be designed to prevent adverse selection and moral hazard. Observability has implications for monitoring and enforcement of contracts and their subsequent incentive effects on agent's behaviour (Laffont and Martimort, 2002).

Other problems of contract design include commitment, credibility and incomplete contracts (Salanie, 2002).

Economic theory provides important insights into why transactions do not take place for environmental goods and services and opens-up the prospect of new policy mechanisms.

3.2 Experimental economics and field pilots

Although economic theory is always the starting point for economic design problems, there are situations where theory is unclear about specific design issues and where there is insufficient practical experience to guide design teams. Both experimental economics and field pilots can be used to assist in designing markets, where these are inefficient or missing.

Experimental economics - Experimental economics is an important new tool that is increasingly being used to contribute to the design of policy mechanisms. Kagel and Roth (1988), Plott (1989) and Plott (1999) provide surveys of the use and application of experimental economics. This approach involves the use of individuals who participate in laboratory experiments which test new policy settings or market design. These experiments are developed using experimental methods involving human participants confronted with treatments such as: different incentives, conflicts across objectives, and different mechanisms to resolve conflicts. Experimental approaches are used in conjunction with economic theory typically to fill the gaps between theory and design, importantly, experiments can be used by economists to provide decision-makers with quantitative comparisons of different policy options and alternatives. Roth (2002) notes that laboratory experiments are useful to inform decision makers about how people will behave when confronted with new and unfamiliar policy instruments, both when they are inexperienced and as they gain experience. Smith (1982) and Plott (1979) describe a theory of laboratory experiments in economic applications that interacts with the development of economic theory relevant to resource allocation and institutional design. Gangadharan and Duke (2002) note that there are three areas where experimental economics can be useful: "in testing and screening economic theories; in the discovery of new facts that require theoretical explanation; and in designing as well as demonstrating new approaches to problems of public policy." Roth (2002) observes that laboratory experiments are useful to inform policy makers about how people will behave when confronted with new and unfamiliar policy instruments, both when they are inexperienced and as they gain experience.

Experimental economics techniques have been applied to a wide range of design, testing and screening of environmental policy mechanisms including: emission trading schemes (Cason and Plott

1996; Gangadharan 2000; Cason, Gangadharan and Duke 2003), design of auctions of conservation contracts (Cason, Gangadharan and Duke 2000) and ecolabelling (Cason and Gangadharan 2002).

Field pilots - Field pilots are another means of demonstrating, familiarising and refining policy mechanisms before they are adopted by government and other environmental organisations. Pilots are relatively more expensive than laboratory experiments and the consequences of failure or success may be greater than laboratory experiments. The Hunter Salinity Trading Scheme (EPA 1995) and the auction of conservation contracts in Victoria (see Stoneham et al. 2002) are two examples of field pilots where artificial markets have been designed for environmental outcomes. There are several criteria that are relevant to the use of laboratory experiments or pilots:

- Objectives - Laboratory experiments allow much more latitude to examine radical changes to mechanism design than is generally the case with field pilots. For example, laboratory experiments can be designed to examine completely new property right arrangements whereas field pilots are constrained by existing property rights.
- Political risk - Laboratory experiments are virtually free of political risk free whereas field pilots often carry some political sensitivity.
- Cost - Laboratory experiments are much less costly than pilots.
- Timing - Laboratory experiments can be designed and completed relatively quickly (months) compared with field pilots that often take years to have approved, design, implement and evaluate.

3.3 Information technology

The rapid growth in information technology and analytical capability has also had an important influence on the prospect of creating markets for the environment. It was noted earlier in the paper that information problems prevent markets from functioning efficiently and in some cases prevents markets from emerging at all. While agents able to supply environmental goods and services have private information that would need to be revealed before transactions can take place, so to do scientists, ecologists and environmental scientists. The rapid progress being made in hydrology modelling, for example, has raised the possibility of providing information about the impact of interventions in the landscape. Languages, such as measures of habitat quality (see Parkes et al. 2003), and landscape systems models (see Beverly et al. 1999) are now being developed to link the impact of landscape change with environmental impacts such as: salinity, water quality, carbon and water quantity. This previously missing information, along with hidden information about the opportunity cost of land-use change, provides the basic information needed to write contracts for environmental conservation. Similarly, the ability to implement a tradeable salt permit approach for irrigation farms relies on the availability and credibility of models that provide estimates of the impact of farm location and irrigation technology on accessions to the watertable. Advances in our ability to model complex, buffered systems will therefore influence the ability of economists to implement market-based approaches. Advances in other aspects of information technology, such as surveillance and monitoring technology, can dramatically alter scope for efficient contract design and monitoring strategies.

4. Summary and conclusions

Competitive markets are the predominant mechanism employed in the economy to facilitate value creation. There are, however, many different types of transactions that create value. At one extreme, commodity markets allow transactions to occur without inspection of the goods in question. These markets evolve as a result of agents searching for low transaction costs. In Roth's words they "grow like weeds". In other cases, transactions occur within the firm because this offers lower transaction costs than would be the case between firms. In some cases, such as the environment, transactions do not occur at even thought these exchanges would create value to society. For these situations economists are now interested in designing mechanisms that do the job of markets but which will not evolve by themselves. Roth likens these to "hothouse orchids" because they need to be designed and nurtured under artificial conditions.

Economic theory, experimental economics, field pilots and information technology can assist economists to design these institutions or artificial markets. Economic theory enables economists to diagnose the reasons why markets are missing and to propose mechanisms that correct for the specific problem identified. Economic frameworks including game theory and information economics offer important insights into the environmental policy design problem. Experimental economics is a new tool that can assist economists to test and screen different policy mechanisms, discover new information about policy mechanisms and design and demonstrate new approaches. Field pilots can also be used to demonstrate whether new approaches can be operationalised and how agents respond to alternative policy mechanisms. Finally, developments in information technology and surveillance can greatly improve the ability to implement theoretical propositions through more efficient contracts and monitoring strategies.

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Market based tools for environmental management

Jackie Biro[1]

1. Introduction

This gathering brings together a diverse range skills, experience and interests to this symposium.

Some of you are directly involved in catchment projects; many of you are involved in the academic research side of MBIs; and some of you, like me, work in policy development.

I hope you will take home at least two pieces of knowledge as a result of hearing this presentation:

First, you will be able to identify the kind of information and insights you can gain from the *National MBI Pilots Program*; and

Second, you will know how to gain access to this knowledge.

I will initially outline why the program was established, then give you an overview of the insights to be gained into MBIs from the program, and finally let you know how to stay in touch and get information you need.

2. Why the program is needed

In setting the scene for the project, there are several key points to be made.

Interest in using MBIs to manage natural resources and environmental problems has increased significantly over the last ten years and is likely to continue to grow.

Governments now view MBIs as potentially useful additions to their existing suite of natural resource policy tools. Importantly, they are also aware of their limitations.

In general, government officials will acknowledge that MBIs are not a quick or easy fix for natural resources management.

The hard work it has taken you to set up the projects that are now in operation shows that careful planning, design, piloting, evaluation and implementation is vital if MBIs are to be proven as workable policy instruments.

I have three observations about how governments view the growth and development of MBIs.

First, governments are asking to what extent can MBIs help us manage difficult natural resources allocation and management issues, and in what circumstances should they be employed.

While there is considerable interest among policy makers, practical application of MBIs in Australia is still relatively limited. As you have heard this morning, while there have been some successful applications of MBIs, many projects are still in the design phase or have only recently moved into implementation.

Of these, governments are now asking how transferable the models are to different locations and other types of natural resources or pollutants. They are also asking what aspects of MBIs are not being tested in current work.

Second, natural resource Ministers from all States, Territories and the Commonwealth have agreed that there are significant gaps in knowledge about MBIs. I will discuss some of these knowledge gaps in a moment.

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The impact of these gaps is they limit our ability to reach conclusions about the applicability of MBIs in different circumstances. Filling them will help establish the extent to which MBIs can help deliver better natural resource outcomes.

Third, the NRM Ministers agree that many of these knowledge gaps are common to all jurisdictions. I'll illustrate this with a simple example.

In order to develop auction-based approaches for awarding government grants, all governments would need to rate the natural resource benefits of various actions and then develop evaluation indices to reflect these ratings.

While individual schemes may need to be tailored to different circumstances, it makes more sense to work together on the design of the wheel, rather than to invent and reinvent it.

Ministers have agreed that a national program would be the most efficient way to fill the gaps in our knowledge. This will make the best use of limited skills, and is the most effective way to benefit from and build on information held in all Australian jurisdictions and overseas.

In May 2002 Ministers agreed to establish the *National Market-based Instruments Pilots Program.* The Program aims to go some way to filling these knowledge gaps, and through this to increase Australia's capacity to use MBIs to manage natural resources.

As its name suggests, Ministers elected to fill these knowledge gaps by running strategic pilot schemes. The Program complements existing programs and builds on work already completed in some States and at the local level. The focus is on filling common knowledge gaps. Jurisdictions may also choose to conduct their own MBI pilots to meet their specific needs.

The Program is a joint initiative of the State, Territory and Commonwealth governments and is a part of the National Action Plan for Salinity and Water Quality (NAP). All governments have contributed funding to provide $5 million for the first round. The NRM Ministerial Council has approved in principle an additional $5 million for a second round on the basis that the first round delivers significant knowledge gains.

Many of you will be aware that capacity building is an important component of the NAP. This Program is the NAP's first national capacity building project.

Representatives from the NRM Departments in each jurisdiction sit on an MBI Working Group. This Group designs and oversees the Program on behalf of their CEOs and Ministers.

Expressions of interest for pilot projects were advertised last year. The focus was on selecting projects that offered strategic research benefits rather than picking 'winners'. In other words, we were more interested in building our capacity to successfully use MBIs in the future rather than achieving high net benefits in the particular cases.

I will return to the selected pilots in a moment, but first I would like to briefly highlight some of the knowledge gaps.

3. Common knowledge gaps

The Working Group has identified the following knowledge gaps:

- how existing MBIs can be applied to new situations (new locations or a new component of the environment);
- how to deal concurrently with point and diffuse sources of pollution;
- how best to engage the private sector in MBIs;
- how to define commodities and establish property rights;
- how to account for multiple benefits flowing from a single environmental restoration activity;

- how to determine the optimal scale and market boundaries for MBIs; and
- how to link actions on the ground (at a property level) with larger scale environmental outcomes.

Other papers presented today have examined some of these knowledge gaps in more detail.

The Working Group recognised that there may be other knowledge gaps that it was not aware of, so left it open to applicants to address any knowledge gaps, and make the case for that being a significant gap to fill.

4. Project selection

In April this year Minister Kemp and Minister Truss announced the successful pilot projects. Ten pilots will be funded, with a total investment of approximately $4 million.

An independent selection panel assessed the projects. It comprised Professor Hugh Possingham (Chair) from the University of Queensland, Dr John Keniry from Ridley Corporation Limited, Ms Di Bentley from Gunnedah Management Consultants, Associate Professor Geoff Edwards from La Trobe University, and Mr Drew Collins, partner in the BDA Group. Collectively the Panel's skills and knowledge spanned economics, biophysical processes, land management; public policy; and community engagement. The selection process employed accepted practice for dealing with real or perceived conflicts of interest.

Many of the project managers of these pilots are here for the symposium and will be presenting details of their pilots during the poster session. (See Appendix 1)

5. Project overview

What I'd like to do now is give you an overview of the potential knowledge to be gained from the pilots collectively.

Five of the pilots are exploring price-based mechanisms, four quantity-based instruments, and one market-friction.

5.1 Price-based mechanisms

Within price-based mechanisms, four of the pilots will explore the feasibility of using auctions to allocate subsidies. From these we expect to learn:

- how to run low-cost auctions;
- how to run auctions for multiple environmental services;
- how to incorporate a duty-of-care benchmark into an auction;
- how to run an auction where there is complementarity between bids;
- ways to measure improvements in biodiversity and water quality; and
- ways to measure multiple natural resource outcomes and assess the trade-offs between them.

For example, Onkaparinga Catchment Water Management Board is running a pilot to test a low-cost biodiversity and water-quality assessment and auction tool for use by regional natural resource management bodies. It will also test how measures for 'risk reduction' and actions that cross property boundaries can be included in assessing bids.

In the area of government subsidies, one of the selected pilots will explore whether public sector funds can be leveraged to increase private sector investment.

5.2 Quantity-based MBIs

Three of the recommended pilots will help us design trading schemes for both salinity and water quality. They will cover existing, developing and new irrigation areas. From these we will learn:

- the extent to which trading schemes are a cost-effective way of managing these natural resource issues; and
- how to estimate and monitor induced salinity from irrigation farms.

For example, Central Queensland University will examine how a salinity trading scheme might work in new and developing irrigation areas. Rather than using experimental economics, it will use choice experiments, where industry, irrigation and grazing participants are asked to indicate the choices they would make under a variety of circumstances. The project will explore the potential use of cap-and-trade pollution permits using the Fitzroy River as a case study.

Another of the pilots, being run by the NSW Environment Protection Authority, is implementing three field-based salinity offset schemes. From this pilot we will learn:

- how to design a scheme that offsets increases in point source salinity with reductions in diffuse source salinity; and
- the institutional frameworks needed to use offsets more widely.

5.3 Market friction

The final pilot will explore how to make existing markets work more efficiently. It will examine whether insurance products could help farmers change to more sustainable farming practices.

5.4 Salinity tender

In March 2003, Ministerial Council noted that none of the 10 recommended pilots funded in the first round addressed how MBIs can be used to manage dryland salinity. They agreed that this gap should be filled in the first round of the Program because it is an issue of fundamental importance to the NAP, and to tender for a pilot concerning dryland salinity trading and offset schemes. Tenders were called and applications closed at the end of July 2003.

The pilots were required to focus on the causes and impacts of human induced and water table related dryland salinity. It was not intended that they cover other naturally occurring saline land issues, such as dry saline lands. Knowledge arising from the pilot will need to be applicable to a significant number of States and Territories. It was also desirable that the pilot should:

- develop cost-effective solutions to problem of dryland salinity, using market-based mechanisms alone or in combination with more traditional approaches (such as regulations, zoning, compliance or penalties and charges);
- provide for collaboration across a number of jurisdictions; and
- incorporate relevant catchment salinity targets, where established.

Standing Committee (made up of CEOs of NRM agencies around the country) will shortly consider the Selection Advisory Panel’s recommendations on the applicants for the tender.

6. How to get access to information

The sharing of knowledge between the pilot managers and the transfer of knowledge to those who stand to gain from it are essential to the success of the Program. We have set aside 2.5% of the budget for knowledge transfer.

The Program has supported this symposium as the first step in building knowledge about MBIs generally and the pilots specifically. Our aim has been to enhance the knowledge and capacity of various stakeholders – community agencies, academics, consultants and policy advisers. The poster sessions tomorrow and informal networking should give you more background about the Program outputs that will be of most use to you.

If you haven't done so already, I would encourage you to join the e-mail list on our website. You will receive e-mails when important milestones are reached in the Program. The site is regularly updated. You can find us at www.napswq.gov.au/about/mbi.htm.

The Working Group will host and fund annual workshops for the pilot managers, to promote shared learning about the pilots' design, implementation, operation and evaluation. It will also allow Pilot Managers the opportunity to give and receive feedback from each other on their pilots and solve problems encountered in running them. The first workshop of this type will be in the first half of 2004.

We have left open using possible other mechanisms for knowledge transfer during and after the pilots as we would like to hear from you as to how best to support knowledge transfer.

Gary Stoneham is currently developing this knowledge transfer strategy, so I encourage you to talk with him and express what particularly would be useful for you to know, when and how best to transfer this information, or possibly skills, to you.

The Standing Committee will publish an *Overview Report* when the pilots finish which will identify the lessons learnt from individual pilots and from the Program overall.

I hope the information emerging from the program will benefit many of the projects that you are involved in. I also look forward to hearing from you and making use of your insights and experience of market-based instruments.

Day 2

Session 1: New MBI tools = new ways to address environmental management issues

Missing markets and the design of environmental "Market Based Instruments"

Professor Peter Bardsley[1]

Abstract

Market failure is pervasive in the environmental sector, and naturally occurring markets are, in many cases, unlikely to produce socially optimal environmental outcomes. Despite this, the case for using "market-based instruments" has recently become popular in the Australian environmental policy debate. The purpose of this paper is to survey some of the broad issues that arise in this debate. What do we mean by market-based instruments, and what is the conceptual foundation for their use? What contribution can they make to Australian environmental policy? What needs to be done to improve policy development and implementation, in order to use these new instruments effectively?

1. Introduction

The term "market-based instruments[2]" has recently become popular in the Australian environmental policy debate. While recognising that market failure is pervasive in the environmental sector, so that naturally occurring markets are unlikely to produce socially optimal outcomes, the idea is that often "market like" instruments may still have a valuable role to play. This thesis is in contrast, on the one hand, to centralised regulatory approaches of the "command and control" type, and on the other hand to totally decentralised policies that rely on voluntarism and untargeted subsidies. Sometimes, paying careful attention to incentives and information constraints, it may be possible effectively to decentralise intervention in a way that gains at least some of the benefits that are associated with well working markets. If this can be done then there may be significant benefits in efficiency, in practical implementability, and in the ultimate delivery of environmental outcomes.

From a more conceptual point of view, the issue at stake is the optimal design of institutions in imperfect information environments. Instead of using an "off the shelf" policy instrument, one may try to design one that is tailor-made to the problem at hand. Sometimes we may end up with something that looks like a standard regulatory approach; sometimes it may look quite like a market or an auction; sometimes it may look different to either. The outcome, or the form of the instrument, should not be pre-judged: it should emerge from the actual situation, the policy problem, and the analysis. There are new tools in economic theory (mechanism design) and in experimental economics that have enhanced our capacity to do this kind of economic design. These tools have been used with great success in other parts of the economy (see McMillan 2003, Milgrom 2003, Roth 2002). It is now time to find out what they can do for the environment.

The purpose of this paper is to survey some of the broad issues that arise in the debate on "market-based instruments" and to consider what needs to be done to improve policy development and implementation.

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[1] University of Melbourne

[2] This term is somewhat unfortunate, but it seems to have become embedded in the Australian policy debate.

2. Back to some basic theory

It is useful, as always, to go back to the fundamental theory of welfare economics and market failure. Speaking in broad terms, we know that, in the absence of non-convexities, if we have a complete set of markets then these markets will deliver a Pareto optimal outcome, and that any efficient outcome can be decentralised in this way. If we put aside the question of non-convexity (for example natural monopolies) then market failure is generically associated with the lack of a full set of markets. For example, in the case of Coase's famous example (Coase 1960) of the smoking factory next to the laundry, there is no market for smoke.

If one asks why such a market might not exist, then the most common answer is probably "transaction costs." However this term is really too vague, and too imprecise, to be very useful. One of the lessons that we have learned about transaction costs is that it is asymmetric information that is very often the root cause of market failure. It is dangerous to do business with somebody if you are at an informational disadvantage; special contractual arrangements may be required[3], or in their absence markets may not exist at all. To understand such market failure it is necessary to be specific. What is the cause: is it information or something else? If it is information, is the problem hidden action, hidden knowledge, or some combination of the two? It is necessary to be specific, because the policy implications are different. In particular, the so-called Coase Theorem need not hold if the transaction costs are due to asymmetric information (Farrell 1987, Maileth and Postlewaite 1990).

3. Designing policy

How should we proceed in an environment in which standard market mechanisms will not work? To be more specific, how should we proceed if our analysis leads us to conclude that an information related market failure is at the heart of the problem?

The first and most natural observation to make is that the mere recognition that an informational defect is at the root of the policy problem may in itself be very useful. A direct attack on the information issue may be possible. Policy design, especially in the environmental area, is always a multidisciplinary affair. Environmental policy problems arise because of the interaction of complex biological systems and complex economic systems. Economists, scientists and other professionals must work together on such problems. It may be useful for economists to emphasise to scientists that an informational problem is at the heart of the policy problem. This insight is not likely to be apparent to scientists unless it is pointed out, yet it is the scientists who may be able to do something about it. Technological innovations, for example in the areas of remote sensing, information processing, and the application of landscape scale biophysical models may, if applied creatively, transform the nature of the policy problem. At the very least, scientists should be aware of the informational constraints to policy and of the value of addressing such constraints in their scientific research programs.

Even if we cannot correct or mitigate the information problem directly, we may attempt to design policies that are optimal subject to these informational constraints. There is now an enormous literature on how to do this. Recent texts include Laffont and Martimort 2002, Milgrom 2003, and Salanie 1997, 2002, and recent survey articles include Roth 2002 and McMillan 2003. The key concepts that arise include incentive compatibility, the minimisation of information rents, the optimal allocation of risk in Principal-Agent problems, credible policy commitment and the intertemporal consistency of policy. The typical institutional designs that emerge from this approach include auctions of various kinds, market matching algorithms, non-linear pricing, incentive contracts, menu-based self selection mechanisms, and various hybrids of these. Because there is such a rich body of theory behind these methods, there is a much richer array of policy instruments to work with than is available under traditional command and control approaches. These traditional instruments (quotas, taxes, direct regulation, redesign of property rights …) are of course still available to the policy maker, and may indeed emerge as the optimal instrument in some cases. One of the strengths of the

[3] The principal-agent literature deals with such arrangements.

optimal design approach to policy making is that it is based on an in-depth, case-by-case study of each policy problem. In this hand-made approach to policy design, as opposed to an off-the-shelf approach, there is a greater likelihood that there will be a good match between policy and the problem. Another of its strengths is that feasible implementation is built in from the beginning as a design consideration.

In practice, policy making is much messier than this. There is rarely a perfect match between the policy issue and the textbook model. However, by starting with a rich conceptual framework we are in a much better position to find a good practical solution. Furthermore, we must be prepared for second best solutions. For example, many environmental goods have the nature of public goods, and we know that there are no markets to aggregate consumer preferences for these goods. However we do have political markets, which may act as a proxy. We know that voting over public goods may not be optimal (it reflects the preferences of the median rather than the average voter; and once we introduce multiple issues the situation is even less clear), but it may be a good start to work with the policy preferences that emerge through political institutions and political processes.

A second example where a partial solution may be worthwhile occurs where market failure affects only one side of the market. Consider again the case of a public good. Even if there is no effective market to aggregate demand, so that demand must be estimated subjectively or through contingent valuation methods, it may still be valuable to create mechanisms for efficient supply. The literature on efficient procurement is relevant here (see Laffont and Tirole 1993). This ensures at least that the good is produced at minimum cost. It also ensures that the cost of the good is made explicit, as well as clarifying the implicit tradeoffs that are being made. These tradeoffs may usefully be fed back into the decision making process, even if at an informal level.

Finally, while theory provides the starting point for market design, it is by now a well established principle that a program of experimental testing is a key step in the process from design to implementation.

4. Markets for biodiversity

As an example of how the modern instruments of market design are being used to create new environmental policy instruments, I would like to consider the Bush Tender habitat procurement auctions that have been developed and trialled by the Victorian Government. I will not discuss these auctions in detail (see Stoneham et al 2003 for a full account). Rather I will focus on the conceptual framework and how it was developed.

The policy problem to be addressed was how to preserve and manage areas of remnant habitat in the Victorian agricultural landscape. These small, widely scattered areas have survived the process of wholesale agricultural development largely by accident. Because they are the last remnants of what were once widespread ecological systems, they are a valuable biodiversity resource. Being on private land, their management poses difficult problems.

Preservation of remnant habitat is to a very large extent a pure public good. It enhances the survival probability of species and ecological systems whose existence is valued by society. Individual landowners thus have inadequate incentives to protect these assets, because of their public good nature, even though to do so provides an economically valuable service. Of course some landholders derive private value, some of which may be altruistic, from such actions; even so, this value will not include the full economic or social value of the public good. In principle, landowners could specialise in managing biodiversity and sell this service, in exactly the same way that they produce and sell crops and livestock products. However there is no market for biodiversity preservation, and in the absence of such a market these economic gains will not be realised. Bush Tender is an attempt to fill this gap.

There are clear reasons, on both the supply and demand side, why markets for biodiversity preservation do not exist[4]. On the demand side, the standard arguments about free-riding apply, and they are sufficient to show that there will be no effective expression of demand. However, as noted above, this does not mean that there is no role for policy. In the first place, there are political markets and institutions that act as proxy markets in which demand for environmental services may be expressed. These markets may be imperfect, but they are a starting point. In the second place, even if demand is not expressed perfectly, it is worthwhile to ensure that environmental services are provided at minimum cost. This may be achieved if the supply side of the market is working properly.

Bush Tender is concerned almost wholly with this supply side of the market, not with demand. We assume that the government demands these goods on the part of the public, and we do not inquire whether the level of this demand is or is not optimal. The problem is then to ensure the efficient procurement of public goods (Laffont and Tirole 1993). In principle, the government announces that it wishes to fund small scale localised projects, typically undertaken by a single landowner or by several cooperating landowners to protect or rehabilitate an area of remnant habitat. The aim of the government is to acquire, at minimum cost, the optimal portfolio of projects.

Information effects stand out as the major impediments to efficient supply of such services. Three such effects may be identified.

In the first place, the value of the services is imperfectly known. Some habitat is extremely valuable; some less so, either because it is degraded or because there are good substitutes. To a large extent, this ignorance is symmetric. Neither the seller (the landholder) nor the buyer (the government) is well informed. On the part of the landholder, this is because of a lack of technical knowledge; on the part of the government, it is because the information is scattered in many diverse locations. Remedying this lack of knowledge is inevitably expensive. Whether it is too expensive is ultimately an empirical matter; assessing this is one of the reasons for running a series of field trials. The cost of learning the value of these potential services that could be purchased depends on the scientific and technical framework that is available.

Good science and good information engineering has been enormously important in the Bush Tender project, as has been close teamwork between scientists and economists. The main elements of this framework have been as follows. Ecologists have created a methodology for assessing and scoring the value of habitat at minimum cost. This assessment requires a visit by a trained field officer, so it is expensive. The cost can be reduced by targeting effort through the use of landscape databases, remote sensing, biophysical models and other ways of making a preliminary low-cost assessment, and by an education process that encourages landholders to come forward with high value proposals.

In so far as this is a search process to discover value enhancing trades, both sides of the market benefit, and we might hope that neither side should have a major incentive to hide or distort information. However there is the potential to run into problems of this kind. If a landholder knows or fears that an endangered species will be found on their land, then they may worry that the government will expropriate their property, either directly or by vigorous enforcement of regulatory frameworks that usually lie dormant for lack of information. On the other hand, the government may fear that a landholder may hold it hostage, attempting to expropriate the full value of the discovery by a threat to destroy it. In this situation the government may be tempted to conceal the value of what has been found.

We encounter here some issues that are pervasive in problems of this kind. The first is the question of how the gains from trade are to be shared. At the very least, the government must be able to meet a participation constraint. Participants must not be made worse off (for example by the risk of

[4] There is some private provision of this public good, and some market activity associated with this provision (for example, the purchase of habitat by birding groups). However this does not mean that there are properly working markets in which biodiversity preservation receives its true economic value.

expropriation) by participating. This leads into the second issue. The government must be able to credibly commit to this position. In the process of searching for trades, or later in contracting for the supply of services, new information will inevitably come to light. If the government cannot commit not to take advantage of this and not to exploit the landholder by renegotiating when this new information comes to light, then the initial gains from trade may be seriously eroded. Either the landholder may not participate in the first place, or may do so only at a very high price. This issue becomes especially important when we come to repeated contracts and long term relationships. To some extent these problems arise and must be dealt with in the formal structure of the policy mechanism. But there is also an important cultural component of trust and respect that must not be lost sight of.

Once the value of the environmental service becomes apparent, a second information problem arises, due to asymmetric information about costs. Some components of the cost (for example the value of materials) may be readily apparent, but some components (for example the value of the resource in alternative use) will be private information. In any bilateral contracting with the government, the landholder has an incentive to overstate this private cost. This problem is well understood, at least in principle (see for example Laffont and Tirole 1993), and it is known that auctions, of one form or another, perform well in this situation. A discriminating price closed bid auction (a "Treasury Bill auction"; see Menezes and Monteiro 1995) is used to induce competition and honest bidding by landholders.

A third, quite serious information problem now arises. This is the problem of monitoring whether the agreed actions have in fact been carried out. This hidden action problem, commonly called "moral hazard" (a term from the insurance literature), is also well understood (see Salanie 1997), at least in principle. It can be addressed through careful attention to contract design, and through the clever use of technology. We know that the optimal contract must focus on the ultimate objective (the desired ecological outcome), even though this is difficult to measure, especially over the short term. We also know that it must take into account actions that are easier to monitor (for example erecting fences), which are connected to the final outcome in an indirect or instrumental way. We also know that, in order to provide appropriate incentives, the landowner must accept some responsibility for the final outcome, even though this outcome is risky and not entirely within his or her control. In practical terms, this means that the optimal contract will be balanced between paying for inputs and rewarding outputs, and that it will balance the need to provide incentives with the need to protect the landholder from carrying too much risk.

This seems a very difficult, perhaps impossible, task. However good science, and creative use of technology, can come to the rescue. Since defective information is the source of the contracting problem, a direct attack on the information issue can transform the contracting problem into one that is more tractable. The approach that is being explored is to provide landholders with digital cameras and to write into the contract a schedule of photo-points and photo dates, to create an effective monitoring regime. Files can be downloaded in digital form for evaluation and record keeping. This regime can be backed up through remote sensing technology and random site visits. While technology cannot provide complete information, it can greatly reduce the informational transaction costs and make feasible a richer array of contracting possibilities. One can go further. By photographing both treatment sites and control sites, it is possible to measure not only whether simple actions (say the erection of a fence) have taken place, but also to assess ecological outcomes (for example changes to vegetation cover relative to a control site). It may be possible to train landholders to perform more complex measuring tasks. This approach makes it feasible to reward outcomes as well as inputs. The proper use of control sites also allows one to compensate, to some degree, for seasonal effects, and thus to reduce the risk imposed on the landholder.

Stepping back from the formal analysis of auction design and contract theory, a very important part of this project is to transform the role of landholders from passive to active. Once a market of some sort is created, landholders can produce biodiversity services in the same way that they produce other commodities. They should be able to bring all their skills and intimate local knowledge to this task, once they learn how to do it. Centralised command and control cannot hope to achieve this.

Experience in the field (see Stoneham et al 2003) has confirmed that this approach seems to be workable. There is some evidence that the cost of procurement under this approach is very favourable in comparison to alternatives. There is also evidence that both field officers and landholders believe that it is working well. There are also benefits of a wider kind. The bidding schedule provides good information on the supply curve for these environmental services. With only an imperfect estimate of demand we cannot say with confidence that the equilibrium price in this market represents the marginal social value of these services (though it is arguably the best estimate available). However it does provide a good indication of the tradeoffs between various policies affecting some types of biodiversity preservation or destruction. For example it provides a shadow price for evaluating the cost of similar habitat destruction in activities such as forestry. It also provides a price signal to non-participating landholders of the true economic value of habitat and other resources for biodiversity preservation.

5. The Murray-Darling Basin

As a second example of the role for "market-based instruments" in environmental policy it is interesting to consider the case of the Murray-Darling. The riverine systems of the Murray-Darling Basin are one of Australia's great economic and environmental resources yet one of the most degraded and at risk. It has been recently asked what role market-based instruments might play in the management of these rivers. More generally, what is the place for formal economic design in the management of this highly complex system?

It is interesting to consider, at least in outline, some of the broad parameters of the problem[5]. In a full analysis it would of course be important to start with a detailed understanding of historical relations and existing institutions before recommending how one might move towards an optimal set of arrangements – there is no attempt to do this here. But it is also quite informative to consider the issues from first principles, especially as some of the issues are different from those discussed above in relation to the Bush Tender project.

In discussing Bush Tender, we started with the demand side. We observed that although we are dealing with a public good, there are proxy political markets which give a measure, although imperfect, of demand. In the case of the Murray-Darling, the situation is much more complicated. From an economic decision making point of view, one of the most striking characteristics of the Murray-Darling problem is that it is an inter-jurisdictional one. Several state governments are involved, as well as the federal government. While there is undoubtedly a great deal of common ground in the objectives of these bodies, there is also scope for disagreement. Any institution[6] through which these bodies interact, either cooperatively or in rivalry, defines the rules of a game. Game theoretic tools and concepts can be used to analyse and evaluate the performance of such an institution from an economic perspective. Furthermore it is possible, using techniques from game theory and experimental economics, to attempt to design optimal institutions[7]. Any "Market Based Instrument" approach to the management of the Murray Darling Basin should ideally start at this level. Reform at this level may be difficult or impossible, but it is necessary to understand the constraints under which one operates.

Still considering the demand side, we observe that we are dealing with a very complicated system, with complex externalities and interactions involving water, salt, river flow, and groundwater. These interactions involve biological, physical and economic systems. Even a superficial consideration of the complexity of the system suggests that a centralised command and control approach will probably

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[5] I am indebted to Mark Eigenraam for some of the ideas in this section. See Eigenraam 1999, Eigenraam et al 2003.

[6] For example, the Murray Darling Basin Commission.

[7] There is an enormous literature on mechanism design, which deals precisely with problems of this kind. For a survey of such institutional evaluation and design from the perspective of "the Economist as Engineer," see Roth 2002.

achieve only a limited amount. It is important to note the water (and salt) are not ends in themselves. What matters are economically relevant outcomes. In particular, we are concerned with environmental outcomes. These outcomes may be to some extent localised (for example by their upstream or downstream location), and they are likely to be influenced in specific and nonlinear ways by river management (for example, by floods).

All this suggests that if "market-based instruments" are to play an effective role then decentralised, active environmental managers will be required, with the power to trade actively in salt and water markets. The role of these managers is to express demand for environmental outcomes at a local level. These agents will need to have incentives that are closely aligned with those of the global river manager. In order to align incentives, information is extremely important. So once again we return to the importance of measurement, evaluation, monitoring, and the interpretation of outcomes through scientifically valid frameworks. The scientific infrastructure is in fact crucial. One way to think of this approach is that we would be bringing into the market artificial agents with specially designed environmental property rights to trade on behalf of the environment. The precise rules and incentive structures under which such a group of environmental managers might operate is again a question that can be addressed through the tools of market design and experimental economics.

The supply side is to some extent more straight-forward than in the Bush Tender example. In so far as the problem is one of river management, trading in water, river flows, and salt is likely to be the main mechanism to achieve environmental outcomes[8]. Thus the effective use of "market-based instruments" depends on well working markets for water and salt. Existing water markets are imperfect and salt markets rudimentary. There may be very considerable environmental benefits from reform of these existing markets, provided that it is accompanied by the creation of agents who can trade on behalf of the environment.

The main role for economic design in managing this river system would seem to be in specifying the nature of the environmental managers who would trade on behalf of the environment. This means specifying the incentives of these agents (a problem in contract design), and the environment in which they operate (a problem in market design).

6. What we need to do

Returning again to the basic principles of welfare economics, the standard recipe applies. The first step in the economic policy process is to analyse what is going on. Who are the agents? What are their decision variables? How much do they know, how much can they observe? What are their incentives?

The second step is diagnosis. Is there a market failure, or is the outcome optimal? If there is a market failure, what is its source? The fundamental theorems of welfare economics provide the basis for this diagnosis.

The third step is to find a remedy that addresses the source of the market failure.

So far, the process is classical, and it may be found in any text on public economics. The "market-based instruments" or economic design approach suggests that, in searching for a remedy, we should not just take existing markets and institutions as we find them. By careful design we may be able to modify these institutions, or to create new markets and institutions, in such a way that we remedy some or all of the market failure. I would suggest that the Bush Tender habitat procurement auctions have attracted attention not so much for the particular application, but because they demonstrates a new approach to policy development with much wider scope for application.

Theory provides an indispensable road into this market design process. It provides the appropriate concepts, directs attention to the important issues, and it gives some general outline of what the optimal solution would look like. However it cannot provide a stand alone solution. A great deal of

[8] It may also be desirable to engage in other activities, such as engineering works.

expert judgement is called for, and there is an equally indispensable role for experiments and pilot schemes.

It is very important that policy makers appreciate that market design is a process, and not be mislead by identifying it with the outcome in any particular case. Let us take for example the Bush Tender project, which has lead to something of a fashion for auctions. It is an error, but unfortunately one that can be made by unsophisticated policy makers without the appropriate conceptual background, to assume that the use of "market-based instruments" just means the use of auctions. In the case of Bush Tender, an auction is indeed a key part of the policy package. However it is just one part – contract design and the integration of economic design with biophysical modelling are equally important – and it is a particular kind of auction, implemented in a particular way. In the case of the Murray-Darling Basin, which we also considered above, auctions may not play such a central role. Copying an auction without understanding the reasons for it, or the way that it is integrated with other instruments, can only lead to disappointment and bad policy. See Klemperer 2002a,b for some truly spectacular examples of policy disasters of this kind. Unfortunately, bad outcomes due to bad design can discredit the use of new instruments and new approaches. This would be unfortunate, since these new ideas may allow us to deliver much better environmental and economic outcomes.

Economists are well placed to explain to policy makers the nature of good policy, and to damp down unrealistic expectations. In particular, it is unrealistic to expect that new instruments can be developed and implemented very quickly, especially in such a complex area as environmental policy.

What then are the prerequisites for the application of economic design principles in environmental policy? The first is good theory. The toolkit of the traditionally trained agricultural economist or environmental economist probably needs to be updated. We need people with training not just in price theory and classical welfare economics, but also in information economics, game theory, mechanism design, experimental economics and economic design. Meeting this need is an issue that should be addressed at the education and recruitment level. So far as I am aware, no Australian University offers a subject in Economic Design. It should also be addressed at the policy formation level. Policy makers should be aware that they may need to go beyond their traditional sources of advice.

The second prerequisite is good experimental economics, which goes hand in glove with good theory. Virtually the same remarks apply. In particular, so far as I am aware, no Australian University offers a subject in Experimental Economics.

The third prerequisite, which is clear on both theoretical grounds and in experience, is that there needs to be a close partnership between economists and environmental scientists. The ecological systems that we deal with are complex, and require sophisticated understanding and management. The economic systems are equally complex, especially with respect to decentralised decision making, incentives and information constraints. Economic design in the environmental area requires an integration of expertise in both areas.

The final prerequisite, which is perhaps implicit in the first three, is meticulous attention to detail. Given these prerequisites, "market-based instruments" as implemented through a disciplined process of economic design, have an important role to play in environmental policy.

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Market-based instruments – International patterns of adoption, remaining challenges, and emerging approaches

Professor Alan Randall[1]

1. Introduction

In discussions of environmental policy, it has become a truism that command-and-control regulation is in eclipse and flexible incentives are on the rise worldwide. While there is some broad-brush truth to that claim, the change has been much more evolutionary than the rhetoric suggests.

First, command-and-control is not a convincing descriptor of the regulatory approach that predominated in the previous generation of environmental policy. It is true that the predominant regulatory instruments in the US and many other countries encouraged the adoption of prescribed pollution control technologies, thereby limiting the flexibility of regulated entities to minimize compliance costs (and this is no trivial matter), but the regulator hardly wore jackboots[2]. Typically, the regulator and a violator entered lengthy discussions about many things (not just the violation and its remedy, but also compliance costs, impacts on national and local employment and economic vitality, etc.), with resulting compromises of various kinds. Often, the violator could earn extensions of time, variances, and other regulatory indulgences by claiming to have made a diligent effort to solve the problem. And regulatory enforcement was restricted not only by the courts but also by limited agency budgets. Outcomes were negotiated rather than unilaterally imposed, albeit negotiated against a backdrop of design based regulations.

Second, flexible incentives (FIs) are themselves a complicated and ever-changing mosaic that includes market-based instruments (MBIs), negotiated agreements, voluntary agreements, industry standards and norms, and eco-labelling. These approaches cover a broad range of possibilities, which vary along several dimensions including the assignment of responsibility among different levels of government and between the public and private sectors, the choice of policy instruments, and the degree of rigor with which accountability is assigned and policies are enforced – the devil truly is in the details. Market based instruments (MBIs), especially pollution charges and pollution trading, provide the kind of flexibility that appeals to economists (flexibility to minimize the costs of pollution control), whereas polluters seem to be seeking also flexibility with respect to environmental targets and their enforcement.

In what follows, I provide a brief and necessarily sketchy review of progress around the world in adopting FIs of various kinds. In recent years, a growing number of countries have implemented MBIs, including pollution charges and pollution trading, to deal with a greater array of pollutants. However, adoption of negotiated and voluntary agreements, industry standards, eco-labelling and the like is growing even more rapidly. Research on the effectiveness of various FIs is beginning to accumulate, and I summarize some of the results (again, sketchily).

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[2] As a *Google* search quickly confirmed, the standard usage of "command and control" is military. Its application in environmental policy discourse seems to be an exercise in hyperbole aimed mostly at discrediting design standards approaches in order to advance the flexible incentives agenda.

The remainder of the paper focuses on pollution trading, with particular reference to water quality trading where nonpoint sources are part of the mix. Point-nonpoint (P-NP) pollution trading has been adopted in a few dozen US watersheds, but has thus far generated surprisingly few trades. An argument can be made that this stylized fact supports the case for trading policies (trading arrangements have stimulated cost savings on the P side even in the absence of trades), but many observers have attributed it, less sanguinely, to various flaws in existing trading schemes. A number of thoughtful observers (some of them in the regulatory agencies) are converging toward a more fundamental critique: the potential of schemes to trade measured effluents on the P side for promises to implement abatement technologies on the NP side is inherently limited (a point that, if true, has unsettling implications also for agricultural participation in carbon trading). I survey some of the alternative approaches under discussion, finishing with a brief summary of on-going research at Ohio State University, where we plan soon to begin implementing a group-performance contract for NP sources in a demonstration watershed.

2. Adoption of flexible incentives

Flexible incentives come in a wide range of configurations – so much so that no consensus typology has yet emerged (Andrews 2002). Here, I will use two broad classes, MBIs and other FIs. MBIs include pollution charges, pollution trading, and market reforms, and other FIs include negotiated agreements, voluntary agreements, industry standards, and eco-labelling. Each of these categories is itself broad, and includes programs that differ widely in rigor, scope, and effectiveness. Furthermore, data on adoption (typically by country adopting the program, and environmental problem addressed) are incomplete, uneven, and not always up-to-date. In some instances, there is more happening in the real world than appears in this data (e.g., certain programs are inadvertently omitted), but in other cases, there is less (adoption data include pilot programs, information clearinghouses, and proposals under study, such that the appearance of a country in these data might signify only that a proposal is under study in a single locality). With these caveats, I proceed to offer an impressionistic international survey of adoption of FIs.

2.1 Market-based instruments

2.1.1 Pollution charges

Pollution charges include effluent fees, deposit-refund systems, user fees, and tax differentiation favouring environment-friendly practices. OECD reports 70 country-programs of effluent fees (a country-program is one program in one country, such that a country with effluent fee programs for six different pollutants would count as six country-programs). Sixteen countries have programs for SO_2, 11 for NOx. Carbon taxes are in place in five northern European countries. Deposit-refund programs have been widely adopted, with 34 country-programs reported. Twenty-five countries have programs for beverage containers, while a variety of environmental concerns are addressed by programs in single countries (e.g., refrigerators in Austria, small chemical containers in Denmark, and plastic shopping bags in Italy). User fees are used in 13 countries, for things we might expect (sport fishing, hunting equipment, and inland waterways), but also for some things that might surprise us (e.g., auto batteries in Denmark, and fertilizers in Sweden). Tax differentiation is used in more than 20 countries. The US taxes insurance premiums for various components of the energy and chemical industries; 18 countries apply differential sales or VAT rates to motor fuels, and 13 countries have differential rates for new automobiles; and at least 20 countries offer tax incentives such as reduced rates for public transportation and accelerated depreciation for "green" investments. Whereas OECD reports focus mostly but not exclusively on the relatively rich countries, Anderson (2002) reports examples of programs in developing countries, including emissions/effluent fees in China, the Philippines, and several eastern Europe and former Soviet Union countries; taxes on leaded gasoline in Thailand and the Philippines; and many instances of favoured tax treatment or other subsidies for environmentally-friendly practices in various countries.

What most impresses the reader of reports such as those of OECD and Anderson (2002) is the vast variation within these categories. Emissions/effluent fees are quite large in some cases but laughably small in others; tax incentives range from substantial to relatively trivial; programs in some countries are national while others are local; and deposit-refund programs are mandatory in some jurisdictions but voluntary in others. Just counting country-programs clearly overstates the global spread and impact of pollution charges, because it includes many programs with few real teeth and, an economist would expect, commensurately modest impact on environmental quality.

2.1.2 Pollution trading

Pollution trading includes cap-and-trade programs and trading in pollution reduction credits (PRCs), and Stavins (2001a) expresses a clear preference for cap-and-trade programs. Cap-and-trade programs distribute pollution permits, strictly limited to meet ambient environmental quality targets, and encourage subsequent trading. Initial distribution could be by auction so that government captured the value of the right to pollute, or by "grandfathering" to ensure Pareto-safety for polluting firms. Firms with plans to enter the market or expand operations would need to purchase credits, so that their "new" pollution would be offset by reductions in other firms. Trade in PRCs could conceivably work just like a cap-and-trade system: the cap would be divided among firms which could earn tradable credits by reducing their pollution below their allowable cap. Stavins' concern is motivated by the observation that not all PRC trading programs are so rigorous. In some cases, PRCs are earned by imputed percentage reductions, not measured quantity reductions; in others, ambient quality is not assured because there is no effective requirement that new or increased pollution be offset by reductions elsewhere within the trading boundary.

Examples of effective cap-and-trade programs are CFC phase-out, phase-out of lead in gasoline and, especially, SO_2 allowance trading in the US. In the early years of SO_2 trading, observers were surprised by the relatively small number of trades and the relatively low prices of allowances (Burtraw 1996). One explanation is that the change from design based regulation to allowance trading involves two elements. Actual trading is preceded by a switch from design based to performance based regulation; and that this switch alone generated significant cost savings within firms. Nevertheless, a robust market in allowances eventually emerged, and compliance cost savings were estimated at greater than $1 billion through 1999 (Carlson et al. 2000), with welfare gains several times larger and consisting mostly of gains in human health (Burtraw et al. 1998). Despite its broadly acknowledged success, the SO2 allowance trading program has encountered some criticism, mostly for a perceived failure to address spatial (mostly upwind-downwind) concerns.

In the US, trading institutions, ranging from tradable permit markets to wetlands mitigation (one kind of resources-for-resources trading), have increasingly been used for protection of water quality (USEPA, 1992; Netusil and Braden, 1993; Keohane, et al., 1997; Stavins and Whitehead, 1997). Public trustees pressing claims for compensation for natural resource injury are now less inclined to assess the compensating monetary payment, seeking instead to determine the compensating scale of resource restoration, in order to implement resources-for-resources compensation (Randall 1997).

Traditionally, tradable permits were seen as a uniquely American preoccupation; in Europe and much of the world, serious consideration of incentive based instruments was limited to environmental fees and taxes. This is changing, as Australia, New Zealand, Canada, Mexico and nine European countries currently operate tradable permit systems for some particular environmental problems. OECD reports 42 country-programs involving tradable permits in 14 countries. Representative examples are shown below (Table 1). Not all are air or water quality programs – some more traditional programs dealing with fisheries, hunting, etc., are included. Examples from developing countries include emissions trading in Santiago, Chile (Anderson 2002); and China is studying proposals for water quality trading Rousseau (2001).

As with pollution charges, we might reasonably be concerned that mere numbers of programs may overstate the impact of pollution trading programs. Effectiveness depends on program details . Stavins (2001a) credits the success of SO2 allowance trading in the US to (among other things) provisions addressing exceedances with a stiff $2,000/ton penalty and a requirement that they be offset the following year.

Table 1. Tradable permit systems: examples as of December, 2002.

Traded item/category	Countries	Traded item/category	Countries
CO_2	Denmark	Wetlands	USA
	Norway	Fisheries	Australia
	Sweden		Canada
	United Kingdom		Iceland
NOx	Canada		Netherlands
	Switzerland		New Zealand
	USA		USA
SO_2	USA	Air quality	Canada
Water qual. trading	Australia		Chile
	USA		Poland
Hunting	Canada		Singapore
	Mexico		USA
Land use	France New Zealand	Other	Canada (maple grove permits)
	USA		USA (permits for lead in gasoline)

Sources: Anderson (2002), OECD (2003).

2.1.3 Market reforms

Market reforms include those that reduce the frictions impeding environmental markets and promote the internalization of externalities, and those that remove or reduce government subsidies for polluting activities, count also as MBIs. Under market reforms, Stavins (2001a) lists market creation (e.g., water markets and deregulation of energy markets), liability rules (particularly strong in certain Scandinavian countries), product labelling programs, and reporting requirements (e.g., for toxic releases). OECD (2003) reports 21 labelling or information reporting programs in 13 countries. Many labelling programs are voluntary and therefore are effective only if consumers seek labelled goods. Information reporting programs, such as the US toxic release inventory, are often mandatory. Anderson (2002) notes, among other market reforms, the elimination of fuel subsidies in China and subsidies on certain agricultural inputs in Egypt.

Stavins (2001b) concludes that the performance of MBIs in the US to date provides compelling evidence that these approaches can achieve major cost savings while accomplishing their environmental objectives. Nevertheless, he offers some “normative lessons” for design of effective MBIs. I highlight several:

- MBIs work best when emissions performance is the regulatory focus, and flexibility to choose abatement strategy is maximized.
- Trading programs work best when aggregate pollution standards are specified and absolute baselines not relative ones are used. That way, “paper trades” that actually increase aggregate emissions are avoided.
- Monitoring and enforcement are keys to success. Whereas programs with defective monitoring and enforcement typically have been ineffective, the successful SO2 allowance trading program has employed continuous monitoring and stiff penalties.

Public finance considerations have implications for the choice between pollution charges and trading, and between trading programs that auction permits and those that "grandfather" them. Pollution charges and auctioned permits generate revenues that may replace distorting taxes of various kinds, providing a fiscal benefit not provided by "grandfathered" permits, along with the standard net benefit from pollution reduction and the fiscal cost associated with the increased cost of the polluting industry's products (Goulder *et al.*1997). This argument is well-established in the literature, but has thus far made little impact in policy circles[3].

2.2 Other flexible incentives

The other major category of FIs is non-mandatory, i.e., negotiated and voluntary, approaches. These range from formal agreements between regulatory authorities and polluters to industry standards and eco-labelling adopted by firms or coalitions of firms seeking advantage in the marketplace (Khanna 2001).

2.2.1 Negotiated and "voluntary" agreements

These have become major tools in the regulatory arsenals of many countries in western Europe since the early 1980's. While the term "voluntary agreements" has achieved some currency, I tend to regard it as a misnomer. Such arrangements cannot be effective without a regulatory backstop, typically a credible threat of harsher regulatory action, and agreements negotiated in such a setting cannot reasonably be called voluntary.

Negotiated agreements are contracts between regulatory authorities and regulated entities (one thinks of a firm or industry, but often these agreements are between levels of government – a municipality reaches agreement with the relevant regional or national regulatory agency regarding, say, waste water treatment). Unlike traditional unilateral regulation, both the regulated entity and regulator contribute to policy formulation. This type of solution is being applied to a wide variety of environmental issues. The European Environmental Agency reported 312 active agreements in 1997 in 15 countries, covering climate change, water pollution, air pollution, waste management, soil quality, and ozone depletion. This seems to be the most recent attempt at a census of voluntary agreements in Europe, but it is reasonable to expect that the number has continued to grow since 1997. In the US, there are two EPA-sponsored programs that encourage negotiated agreements. One of these (Project XL) has engaged some major firms such as Intel, which provides some special challenges for environmental regulators, because its production processes, involving hazardous materials, change frequently, with each new vintage of computer chips (Mazurek 2002).

Given the extensive reliance on negotiated agreements in Europe, it is not surprising that they have attracted considerable research aimed at assessing their effectiveness and identifying characteristics that increase it. Most of this work involves detailed case studies of particular agreements. Bruyninckx (2001) has evaluated the negotiated agreements between municipal governments and the regional government of Flanders. DeClercq et al. (2000) report a comparative study of several negotiated agreements, and tested several hypotheses regarding performance of the agreements (see also CAVA 2001). OECD (2003) examined several voluntary approaches, including negotiated agreements, in rather detailed case studies. The picture that emerges from these various studies is quite consistent, and consistent also with the theoretical analysis of Segerson and Miceli (1998).

Here, I summarize the findings of Bruyninckx, with respect to the negotiated agreements that are widely used by the Flemish government. The provincial government, which had long neglected environmental policies aimed at municipalities, made it clear in 1992 that municipalities henceforth would be expected to commit to environmental improvement objectives. After about eight years of operating experience with this policy, Bruyninckx concluded, 38 percent of municipalities had met all of their commitments. He considers this a significant accomplishment given that the policy is

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[3] Nevertheless, this discussion was featured prominently at the EPA conference in Washington, DC, May 1–2, 2003 (website in References).

relatively new, the baseline level of environmental performance was low, and many of the municipalities in the noncompliant 62 percent had met at least some of their commitments. He observes that these kinds of agreements are more likely to effective, if:

- policy objectives can be accomplished even if there remains significant non-participation of potential actors (to put it another way, approaches stronger than "voluntary" agreements are necessary if success requires that everyone comply);
- the goals are clearly defined in terms of performance indicators;
- the agreements have a motivational or norm-setting aspect that can move other actors in the same direction;
- the obligations of all parties are clearly defined; and,
- a serious enforcement mechanism is in place.

2.2.2 Voluntary approaches

Voluntary approaches include government-sponsored programs, and industry standards and eco-labelling adopted by firms or industry groups seeking advantage in the marketplace. The USEPA has been active in sponsoring voluntary programs and agreements with firms and industry groups (Mazurek 2002). To qualify as voluntary in Mazurek's analysis, a program must provide for voluntary participation (e.g., Energy Star, an eco-labelling program for electrical appliances) and any agreements committing participants to environmental targets (e.g., the 33/55 pollution reduction program) must have no provisions for enforcement.

Citizen demand for environmental quality may motivate the behaviour of private firms, which rationally seek good environmental reputations (e.g., by implementing eco-labelling) and – if the best way to gain a good environmental reputation is to earn it – will do some environmental good in the process (Thogerson 2002). Eco-labelling may be initiated by individual firms, as in the case of dolphin-safe tuna (Teisl et al., 2003), by government agencies (e.g., Energy Star) or by industry associations.

Industry standards and codes - e.g., the International Standards Organization's ISO 14001 program, the Responsible Care program of the American Chemistry Council, and the Forest Stewardship Council's "certified forest products" program - apply the principles of eco-labelling at the industry level. Participation provides a means of signaling "greenness" to consumers, and such codes have achieved some environmental successes. Impacts can be substantial when industry leaders such as Ford and General Motors require their suppliers to be certified under ISO 14001 (Nash 2002), and when major retailers of forest products such as Home Depot and IKEA can be persuaded to stock only "certified" products (Teisl 2003).

Nevertheless, OECD (2003) concludes that the environmental effectiveness of voluntary approaches is often questionable, and their economic efficiency is generally low. While administrative and transaction costs vary greatly among voluntary approaches, it is clear that if too few resources are spent in their preparation, negotiation and enforcement, their environmental impacts are likely to be modest. Combining a voluntary approach with a tax or a tradable permit system can trigger quite significant additional administrative costs, and the environmental integrity of the other instrument can be weakened. Randall (2002) concludes that "innovations such as voluntary (or negotiated) agreements, industry codes, and green marketing should be viewed as promising additions to the environmental tool-kit, but they should supplement, not supplant, the regulatory framework. They make a nice frosting on the regulatory cake. But the cake itself must be there."

3. Water quality trading

In the US, water quality trading enjoys enthusiastic support among federal policy makers, seeking to emulate the widely acknowledged success of the SO2 allowance trading program that has saved compliance costs, met environmental quality targets, and enjoyed the support of the regulated industry. Since 1970, design based standards have enjoyed considerable success in reducing water pollution from point sources, so that remaining problems are attributable disproportionately to non-point sources, including agriculture. Effluent trading has appeal in the P source context mostly as a way of reducing compliance costs, but in the NP context its appeal is even stronger: given the long-standing exemption of agriculture from serious environmental regulation and the "polluter pays" principle, and the dismal environmental performance of approaches that subsidize "best management practices" (BMPs), P-NP trading holds the promise of at last inducing some serious abatement from agriculture.

Rousseau (2001) reports 46 water quality trading programs around the world, 40 of them in the US. Of these 40, 37 are trading programs or pilot programs approved by the USEPA (the remainder involve informational clearinghouses, web-based trading calculators, etc.). All the water quality trading programs that include NP pollution envision the NP sources as sellers of PRCs. Responsibility for ambient water quality is assigned to the P sources, who must meet the targets alone, or pay NP sources to help; that is, these programs do not bring "polluter pays" to the agricultural sector.

Despite the approval of these 37 US water quality trading programs, there is less here than meets the eye. At last count, these 37 trading programs had generated a total of six actual trades; obviously, the median number of recorded trades per program was zero (King and Kuch 2003). What explains the paucity of trades? Perhaps trading programs have induced P to introduce cost-saving innovations, and have thus generated economic benefits even in the absence of trades, much as Burtraw (1996) observed in the early years of SO2 trading. Some of this happened, I would concede, but it cannot be the whole story. Existing trading programs are design based, and bogged-down with rigidities and inefficiencies that contribute to their relative failure. The bureaucracy remains intrusive: PRCs gained from implementing BMPs are calculated from simulation models, not measured; trading ratios (t-ratios), which discount calculated PRCs from NP abatement in order to provide the regulators some assurance that water quality targets would be met, were so high as to impede trade; and in the early trading programs (such as the Tar-Pamlico, North Carolina, program) "prices" were set not in the market but by bureaucrats.

3.1 Trading practice

Standard P-NP trading schemes are designed for trading in pollution reduction credits. Pollution from P sources is capped or otherwise penalized, so that a P source seeking to reduce compliance costs or increase effluents will seek to buy PRCs. NP sources want to sell PRCs, but it is in the nature of non-point pollution that individual contributions to total pollution, or to its reduction, are not readily verifiable. So, NPs are able only to offer to implement BMPs approved by the regulator; that is, P-NP trading programs are design based on the NP. Furthermore, capacity to monitor the BMPs is limited, so the NP source actually offers promises to implement BMPs. The regulator translates promises to implement BMPs into PRCs, using models to predict the pollution reduction gained by implementing BMPs, and then applies a t-ratio (always greater than 1.0; a t-ratio of 3 may be typical) to impose a degree of conservativism on the calculation of PRCs earned. As indicated above, trades have been rare. Clearly, there are design issues in the BMP trading programs that have been established (Schary 2003): programs have been designed without sufficient stakeholder input to assure buy-in; programs have not always dealt effectively with the spatial considerations impacting the effectiveness of on-farm practices in reducing ambient pollution loads at some point downstream; and "trading" programs where bureaucrats determine the price are surely rather timid experiments with pollution markets. I would endorse all of Schary's concerns, and argue also that trading programs premised on NP sources offering promises to implement BMPs are inherently problematic.

3.2 Why are P-NP trading ratios so high?

Even if all of the other problems with P-NP trading were resolved, high t-ratios are sufficient to limit seriously the potential of P-NP trading, because they reduce the number of PRCs that can be sold as a result of implementing a given suite of BMPs, thereby increasing the effective costs faced by NP producers of abatement. Why are t-ratios typically so high? Most observers agree that the regulator's motivation for t-ratios greater than 1 is to reduce the chances of failure to meet ambient water quality targets. Assuming that effluents from P sources are routinely measured, whereas those from NP sources are merely estimated, a t-ratio greater than 1 would reduce the probability that random error in estimating NP abatement would result in failure to meet the abatement target[4]. But, random error in estimating NP pollution abatement is, I argue, the least of the regulator's worries. More pressing concerns include the following.

- The abatement performance of BMPs on farms is necessarily estimated, not measured – performance may have been measured under experimental conditions but is, by the definition of NP sources, not readily measurable under field conditions. It is reasonable to expect that field performance is not just more variable, but also worse on average, than performance under experimental conditions.
- The regulator's faith in the performance of farmers in implementing BMPs is undermined by possibilities of adverse selection and moral hazard.
    - Moral hazard arises because the regulator has limited capacity to monitor BMPs on farms. Farmers may simply fail to implement BMPs. Even for BMPs having a fixed investment component that may be observable, there is the possibility that the farmer may stint on variable inputs that complement the fixed component. To illustrate the issue, imagine a cosmetic BMP that third-party observers cannot distinguish from an effective BMP, but costs less. Farmers may be tempted to implement the cosmetic BMP.
    - Adverse selection arises when the regulator or P sources are at risk of contracting with an inferior group of NP source abaters. The moral hazard described above would lead logically to adverse selection, because those farmers who intend to implement the cosmetic technology might be among those most willing to offer to implement BMPs.

These concerns, along with the higher NP pollution abatement costs imposed by the design based arrangements on the NP side of existing P-NP trading schemes, suggest that the rather unimpressive performance of existing programs might be attributable to inherent flaws in those programs. In fact, the enthusiasm of US regulators for water quality trading seems greater in Washington than in the field, and greater where agricultural pollution is a relatively minor part of the mix[5]. Those working most closely with trading programs that depend on strong participation from agriculture seem to be suffering some loss of optimism King and Kuch (2003).

Given that design based approaches to NP abatement have been disappointing, it makes sense to consider performance based approaches. The abatement performance of individual sources is not readily observable, but the aggregate contribution of a group of NP sources to ambient pollution loads at some point in a stream readily can be measured. These considerations provide motivation for developing a group performance contract for NP pollution abatement.

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[4] Horan (2001) argues that this logic is false: regulators seek to meet not abatement targets but quality standards and, with the greater uncertainty pertaining to the quantity of NP pollution, a failure-averse regulator would be motivated to reduce the proportion of NP pollution in the mix, and would therefore apply a t-ratio less than 1. Greater uncertainty of NP pollution should imply a premium, not a discount, on NP abatement. Horan's argument requires some special assumptions (e.g., NP pollution is uncertain, whereas P pollution and abatement performance for both P and NP are not), and ignores the issues that (I argue below) matter most in understanding high t-ratios.

[5] For example, currently there is some optimism about prospects for trading programs that include urban storm-water run-off.

3.3 Mechanism design – a group performance contract

A group performance contract would have obvious advantages: NP sources could sell PRCs, eliminating the trading ratio, and individual NP sources would be free to choose least-cost abatement technologies. However, a successful group performance contract would need to solve the moral hazard and adverse selection problems. The moral hazard problem may be attacked via a contract that makes individual payments conditional on team output, so that each individual is made worse-off by any action that reduces team output. Solving the moral hazard problem would eliminate one kind of adverse selection (those intending to shirk are over-represented among those offering NP abatement), but other adverse selection concerns remain. Agents have different abatement resources and technologies, and therefore different costs, but agent's type is private information. A contracting process is needed that will attract low-cost abaters into the contracting group. Our research group at Ohio State has recently developed two such contracts (Pushkarskaya 2003, and Taylor 2003). Pushkarskya's contract solves a 2-stage generalized agency problem.

1. The regulator offers to buy pollution reduction credits from a contracting team of NP sources. The adverse selection problem is solved via a bidding process that selects the least-cost team of NP abaters.
2. Individual abatement targets are assigned and enforced within the team.

The incentive-compatibility of this contract can be proven only if it is assumed that team members know each other's costs. While this clearly assumes greater knowledge than exists, it is reasonable to assume that NP sources in a sub-watershed (neighbors farming in a natural amphitheater) have better information about each other's costs than the regulator.

Taylor's contract relaxes the assumption regarding team members' knowledge of others' costs. He, too, solves a 2-stage generalized agency problem.

1. The regulator solves the adverse selection through an abatement procurement auction. NP sources bid individual abatement quantity and associated price; the contracting team is formed from the lowest cost bidders.
2. Moral hazard is solved by an "all-or-nothing" team contract – all are paid if the aggregate NP abatement target is met, but none are paid in the event of a shortfall.

3.3.1 Contract application and evaluation

On-going research at Ohio State is moving toward application of these contracts. Pushkarskaya (working with psychologist Hal Arkes) is exploring the performance of her contract in a structured series of experiments. Among other things, various assumptions may be relaxed, including the strong assumption that farmers know each other's abatement costs. Currently, experiments are underway with students in a laboratory setting, but soon she will begin to experiment with farmers using a mobile laboratory.

Our research team has completed a series of focus groups using Taylor's contract with farmers. After the usual sorts of focus-group questions and discussion, the group participates in a sequence of two experiments with the contract. Each participant, provided with private information about his resources and abatement costs, offers by sealed bid (abatement amount offered and payment asked) to join the team. A team of low-cost bidders is chosen, and each team member submits a sealed statement of how much abatement he will actually attempt (which may be equal, greater, or less than the amount bid). Uncertainty about abatement performance is introduced by a weather lottery to determine the actual abatement delivered (less than the abatement attempted if the weather is unfavorable, and more if it is favorable); aggregate abatement is calculated; and individual payments are made if the group target is met or exceeded, but not if there is a shortfall. In subsequent discussion, the participants learn the opportunity costs associated with strategic mistakes (bidding too high or low, attempting too much abatement or too little, etc.). Then, the experiment is repeated. Generally, we concluded, farmers become quite comfortable with the contract by the second experiment. One interesting finding is that farmers tend consistently to worry more about unfavorable weather than shirking within the group, as sources of possible failure to meet the group abatement commitment.

The next step with Taylor's contract will be to take it on the road, to conduct experiments with farmers using the mobile laboratory. The final step in research currently planned will be a demonstration in a watershed in Ohio, where farmers have agreed to use Section 319 funds (money that typically is used to subsidize implementation of BMPs) for payments to farmers as specified by Taylor's contract. Why would farmers agree to such an arrangement? I would not want to discount frustration among enlightened farmers concerning the lack of demonstrated success of current NP pollution abatement programs. Nevertheless, I think these farmers were attracted also by the profit opportunity – under this contract, farmers can profit from abatement if they can find cost-saving ways of accomplishing it.

4. Concluding comments

After roughly two decades of reliance on design standards regulation to control pollution, the seeds of change were evident by the end of the 1980s. Design standards regulation, with its focus on large-scale polluters (the "smoke stacks and effluent pipes" approach), had accomplished significant reductions in ambient pollutant nationwide, but had come increasingly to be regarded as inflexible, inefficient, and stifling to innovation, all of which tend to increase pollution control costs. In addition, changes in the economy – the service sector grew faster than manufacturing, and more dispersed modes of manufacturing gained at the expense of traditional, concentrated forms – necessitated changes in the standard ways of doing environmental regulation (Rejeski and Salzman 2002).

Economists were early and vigorous proponents of market-based instruments, especially pollution charges and pollution trading, to provide polluters the flexibility to minimize compliance cost. Stavins (2001b) speaks for most economists, when his "normative lessons" consist mostly of endorsing MBIs while arguing for more flexibility in choice of control strategies at the firm level, within a framework of strict pollution caps and rigorous monitoring and enforcement. However, polluters seeking flexibility also with respect to environmental targets and their enforcement have enjoyed some success in many jurisdictions around the world. Flexible incentives include some sorts of MBIs and all manner of voluntary approaches that make environmental economists nervous, and many analyses (most recently, OECD 2003) tend to confirm these fears: the mushier sorts of FIs are inadequate stand-alone instruments, but may have useful roles in combination with more traditional instruments. The approach recommended by Randall (2002) is hierarchical: serious environmental regulation to protect human and ecosystem health is the foundation, and MBIs are the favored instruments where feasible. That much is standard economics. Yet, because we economists are no longer quite so sure we have all the answers, the policy framework should be open to experiments with a variety of flexible policy instruments used to supplement traditional regulatory tools, and good environmental citizenship should be encouraged for industries, firms, public agencies, and individuals.

In the US, water quality trading is all the rage among federal policy makers, seeking to emulate the widely acknowledged success of the SO2 allowance trading program. However, empirical support for their enthusiasm is hard to find. On the contrary, the 37 EPA-approved water quality trading programs around the US have thus far generated little in the way of trades and/or water quality improvements. King and Kuch (2003) argue that the design flaws of existing P-NP trading programs can be overcome but, nevertheless, P-NP trading programs are likely to enjoy widespread success in the US only when two pre-conditions are in place: regulatory pressure on NP sources is increased substantially, and government programs shift away from subsidizing on-farm BMPs. I do not disagree that farmer-polluters have enjoyed too little regulation and too much subsidization, but I have argued above that design based P-NP water quality trading programs are fundamentally flawed. Regulators have good reasons (contrary to Horan 2001) to insist on high trading ratios, but high t-ratios impede NP source participation in trade.

On-going research at Ohio State is taking performance based approaches to NP pollution control seriously. We have designed group performance contracts for NP pollution abatement, and we are currently testing them in focus groups and laboratory experiments, and just beginning a real-money application in a demonstration watershed in Ohio. These group performance contracts could be used in either Pigovian or allowance trading contexts. While our initial thinking was addressed to the standard context of NP polluters as sellers of abatement, these contracts could be applied in modified form to the “polluter pays” setting – if all farmers in a subwatershed were assessed a collective penalty for water quality violations, they could seek to lower their costs (compliance costs plus penalties) by contracting with a sub-group consisting of the lowest-cost abaters among them.

I conclude with three comments. First, on-going research at Ohio State has us (the researchers) excited. Nevertheless, the reader should understand that at this point our claims are limited to having good reasons for taking the approach we are taking, optimism about prospects, and some early successes along the way.

Second, we do not claim that group performance contracting is a new idea. Rather, it has been around in the general literature since the 1970s and in the NP pollution context since the 1980s. Until recently, it has been a non-starter in the mainstream NP policy discussion, so why should it be taken seriously now? We at Ohio State could claim some credit for designing contracts that solve some of the problems in earlier contracts, and developing a carefully phased (“baby steps”) approach to implementation. Perhaps we are having, or will eventually have, an impact. But there is something else at work in bringing group performance contracts back onto the agenda: increasingly widespread frustration about the failure of existing policies to reduce aggregate NP pollution, and the failure of existing P-NP trading programs to emulate the success of SO2 allowance trading. Successful water quality trading depends on some serious breaks with present approaches.

Finally, the weak performance of design based P-NP trading programs that hold P polluters responsible for stream quality but offer them the opportunity to buy promises to implement BMPs from NP polluters, has implications for a variety of potential trading programs involving agriculture. If emerging trading programs for carbon dioxide, dryland salinity, etc., are based on farmers selling promises to implement BMPs, the performance of existing P-NP trading programs provides ample reason for skepticism.

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What new tools and techniques have been tested internationally? How do they work? What is their potential for application to NRM problems?

Professor Charles R. Plott[1]

The behaviour of economic systems and the consequences of policy are tightly linked to the strategic and reactive behaviour of individuals. Central aspects of such behaviours are the substance of wide ranging research. An important new tool that helps in examining the actions of individuals and analysing their implications is provided by rapidly developing laboratory experimental economics

Techniques (Plott 1989 and Davis and Holt 1993 provide useful introductions and surveys).[2]

The lessons of an experiment are derived from the fact that general theories should work in the simple and special cases and if they do not, then they can be rejected as being general theories. The step from basic laboratory science - control, treatment and replicability - to policy making, is facilitated by the methodology 'experimental testbedding' (Plott 1994)[3], in which a policy is implemented in a laboratory environment. If a policy does not work in a simple testbed environment then it is not reasonable to expect it to work if implemented in a complex field setting. Thus the laboratory exercise can be formulated as a 'proof of principle'. If a policy operates acceptably in a testbed environment it must do so for theoretically understandable reasons; it must pass a 'design consistency test' in which it is demonstrated that the behaviour of the process is consistent with the behavioural principles upon which it is built. If the behaviour of the policy is acceptable but not understandable then there is no ground for believing that the policy would operate in the same way in similar but more complex environments.

Experimental testbedding can be applied to a single policy process as a tool for discovering design problems early on and hence reduce the possibility of policy failures, which could be very expensive to society and Government. The methodology also provides a tool for testing competing policies by observing them operating in identical environments.

> *'The evidence is there - market mechanisms and incentives work - especially when they are based on sound science, and not political science - and when they also factor in economic science……, in moving forward with programs such as these, we don't come up with something that sounds good and run out and do it. First, we do the research and the analysis to determine whether what sounds like a good idea really is a good idea. Only after testing that idea - and finding it has merit - do we move forward. That's the difference between sound science and 'political' science when it comes to environmental policy making.'* Remarks of Governor Christine Todd Whitman, Administrator of the U.S. EPA, EPA Conference on Market Mechanisms and Incentives, Washington D.C. May 1, 2003.

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The role of laboratory experiments in the demonstration and design of markets for pollution[1]

Lata Gangadharan [2] and Charlotte Duke[3]

Abstract

In this paper we provide a survey of experimental economic methods, and how these methods have been used to aid policy makers design and demonstrate new approaches to public policy. In particular we focus on experiments and the design and demonstration of markets for pollution. Experiments, however, have a wider application relevant to policy makers. Experiments could be useful to policy makers in the following areas:

- Determining how to introduce competition into natural monopoly industries, such as electricity where distribution may have monopoly characteristics.
- Environmental management systems to determine if consumer demand responds to environmentally friendly methods of production.
- Genetically modified foods to study how information on labels influences consumer preferences.
- Designing markets for water, salinity, nitrogen or phosphorous in different catchments.

1. What is experimental economics?

A large majority of economic phenomenon are based on the behaviour of individuals: the laws of demand and supply are based on individuals' valuation of a good and therefore their willingness to pay or willingness to supply at different prices. Knowledge about how individuals act and react to different kinds of economic stimuli forms the basis of a significant amount of research in economic theory and policymaking. For example, how do different taxation regimes influence individual willingness to pay or willingness to supply? An important new tool that helps in examining the actions of individuals and in analysing their implications, is provided by rapidly developing laboratory experimental techniques (Roth 1988 and Plott 1989 provide useful surveys of the field).

Laboratory experiments use special cases to inform more complex cases. Take for example markets for environmental management - water, salinity, nitrogen, biodiversity. The policy objective is to design a market that reduces the total cost of environmental management efficiently and equitably. The first question policy makers would be interested in is whether a market has the potential to reduce the cost of environmental management as compared to alternative policy mechanisms. Laboratory experiments can be designed to compare the (expected) cost savings under alternative policy mechanisms (see section 3.1).

[1] A previous version of this paper was published as a Division of Agriculture Working Paper. The views expressed in this paper are those of the authors and not necessarily those of the Department of Natural Resources and Environment Victoria.

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In addition, when designing a market for environmental management policy makers will need to consider[4];

- The trading institution by which property rights are traded between participants (see Section 3.2).
- The trading rules (see Section 3.4).
- The effect of uncertainty in the market (see Section 3.3).
- Minimization of the potential for market power and collusion (Section 3.5).
- How information is transferred in the market (see Section 3.2, specifically the *Los Angeles Clean Air Incentive Market*).
- How to minimize transaction costs (see Section 3.6).

The observations derived from the experiments can then help policy makers determine which elements should be included in the market, and how they should be incorporated to minimize cost and maximize efficiency and equity.

An important part of laboratory experiments are the substantial financial incentives that are actually paid to subjects. Subjects actually earn money and must repay any losses incurred during the experiment. There is no role playing in the experiment. The value that people place on the outcomes of policy is replaced in the laboratory by the possible financial payment (loss) that an individual will get (incur) in an experiment depending upon the outcome of the process. With the control provided by incentives, conflicts across the objectives of different individuals can be induced; and, simple mechanisms for resolving the conflicts can be implemented in a laboratory environment and in a manner that is theoretically understandable.

Subjects in an experiment could be university students, bureaucrats who can participate in a policy that they have designed or actual participants such as farmers, water authorities or councils who would be influenced if the policy was implemented in the field.

The lessons of an experiment are derived from the fact that general theories should work in the simple and special cases and if they do not, then they can be rejected as being general theories. For example, experimentalists create simple markets in which, theoretically speaking, the laws of supply and demand (and various incarnations of the law) are expected to be observed in operation. In fact, such models do operate with a great deal of accuracy[5]. Small group experiments, to which game theoretic models can be applied, provide an opportunity to test theories of strategic behaviour, theories regarding bargaining, theories of voting behaviour, etc.

Thus laboratory processes are appropriate testing grounds for general theories about behaviour. Many replications of experiments across different subject pools, experimenters, societies, countries and differing experimental procedures have provided evidence that the behaviours observed in laboratory experiments are a consequence of the decision mechanism and not some special aspect of subjects or procedures (see Section 4). Theories of economics and political science have been substantially influenced by the data from such laboratory experimentation and as a result many of the basic principles found in the literature are backed by solid experimental data. The study of the simple cases reveals the nature of errors and inaccuracies of theories and in response to the data the theories have become modified and improved.

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[4] This is not a comprehensive list, for example the issue of market power and collusion is only cursorily discussed in this paper.

[5] Plott (1983) employs experimental methods to test the theory of social cost. The experimental sessions illustrate that the laws of supply and demand in the presence of an external cost do operate as expected; economic agents respond to private cost not social costs.

The most important advantages of laboratory methods are replicability and control. Replicability refers to the capacity of other researchers to reproduce the experiment and hence results in independent verification of the outcomes. Data from naturally occurring processes (like field data) suffers from the disadvantage that there are often unobserved factors which have an impact on the variables of interest, and these factors are constantly changing, so comparing field data at different points of time would be difficult as there are many factors to control for. Control is the capacity to manipulate laboratory conditions so that the observed behaviour can be used to analyse different theories. In some cases, it is impossible to find natural field data that match the assumptions of the theory (for example, it might be difficult to find economic situations where individuals face questions that directly test the axioms of expected utility theory). In other cases, the data collected could be too messy to be able to distinguish between alternative theories.

1.1 The use of experiments in environmental policymaking

From the perspective of policy development, experimental economics is ideally suited to the examination of emergent markets such as emissions trading.

The step from basic laboratory science to the application of laboratory methods to policy is, however, a big one. The step is facilitated by a methodology of "experimental testbedding" (Plott 1994) in which a policy is implemented in a laboratory environment. If a policy process does not work in a very simple laboratory testbed environment then it is not reasonable to expect it to work if implemented in a complex field setting. Thus, the laboratory exercise can be formulated as a "proof of principle". If a policy operates acceptably in a testbed environment it must do so for theoretically understandable reasons. Formally speaking, the policy must pass a test of "design consistency" in which it is demonstrated that the behaviour of the process is consistent with the behavioural principles upon which it is built. If the behaviour of the policy is acceptable, but not understandable, then there is no ground for believing that the policy would operate the same way in theoretically similar, but more complex environments.

The testbed need not be applied to a single policy process. The methodology provides a tool for testing competing policies by observing them operating in identical environments. New policies can evolve from combinations of those that were tested. At a minimum the data from experiments places a burden on advocates of a losing policy to explain why the evidence should be ignored (Plott 1983), or what type of testbed might yield different results.

As a practical matter the experimental testbeds provide a tool for discovering policy "bugs". Implementation of a policy means that every feature must be made operational. Exactly who does what and when must be specified. Who signs what and who is informed about what and when, are all important details that can have pronounced influences on behaviour. This forcing of detail, commitment to detail, and the interaction of detail with behaviour, can uncover problems with design early on and hence reduce the possibility of policy failures, which could be very expensive to society[6].

2. Emissions trading

To understand the concept of emissions trading, it would be useful to view it in a very simple framework, ignoring the clutter of implementation issues and practical details. Thus the context of a perfectly competitive economy is taken with perfect enforcement and monitoring procedures and efficient mechanisms for emissions trading.

Approximately four decades ago, Dales (1968) demonstrated that in theory an emissions trading system, in which permits to emit pollutants are held by polluting sources and are freely tradable, would induce rational firms to reduce pollution at the least possible cost. This simple but intuitive theoretical argument has been developed, and refined many times since then (see Montgomery 1972,

[6] Plott (1987) reviews a number of ways in which experimental methods could be applied to policy questions.

Tietenberg 1985 and Baumol and Oates 1988). In the presence of asymmetric information and heterogeneous abatement costs, tradable permits can allocate abatement responsibility between polluting firms at least cost. This is because tradable permits create incentives for firms to reveal their private marginal utility (marginal valuation) from an additional permit. The revealed marginal utility reflects the firm's private marginal abatement costs. The market acts as an arena for the transfer of this private information. Trading will continue until marginal abatement costs are equalized across permitted firms. When marginal costs are equalized economic surplus is maximized and a given environmental standard is reached at lowest cost. Other regulatory instruments such as command and control incur higher costs to equalize heterogenous marginal costs with asymmetric information (Gangadharan and Duke 2001 provide a discussion of command and control mechanisms compared to taxes and tradable permits).

The practical details in implementing an emissions trading system are however crucially important. The aim should be therefore to design a system that comes as close as possible to realizing the significant benefits that are theoretically possible. Many important issues such as the nature of the permits being traded, the extent of a mandatory market in permits, the possibility of banking permits, the transactions costs involved in trading and the market power of some of the participants must be considered in designing a practical emissions trading program. Experimental economics can provide important insights into the design of trading systems and in the next section we discuss a body of literature that utilizes the experimental laboratory to explore the different features of these markets.

3. Experiments in emissions trading

3.1 Efficiency comparisons; alternative policies for correcting external costs

A significant motivating factor for the development of emissions trading is the perceived cost savings as compared to the command and control approach. Some of the initial experimental work in this area focused on the efficiency gains achieved by market-based programs.

Plott (1983) was the first to use experimental methods to examine the performance of permit trading in the presence of externalities. Plott compared tradable permit markets to emission taxes and command and control methods. He used the double auction trading institution, which is probably the most commonly used laboratory trading mechanism[7]. The double auction (Smith 1962, 1964) is symmetric in that both buyers and sellers can actively post and accept prices in a public manner. There is typically an improvement rule, which specifies that bids (offers) must be successively higher (lower). Plott (1983) found that efficiency levels increased significantly when the regulatory policy was shifted from command and control to tradable permits (from 34.4 percent to 98.3 percent)[8]. Tradable permits performed better than emission taxes as well (average efficiency levels for taxes were 93.3 percent as compared to 98.3 percent for tradable permits) although in the tax compared to permits sessions the increase in average efficiency was not statistically significant.

Subsequent concerns regarding the permit market have focused upon the actual structure and operation of the market in terms of efficiency, participation, volume of trade, price of permits, transaction costs incurred by participants, heterogeneity of market participants and uncertainty.

[7] The Double Auction is the most efficient and competitive of laboratory trading institutions (Smith 1962), and the Double Auction retains efficiency under environments of imperfect competition. For this reason the Double Auction is often used as a benchmark from which to determine efficiency of alternative trading institutions.

[8] Efficiency in experiments is defined as the actual gains from trade as a proportion of the maximum possible gains from trade.

3.2. Trading institutions

Many recent experiments have evaluated features of the trading institutions implemented or planned for specific emissions trading programs. Trading institutions can have a major impact on price accuracy and volatility in the market[9].

3.2.1 The U.S. federal SO_2 trading program

Policy-makers can influence the choice of trading institutions, and the implications of this choice are clearly seen in the US federal SO_2 trading program designed to reduce acid rain. The US Environmental Protection Agency designed a new call auction for trading allowances to emit sulphur dioxide. In order to encourage early, centralized trading with low transaction costs, the EPA initiated a sealed bid, discriminative price auction in which the highest bids for permits are matched to the lowest offers and the successful bidders pay their bid price[10]. The sellers in this market receive the bid price of a specific buyer. The objective is to maximize economic surplus to the seller. Each bid and ask affects transaction prices and that creates strong incentives for traders to strategically manipulate the market. This auction has been criticized for generating biased price signals as the auction rules cause sellers to choose asking prices that under-reveal their true cost of emission control because lower asking prices increase the probability that a seller trades with high-bidding buyers. Combined with the well-known result that buyers have an incentive to under-reveal demand in discriminative auctions in which they have to pay their bid price (Vickrey 1961), the EPA rules could lead to downwardly biased prices in the market (Cason 1993 and 1995).

Cason and Plott (1996) conduct twelve experiments to evaluate the performance of the EPA auction and compare it to an alternative trading institution: the uniform price auction. In the uniform price auction the bids and asks are arrayed as demand and supply schedules and all trades occur at a uniform price where the demand and supply curves intersect. In this auction design only the bids and asks at the margin affect the uniform transaction price. Cason and Plott (1996) confirm the theoretical prediction that the EPA auction design creates strong incentives for both buyers and sellers to under report their true values and costs of emissions control. In the uniform price auction, as only the marginal trades affect price, traders have an incentive to truthfully reveal their valuations in their bids and asks. Hence uniform price auction trading rules can result in unbiased price signals and more efficient market outcomes as compared to the EPA auction.

Franciosi et al. (1993) focused on the properties of Revenue Neutral Auctions (RNA) and compared them to auctions where revenues were not distributed to firms[11]. Franciosi et al. conduct experiments to compare the RNA to a uniform pricing auction. In the RNA the revenue from the sale of permits were returned to auction participants based on some assignment of property rights.

In brief, the RNA works as follows: K permits are given to N bidders by some predetermined process (grandfathering, for example). If k_i represents bidder *i*'s grandfathered permit rights, $\Sigma k_i = K$. All bidders are required to offer their permits for sale immediately at a government sponsored auction. So all firms enter the auction as buyers. Each bidder submits a demand schedule for permits. The bids are arrayed from the highest to the lowest and the K highest bidders win permits at the auction. The market price is the same for all units, it is the price at the intersection of the revealed bidding

[9] Price accuracy refers to mean price deviations from the predicted competitive equilibrium by period for each experimental session. Price volatility refers to variability of price about the mean price as measured by a coefficient of variation.

[10] The bids are arranged from highest to lowest and the asks are arranged from the lowest to the highest. The lowest ask is matched with the highest bid and the trade occurs at the bid price. Lower asking prices receive higher trading priority and thus lead to higher received prices.

[11] Revenue neutral auction rules were being considered for the EPA auctions in the initial discussion stages. Eventually, a variant of the RNA was adopted for the actual auction rules. The major difference between the auction adopted and the revenue neutral auction is that the one adopted had discriminative rather than uniform pricing rules.

schedule with the inelastic supply curve : K, the number of permits for sale at the auction. The market price is the highest rejected bid. Each successful bidder pays to the government $p*q_i$, where p is the announced uniform price in the market and q_i is the number of units bidder *i* purchased at the auction.

The distinguishing feature of the RNA is the system for distributing the receipts from the auction. Each bidder receives a payment equal to the market value of their grandfathered holding of permits, $p*k_i$. Each bidder makes a net payment of: $\delta_i = (q_i - k_i)*p$ to the government. If $q_i > k_i$, the bidder is a net buyer of permits and makes a positive payment *to* the government. If $q_i < k_i$, the bidder is a net seller and receives a positive payment *from* the government. This auction is called revenue neutral as $\Sigma\delta_i = 0$ (Franciosi et al. 1993).

In the uniform pricing auction, all bidding revenue accrued directly to the seller. Although the pricing mechanism in RNA is identical to the Uniform price auction, the revenue neutral aspect is a nontrivial feature that could alter the performance of the institution. Franciosi et al. (1993) found that the RNA markets perform as well as the uniform price markets both in terms of trading prices and efficiency levels. Therefore, revenue neutrality does not influence the efficiency of the auction market. However, as is expected, the two institutions differed in terms of the distribution of gains from trade, with bidders who are large net sellers relative to their initial endowments gaining the most from the revenue rebate feature.

Cronshaw and Brown-Kruse at the University of Colorado designed an experiment to capture most of the features of the mandatory emissions allowance market under the 1990 US Clean Air Act, including the mandatory transfer of a fraction of permits to the market each period [12], a discriminative call auction, banking of permits and the availability of permits at a fixed price. Cronshaw and Brown-Kruse (1999) found that subjects were able to achieve about two-thirds of the gains theoretically available from banking alone and an additional 39-78% of the potential gains when trading was allowed.

Franciosi, Isaac, and Reynolds (1999), at the University of Arizona, designed an experiment that allowed both a mandatory auction (similar to the EPA auction) and a continuous private secondary market. Each trading period consisted of two opportunities to trade: the private market followed by the auction. The private market was organized as a double auction trading institution and the auction was a sealed bid discriminative auction with a revenue rebate feature. All bids made in the auction were public information (ie, subjects can see the summary of all buy and sell prices and quantities entered in the market at the end of the period) and banking of permits was allowed between trading periods in some sessions. Franciosi et. al. (1999) found that efficiency is improved by trading but that prices in the private secondary market do not always coincide with those in the auction. This could be due to the simultaneous operation of these two trading mechanisms, as subjects are required to arbitrage between the market and the auction[13]. They also found that banking of permits may allow speculative bubbles as indicated by a tendency of the price of the permit to collapse at the end of the session. When banking of permits is allowed, permits become similar to durable assets. Previous experimental research (Smith et al. 1988) has shown that asset markets are susceptible to price crashes and price bubbles. It is seen that in the permit market it is difficult for the subjects to form price expectations when subjects do not have much experience with the trading process and when there is not much trading history to be observed. The authors argue that in the field, this difficulty in

[12] The EPA withholds a portion of each firm's annual emission allowance. The withheld allowances represent 2.24% of total allowances. This is to facilitate trade between permitted facilities and to allow new firms to enter the market.

[13] Franciosi et al (1999) discuss this incomplete arbitrage as a failure of the Rule of One Price. In many of their experimental sessions, market prices were different from the prices from the auction, even at the end of the session. Even when the market prices were near the auction prices, there was usually a significant spread in the auction market bids. The authors suggest that more experiments would need to be conducted to investigate this issue further.

forming price expectation could be higher due to the uncertainties about technology and about the strength of property rights.

3.2.2 Nitrous oxide trading program in Southern Ontario, Canada

The Canadian government has been evaluating proposals for a nitrous oxide allowance trading program in Southern Ontario. The proposal intends to create two trading assets: coupons and shares. Each coupon would entitle the holder to discharge one ton of nitrous oxide within a year. Shares entitle the holder to a stream of coupons for future years. Coupons would be valid indefinitely, ie, banking would be allowed. Coupons would be distributed to firms in proportion of their holding of shares, where shares may be allocated on the basis of grandfathering, for example. The market institution proposed is unstructured, and private negotiated trades in coupons and shares are expected to develop.

Researchers at McMaster University have conducted a series of laboratory experiments to testbed aspects of this emissions trading proposal. Muller and Mestelman (1994) conduct experiments where subjects are allowed to trade coupons and shares simultaneously. They adopt the experimental design developed by Cronshaw and Brown-Kruse (1999), however they replace the market institution used in the Cronshaw Brown-Kruse experiments with an institution that resembles the one proposed for Southern Ontario. In Muller and Mestleman (1994), the trading institution used is an open outcry market, which is similar to the pit trading on commodity exchanges. The open outcry institution permits multiple trades among agents and allows contracts to be negotiated privately. Muller and Mestleman (1994) find higher cost savings than do the laboratory implementations of the US EPA institutions using the same parameters. However transaction prices show a mediocre performance as in some sessions, the prices do not converge to the competitive equilibrium levels. This is argued to be due to the lack of public information about trading prices. The open outcry property of the institution increases the likelihood that more information is disseminated than in laboratory markets discussed in Chamberlin (1948) (a search market) upon which this institution is patterned[14]. However a lot less information is disseminated than in an alternative trading institution like a double auction market, in which prices do converge faster in most experimental environments.

The performance of the alternative trading institutions is often evaluated using the following five benchmarks (Cronshaw and Brown-Kruse 1999 and Mestleman, Moir and Muller 1999):

- The command and control benchmark (CC). The CC benchmark represents the performance of the market if neither trading nor banking is allowed. In this case all coupons are used by the subjects to whom they are issued in the period that they are received.
- The perfect foresight competitive equilibrium (PFCE). The PFCE represents performance if subjects trade and bank optimally overtime.
- The banking only equilibrium (BOE). The BOE represents the performance if subjects do not trade, but use their allocated coupons optimally over time.
- The myopic competitive equilibrium (MCE). The MCE represents performance if subjects trade optimally in each period but do not bank.

[14] Chamberlin reported the first market experiment in 1948. Trading in his markets were unregulated and unstructured. Subjects were permitted to circulate freely around the classroom to negotiate with others in a decentralized manner. Transaction prices were posted after the trade was completed. He found that market outcomes, particularly transactions quantity, deviated from competitive predictions. Vernon Smith who was a subject in these experiments, later argued (Smith 1962) that decentralized trading that occurred as students wandered around the room was not the appropriate institutional setting for testing the theories of perfect competition. As an alternative, he devised a laboratory double auction in which all bids, offers and transaction prices are public information and showed that such markets converge to competitive outcomes, even with a small number of traders.

- The adapted competitive equilibrium (ACE). The ACE for each period is the perfect foresight competitive equilibrium conditional on the current inventory of coupons. This equilibrium is calculated for any particular period by adding the total coupons remaining to be distributed to the current inventory, allocating them equally over the remaining periods and reading the price off the aggregate demand schedule for coupons in the current period. Hence if coupons are overused in the initial periods of a session, the ACE price will be higher than the PFCE price.

These benchmarks attempt to isolate each of the features of the tradable permit market (banking and trading) and help to evaluate if markets would perform better if these features were included separately or together. Table 1 summarizes the cost saving realized in the University of Arizona, University of Colorado and McMaster University sessions, where these benchmarks were used. (The trading institution used in these experiments and the results obtained are discussed above: Cronshaw and Brown-Kruse 1999 - the EPA discriminative call auction, Mestleman and Muller 1994 - open outcry trading institution, Franciosi, Isaac, and Reynolds 1999 - EPA discriminative call auction and a private market operating as a sealed bid discriminative trading institution).

The first point to note is that all trading institutions realized positive cost savings relative to command and control. This finding reiterates the experimental observations of Plott (1983) (see section 3.1). The McMaster sessions exhibit higher cost savings than do the laboratory implementations of the US EPA plan. For example, for the Perfect Foresight Competitive Equilibrium: the mean percentage of the PFCE cost saving is 74% for the McMaster sessions as compared to 26.4% and 56.3% for the other two sessions. This implies that in the McMaster sessions, where the trading institution is open outcry, the subjects could bank and trade more optimally as compared to subjects in the other sessions. If we compare the mean percentage PFCE cost saving to the mean percentage MCE cost saving, banking (PFCE) does not lead to gains greater than if subjects trade optimally but do not bank (MCE). Banking, however, is important to minimize unexpected short or long positions at the end of a trading period in the market and therefore reduce uncertainty and risk in the market. The three experimental sessions above allowed for dynamic linkages between periods by banking coupons. Mestleman et. al. 1999, therefore, suggest that it might be best not to allow banking in lab environments, but that some method of overlapping permits such as that suggested by Carlson et. al. 1993 (Carlson et. al. 1993 is discussed below in the *Los Angeles Regional Clean Air Incentive Market*) or a futures market may be needed to encourage good banking decisions .

All three experiments used the same number of firms with the same abatement cost parameters and the same endowments of coupons. The experiments, however, differed in the training of subjects and in the market institution modeled. The McMaster sessions were not computerized whereas the other two were implemented using computers. Participants in all three locations could be described as experienced, however the training of subjects differed in the three places. Relative to the McMaster subjects, the Arizona and Colorado participants were inexperienced and this could in part explain their poor performance in terms of costs savings. The Arizona and Colorado sessions include subjects who were participating in the institution for the first time or subjects who may be familiar with the trading institution, but who had not made decisions linked with monetary payoffs.

Difference in market institutions could also explain some of the difference in performance. The Colorado environment seemed the least complex for subjects. They had to participate only in one market and they needed to allocate their coupons over time and to decide on the marginal value of additional coupons. The McMaster institution was more complex, as it allowed subjects to continuously trade in shares and coupons throughout the period. The Arizona trading environment was the most complex, and subjects needed to participate in both the sealed bid auction and the secondary market. This could also have contributed to the poor performance of the Arizona sessions in terms of cost savings.

Table 1. Abatement cost savings experience from Arizona, Colorado, and McMaster sessions using Colorado parameters

Session	Cost Saving over Command and Control	Coefficient of Variation	% of PFCE Cost Saving[a]	Mean % of PFCE Cost Saving	% of MCE Cost Saving[b]	Mean % of MCE Cost Saving
Arizona						
(Fanciosi et. al. 1999)						
R10	2656		27.4		31.3	
R11	806	0.749	7.5	26.4	9.5	33.4
R12	5043		46.9		59.4	
Colorado						
(Cronshaw and Brown-Kruse 1999)						
1	3215		29.9		37.8	
3	5892		54.8		69.4	
5	7623	0.283	70.9	56.3	89.7	71.2
6	6451		60.0		75.9	
7	7086		65.9		83.4	
McMaster						
(Mestelman and Muller 1994)						
ET1-1	7962		74.1		93.8	
ET1-2	8904		82.8		104.8	
ET1-3	9993	0.200	92.9	74.0	117.6	93.6
ET2-4	5912		55.0		69.6	
ET2-5	7004		65.1		82.4	

Source: Mestelman, Moir and Muller (1999).

Notes: Cost savings are in laboratory dollars.

Coefficient of Variation: Standard Deviation/Mean for the corresponding set of cost savings.

[a] % of PFCE Cost Saving: Cost saving/Theoretical Maximum of PFCE cost saving.

[b] % of MCE Cost saving: Cost saving/Theoretical Maximum of MCE cost saving.

3.2.3 Los Angeles Regional Clean Air Incentive Market

A few experiments were also conducted to testbed the design in the Regional Clean Air Incentive Market (RECLAIM), a tradable permit program implemented in Los Angles to reduce the emissions of sulphur and nitrogen oxides. Carlson et al (1993a,b) showed that issuing permits with overlapping compliance cycles would avoid the need for banking of permits[15].

Cason and Gangadharan 1998, compare the performance of an electronic bulletin board market designed by the regulatory authorities in RECLAIM, to a computerized double auction market. Instead of leaving the market entirely to brokers, the regulators initiated an electronic bulletin board system (BBS) to help RECLAIM participants find trading partners and reduce search costs. Anyone can obtain a password to access this computerized network. The BBS allows firms to indicate trading interests by electronically posting offers to buy or sell permits. Other firms can scroll through these offers and contact the offering firm to negotiate a transaction. The two institutions being compared, differ in that the computerized double auction has no bilateral negotiation, has a successive improvement rule and the bids and asks are binding on the proposer. The BBS institution has none of these features and further, the BBS allows traders to publicly post and privately reveal additional information in regard to trades (Cason and Gangadharan 1998). This form of market organization is relatively new, and until now its performance characteristics have not been assessed using laboratory methods. Some other assets trade using bulletin board markets, such as small stocks, foreign stocks, and limited partnerships on Nasdaq[16].

A recent example of Bulletin board trading is the Chicago Board of Trade Recyclables Exchange Program, a major national electronic trading marketplace to buy and sell recyclable materials[17]. Over 50 companies and municipalities from across the country are participating in this recyclables exchange market. The recyclable materials that are traded include various grades of glass, paper or plastic. Another BBS market is Waterlink, which was developed in cooperation with the Westlands Water District, the largest agricultural water agency in the country. Farmers in California's Central Valley buy and sell water through this BBS, which contains information such as bids, sales, prices, volumes and types of water (PERC Reports 1997). Some of the benefits of all these bulletin board institutions include providing easier access to a larger number of buyers and sellers and timely and more accurate price information. Information available through the BBS can provide easily accessible indicators of market conditions and reduce market uncertainty. An important advantage of the BBS is that it can handle trade of heterogeneous goods.

Overall the results from Cason and Gangadharan (1998) indicate that the electronic bulletin board system does not lead to highly inaccurate transaction prices. The bulletin board sessions generally performed as well as the continuous double auction in terms of price accuracy and volatility. The mean price variations from the predicted competitive equilibrium were not substantially different for the two institutions. The coefficient of variation indicated that price volatility was less in the BBS institution then the continuous double auction. However, the two did not differ substantially.

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[15] To increase liquidity in the market, the compliance schedule for firms is staggered into two cycles. The regulatory authority randomly assigned cycles until about fifty percent of the total allocations were placed in each cycle. Cycle 1 facilities have an annual compliance year of January 1 through December 31. Facilities in cycle 2 have an annual compliance year of July 1 through June 30. Transactions can be conducted with firms in either cycle. This overlapping two-cycle system reduces the likelihood of permit shortages or surpluses at the end of a compliance cycle (Carlson and Sholtz 1994). Overlapping compliance cycles were considered as an alternative to banking, as banking was seen by some Environmental groups as a way of postponing pollution.

[16] In 1990 the National Association of Securities Dealers began a pilot electronic bulletin board market for small stocks and foreign stocks (Los Angeles Times, June 1, 1990; Wall Street Journal, June 11, 1990). In 1994 limited partnerships were added to the Nasdaq electronic bulletin board (Wall Street Journal, May 6, 1994).

[17] See http://www.envirolink.org/archives/recycle/0230.html for bulletin board information.

3.2.4 Emissions trading in China

Emission trading is spreading to the developing countries as well. Rich and Friedman (1998) discuss a permit-trading program that has been implemented on a pilot basis in five cities and is being considered for widespread trading throughout China. Their experiments show that the trading rules designed by the Chinese EPA (a matching market institution) could lead to low efficiency and under-revelation of bids and asks. The matching market model used by the Chinese regulators maximizes the volume of emissions reduction given the revealed ability (or willingness to pay) of the buyers for the emissions permits. This auction is intended to increase trading volume[18]. The auction rules match the highest bid with the highest ask not exceeding that bid, then the next highest bid with the highest remaining ask less than that bid and iterates until the bids are exhausted. As in the case of the US federal SO_2 program, this auction design creates strong incentives for traders to not reveal their valuations truthfully. In the matching market institution, buyers substantially understate their willingness to pay and sellers understate their willingness to accept. Cason and Plott (1996) confirm the disincentive for traders to truthfully reveal their private valuations in such discriminative price market institutions (section 3.2). When a market institution attempts to discriminate with a single good, rational traders know that each bid affects the marginal bid. Buyers know that by bidding under value they increase the probability that they will receive the good at a lower price. Sellers, by understating their willingness to accept know they increase the probability of receiving a higher price for their good. The authors use different kinds of theoretical equilibrium models (Bayesian Nash Equilibrium predictions, Adaptive Learning models etc.) to explain how the matching market results in lower efficiency, more volume and less value revelation than an alternative trading institution like the uniform pricing market.

3.3 Uncertainty

Ben-David et al (2000) explore the specific effects of uncertainty in tradable permit markets on prices, trading volume and the firms' ability to realize cost savings. Their theoretical model addresses individual firm behaviour when future permit prices are uncertain and their results suggest that risk-averse sellers of permits abate less under uncertainty than under certainty and risk averse buyers of permits abate more under uncertainty[19]. Since sellers of permits abate less, they supply fewer permits and the market supply of permits decreases. The buyers of permits abate more, they demand fewer permits and the demand curve for permits also decreases. Hence the number of permits traded in equilibrium could fall with no clear prediction for permit prices. Two types of uncertainty are tested separately in the experiments: uncertainty regarding time at which the permit allocation will be reduced and uncertainty regarding the magnitude of the reduction[20]. The experimental results show that firms respond to uncertainty by adopting a 'wait and see' approach with respect to certain decisions they feel they can feasibly postpone. Hence uncertainty does not lead to decreases in trade volume and ex-ante trading prices are also not affected by uncertainty. The authors suggest that a plausible explanation for these experimental results is that due to the irreversibility of investment in abatement technology there is an incentive for potential buyers to abate less and rely on the permit market until the uncertainty is eliminated and then make the necessary adjustments. This "wait-and-see" strategy, would leave the firms in a more flexible position to make ex-post adjustments in terms

[18] Permit trading in China would involve an offset ratio greater than 1, implying that the seller eliminates more than 1 ton of emissions for each 1 ton permit acquired by a buyer, so increasing the trading volume would help the regulator meet its goal of reducing total emissions.

[19] Sellers are those firms whose initial endowment of permits is more than they would like to hold in equilibrium given their private costs and market price prevailing at the time. Buyers are those whose initial endowment is less than they would like to hold in equilibrium given private costs and market price prevailing at the time.

[20] The authors argue that while quantity uncertainty is not the same as price uncertainty, it should be an appropriate assumption for their analysis as with linear abatement cost functions a simple change of variable leads one from a probability distribution over quantity to a probability distribution over price. In addition the mean preserving change in uncertainty with respect to quantity will also be mean preserving in price.

of final holdings of permits and abatement levels. While this does lead to a reduction in ex-ante expected cost savings, it may ex-post be optimal in view of the irreversibility of investment in abatement technology. Of course, by waiting for more information firms could be forgoing abatement during earlier periods that could in turn lead to more expensive compliance efforts later. Due to the uncertainty in the permit market, firms could also be uncertain about their future role as potential buyers or sellers of permits and this reinforces the "wait and see" strategy.

3.4. Different trading rules

Cason and Gangadharan (1998) study the impact of the trading restrictions introduced in the Regional Clean Air Incentive Market (RECLAIM), Los Angeles. Trading restrictions are imposed across two zones of the Los Angeles Basin to avoid trades that lead to emissions migration that could harm air quality[21]. They study the impact of inter-zone trading by introducing it as a treatment variable.

In all sessions some sellers were endowed with Coastal permits and other sellers were endowed with Inland permits, and some buyers could only purchase Coastal permits. In one treatment the remaining buyers could only purchase Inland permits. This treatment represents the policy choice of no inter-zone trading (autarky). In the other treatment some of the buyers could purchase either Coastal or Inland permits. This treatment represents the policy choice made by the regulator to allow Inland firms to buy permits originating in either zone[22]. In all sessions the within-zone demand and supply conditions imply a lower price in the Coastal zone than in the Inland zone. This deliberate setting of autarky equilibrium Inland prices in excess of autarky equilibrium Coastal prices operates as a disincentive to trade Inland to Coastal in line with RECLAIM trading rules while not explicitly setting trading rules in the experimental environment. Theory therefore predicts that Inland prices will exceed the Coastal prices in the autarky treatment without inter-zone trading, and that Inland prices will equal Coastal prices in the treatment with inter-zone trading permitted as emissions migrate from the coastal to inland zone. Consistent with this prediction, prices were significantly different in the Coastal and Inland zones for both trading institutions in the autarky treatment.

When trading across zones was permitted, prices equalized across zones in both relevant double auction sessions, but only equalized across zones in one of the two relevant bulletin board market sessions. The failure for prices to equalize in both bulletin board sessions could have arisen from experimental traders not executing all profitable trades. There was a failure for experimental traders in one bulletin board session to import all profitable permit units from the Coastal to Inland zone. Nevertheless, gains from trade with inter-zone trading were 4 to 17 percent higher than gains from trade with no inter-zone trading.

3.5 Market power

Within experimental economics, the issue of market power is related to the analysis of different kinds of trading institutions (for example: one sided versus double auctions) and the ability to exercise market power under alternative trading institutions. Smith (1964) compared the bid, offer and double auction trading institutions in laboratory markets, and found that the bid auction prices tend to be greater than the double auction prices which again tend to be greater than offer auction prices. Smith (1981) used a series of experimental markets to show that a wide variety of market outcomes could occur, between competitive and monopolistic, in single seller markets, depending on the trading institution used.

Of the institutions considered, the double auction was seen to be robust to market power pricing outcomes. This was due to the fact that within this institution, non-market power firms can withhold

[21] Tradable permit schemes with no geographic restrictions can result in concentrated emission hot spots when the pollutant does not mix uniformly in the air or water shed.

[22] This restriction is intended to limit upwind (Coastal) emissions to maintain air quality improvements downwind (Inland).

demand; hence indirectly forcing the firm with market power to lower prices. Smith described this apparently unorganized, collective behaviour among buyers as a form of tacit collusion. The result was near competitive market prices, although traded quantities were reduced. Smith and Williams (1989) also replicated these results.

Muller et. al (2001) conduct experiments in which they aggregate the five buyers into a single monopsonist or the five sellers into a single monopolist. Muller et. al. (2001) consider market power from both sides and adopt a crossover design that allows subjects to participate in both a market power and a competitive market environment in each session. In any one session, they switch between competition and market power and back again. This allows them to contrast between the two market structures. The main result from this area of research is that market power outcomes are frequently observed. Muller et. al. (2001) also find that the double auction's apparent robustness to market power pricing outcomes is not as general a result as the previous experimental literature by Smith (1981) would suggest. However, widespread price discrimination implies that trading efficiency is not hampered as market price in the double auction converges to (near) competitive equilibrium price over time, whereas income distribution effects emerge as the most important consequence of imperfect competition as equilibrium quantity is less than competitive equilibrium.

Soberg (2000) examines the impact of market power in emissions trading markets, when the trading institution is one sided (like the offer auction and the bid auction). He also finds that market power can be primarily interpreted as an income distribution issue and not an efficiency issue: Price is near competitive equilibrium price (the monopolist is unable to extract monopoly rents) but the quantity traded is less than competitive equilibrium.

Permit trading, whether under a single sided or double auction, yields an approximately cost effective allocation of emissions despite monopolization of the permit market.

3.6 Transaction costs

Regulators must make numerous design choices when implementing new permit markets, and many of these design choices affect the transaction costs incurred by market participants. Regulators must also decide how to endow firms or consumers with permits. Recently laboratory experiments have been used to study how transaction costs interact with the initial permit endowment to influence the cost-effectiveness of the overall emissions abatement (Cason and Gangadharan 2001). With zero transaction costs, the initial endowment affects only equity, and not the cost-effectiveness of the final competitive allocation of permits following trading. In the presence of transaction costs, however, cost-effectiveness can be significantly compromised depending on the endowment mechanism used.

Abundant anecdotal evidence exists regarding the presence of transaction costs in emission permit markets (e.g., Atkinson and Tietenberg 1991). However systematic empirical evidence is scarce (Kerr and Mare 1995, and Gangadharan 2000). Transaction costs can arise at various stages of trading. Prior to entering the market, the firm has to learn the rules of the market, work out its optimal production plan and decide whether or not it will trade. Once it obtains information about the market and decides to trade, the firm searches for trading partners and initiates negotiations. Hence, the potential sources of transaction costs incurred by firms in tradable permit markets include search, information, bargaining and decision costs. Another source of transaction costs is the settlement costs of finalizing a trade. The seller must deliver the permit as agreed in the contract, and transaction costs might be incurred to enforce the contract.

Cason and Gangadharan (2001) focus on the impact of two treatment variables: transaction costs and the initial permit endowment. They study treatments in which these marginal transaction costs are zero, constant and declining. The sessions with zero transactions costs are conducted to serve as a baseline case. Constant marginal transaction costs can be thought of as the cost of reporting a trade to the regulatory authority or fixed permit brokerage commissions, which remain the same (per unit) regardless of the quantity traded. Declining transaction costs might occur, for example, if brokers offer quantity discounts, if commissions do not depend directly on the units traded (such as fixed "per trade" commissions), or if traders' transactions costs decline as they acquire more experience in the market. Sellers in this laboratory market pay the transaction costs as is common in many financial and housing markets. In some markets in the field both buyers and sellers (or only buyers) pay transaction fees, but in equilibrium the fees' overall impact on the market is the same regardless of who pays. The other treatment variable considered is the initial endowment of permits. The initial endowment of permits is set to either 20 percent of the equilibrium permit holdings or 60 percent of the equilibrium permit holdings. The 20 percent endowment treatment corresponds to the case in which endowments are not closely tied to past or projected emissions, while the 60 percent endowment treatment is closer to an historic output (i.e., grandfathering) or current output allocation scheme.

Subjects are randomly assigned as sellers and buyers. All sessions have 5 sellers and 5 buyers. The results of the experiments indicate that transaction costs drive a wedge between buyers' and sellers' marginal costs of emission control, so they cause prices and final allocations to deviate from the zero transaction cost competitive equilibrium. This experimental observation supports the theoretical prediction, (Stavins 1995), that the cost-effective solution is no longer equalization of the marginal cost of abatement between permitted firms but the equalization of the sum of marginal abatement cost and marginal transaction costs. Furthermore, Cason and Gangadharan (2001) find that the deviations are equally great with constant marginal transaction costs, irrespective of the accuracy of the initial endowment of permits. With decreasing marginal transaction costs, by contrast, the deviations from the zero transaction costs competitive equilibrium are lower when the initial endowment is further away from the cost-effective allocation. This is because the more inaccurate endowment requires a higher transaction volume to approach the cost-effective allocation, which leads to lower marginal transaction costs when marginal transaction costs are decreasing.

4. Criticisms of experimental methods

It is often argued that the decision makers in the economy are more sophisticated than average undergraduate students, who usually form the subject pool in experiments. This criticism is more relevant for some types of experiments (for example, to examine theories relating to trading in futures markets) than for others (for example, studies of consumer shopping behaviour). To test if the composition of the subject pool matters, the behaviour of decision makers recruited from naturally occurring markets has been examined in a variety of contexts (Smith, Suchanek and Williams 1988, DeJong et al. 1988, Mestelman and Feeny 1988). Behaviour of these decision makers has typically not differed from that exhibited by more standard and far less costly student subject pools. For example, Smith Suchanek and Williams 1988 observed price bubbles and crashes in laboratory asset markets, with both student subjects and business and professional people. However choosing a specific participant pool could be appropriate in some instances and could be helpful to convince policy makers about the application of results in a particular field. For example, a small group of farmers could participate in an experiment to test the impact on efficiency and profits of alternative trading rules in a salinity-trading scheme.

Another criticism is in relation to 'external validity'. External validity refers to the situation where the model to be tested in the laboratory includes all the complex relationships present in the field. Many experiments would not pass the external validity test. Plott (1999), however, argues that a test of external validity constrains ideas about experimental design and inhibits the use of experimental methods (p.309). External validity denies the possibility of understanding complex phenomena through the study of simple cases based on theory. The theory, upon which the complex field process will operate, provides a link between the simple and the complex. Laboratory experiments, as discussed in the Executive Summary of this paper, take general theories of behaviour and test them in simple and special cases. If the general theory does not work in the simple case, or if it works but not for theoretically understandable reasons, then there is no reason to expect the theory of behaviour upon which policy is designed to work in a complex field setting.

Experiments cannot be thought to be the solution to all economic problems. Important issues in experimental design, administration and interpretation would need to be continually examined. Experimental methods are an excellent complement to other empirical techniques, such as econometric measurement and simulation of complex scenarios, however they should not be considered as substitutes.

5. Conclusions

Experimental economics attempts to investigate economic theories and institutions in an environment subject to the control of the experimenter. In particular, experimentation provides a controlled way to investigate the stability and efficiency of an economic institution. The implementation of a proposed trading institution or policy in a laboratory setting, could also serve as a demonstration that communicates the nature of emissions trading to policy makers. Experimental testbeds help us in uncovering problems with the design early on and hence reduces the possibility of policy failures, which could be very expensive for society.

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Session 2:
Lessons for Australian MBI development
(Three parallel poster paper sessions)

See Appendix 1 for abstracts of poster papers and Session 2a from Day 1 for short papers of poster paper prize winners

Session 3:
Limits to markets and integration

The importance of targets and values in market-based instrument development

Jeff Bennett[1]

Abstract

The use of market-based instruments in natural resource management offers important potential cost savings in achieving assigned targets. Their appeal in this regard needs to be considered with regard to efficiency concerns. Specifically, the setting of the targets to be achieved under market-based instruments requires that marginal benefits are equal to marginal costs. Given that marginal costs will be in part determined by the type of market-based instrument used, the setting of the target will be dependent on the means by which the target will be achieved. Of particular interest is the role of transaction costs as a component of marginal costs. Different market-based instruments are likely to be associated with different levels of search, monitoring, enforcement and other transaction costs. Incorporating transaction costs into any process of setting targets is therefore a key step. The possibility of market-based instruments transaction costs exceeding the net benefits generated by their introduction should be recognised. Furthermore, the estimation of the marginal benefits arising from achieving the target is also important in setting the target. Because many of the benefits involved are non-marketed, this necessitates the use of valuation techniques that go beyond markets. If serious attempts are not made to estimate these marginal benefits, rent-seeking behaviour on the part of vested interest groups may well emerge.

Keywords: market-based instrument, transaction costs, non-market valuation.

1. Rules at the margin

The fundamental rule that can be used as a guide to the assessment of resource allocations in terms of their economic efficiency is the equality of marginal benefits and marginal costs. Where this maxim is breached, there is the potential for Pareto improvements through the reallocation of resources. The simple intuitive logic of this rule makes for easy conceptual understanding: if the benefits of more resources being allocated to a specific use exceed the costs of doing so, then it makes good sense to take advantage of the marginal net benefit that is available. Conversely, where the costs of using more resources for a particular purpose exceed the extra benefits so generated, logic suggests reducing the allocation of resources.

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Whilst equating marginal benefits with marginal costs ensures efficiency in the interaction between producers and consumers, it is also necessary to consider the ways in which production is achieved. Society will be made better off if resources are used cost-effectively. That is, those with the lowest costs of production should produce the level of output required to equate marginal benefits with marginal costs. This situation is signalled by the equating of marginal costs across the various producers. A situation where marginal costs are not equal shows that production activities could be reassigned between producers so as to reduce the overall costs of production. Higher marginal cost producers would give way to lower cost producers until all marginal costs were equal. To have unequal marginal costs would signal the existence of wasted resources and hence the potential for welfare improvement.

Economic theory demonstrates that the operation of markets under a rarefied set of assumptions will ensure the simultaneous fulfilment of these equi-marginal conditions (Johansson 1991). Overall output levels are assigned so that marginal benefits equal marginal costs where the level of marginal cost is determined so that it is the same for all producers. The assumptions underpinning this efficient and cost effective outcome primarily relate to the perfect flow of information between economic entities. Markets determine prices that signal marginal cost and marginal benefit information between producers and consumers.

However, the application of the equi-marginal principles is not so simple in reality. We do not live in a world of perfect information flows. For example, the existence of transaction costs brought about through institutional structures that fail to define and defend perfectly private property rights creates complexities. Hence, resource allocation is confounded by the 'theory of the second best': if there are breaches of the equi-marginal principles in the market for one resource, their application in the case of another, related resource may result in inefficiency.

Even more complex is the situation where transaction costs are so high that they swamp the net benefits from trade and so no market emerges to allocate the resource.

In many cases of such so-called market failures, society is prepared to accept the second best world of market-based allocation, acknowledging that the costs of collective action to achieve improvement would be greater than the benefits so generated. However, in other cases, societies see the potential for collective actions that would generate marginal benefits in excess of marginal costs – and so create welfare improvements – even after transaction costs have been accounted for. In developing such collective actions, societies still need to be mindful of the equi-marginal principles given an overall desire to avoid wasting resources and hence to maximise the value being generated for society from the available resources. Overall efficiency and cost-effectiveness are desirable outcomes for collective action as well as private action.

2. Brown and green economics

This recognition of efficiency and cost effectiveness concerns is fundamental in the welfare economics of both private and public goods provisions. It is also well articulated in the literature that centres on negative externalities, most prominently in the pollution control or 'brown' environmental economics literature (Teitenberg 2003).

The process of formulating a response to the presence of pollution is seen as involving two stages:

1. Determining the level of pollution control that equates marginal control costs with marginal damage costs (the marginal benefits of reducing pollution); and,
2. Ensuring that those involved in reducing pollution have the same marginal control costs.

Whilst pollution represents a negative externality arising from an economic activity, the control of pollution is recognised in the above process as one of providing a public benefit: the action of controlling the pollution involves a cost whilst the control itself offers benefits in the form of the avoided pollution damage. The vestment of rights, however, is usually such that the polluter pays the costs and those who would otherwise suffer the damage caused by the pollution receive a benefit. This is achieved through the implementation of policies such as Pigovian pollution taxes (where polluters are required by law to pay a tax equal to the marginal damage costs of their pollution) or the trading of pollution permits (where polluters are required by law to purchase a permit if they wish to operate).

The introduction of pollution taxes and permits has been heralded as a more economically efficient way of dealing with pollution, compared against command and control style regulations that, for example, dictate the use of ‘best available technology’. The main arguments to support this claim are that under such ‘market-based instruments’, polluters are given a dynamic incentive to reduce their costs of pollution control and that polluters will operate so as to ensure the equality of marginal control costs across all sources. They are however, no ‘magic bullet’ because their implementation still encounters the same problem of imperfect information that limits the operation of ordinary markets in such conditions. Specifically, information on the marginal damage costs and marginal control costs are required in order for the state to set the level of the tax or the total amount of pollution control that is required.

In other words, whilst the tax/permit system is able to ensure cost effectiveness endogenously, it is unable to generate, internally, information required as to what is the efficient level of pollution control. Other ways of generating this information must be found if the tax/permit system is to produce not only cost effective pollution control but also an efficient level of pollution control.

The same logic developed in the pollution control literature is now finding a place in ‘green’ environmental economics. Here the benefits sought by the community are those generated by nature protection. They include direct use benefits (such as tourism and recreation), passive use benefits (such as flood mitigation and water quality protection) and non-use benefits (such as existence and bequest values) associated with curtailing the development of natural ecosystems or their restoration. The costs of achieving these benefits include the costs of resources directed to the protection/restoration effort (fencing material, water supply equipment, labour etc) and the opportunity costs of enterprises foregone (such as the agricultural profits given up when land is set aside in conservation reserves).

For society to make the most of its available resources, the equi-marginal principles’ logic requires that the benefits of additional protection/restoration efforts are matched by the marginal costs of provision. Furthermore, the costs of additional efforts to protect/restore should be equal across all the sources of protection/restoration.

A key development in the green environmental economics literature is the recognition that market-based instruments can be just as effective in the delivery of ecosystem protection/restoration benefits as they have been demonstrated to be in the delivery of pollution control benefits. The application of market-based instruments in the ‘green’ context can be through the setting of a Pigovian subsidy paid to those who provide the protection/restoration benefits or through the establishment of protection/restoration ‘permits’ that allow holders to receive payment from the state for a pre-assigned or ‘target’ amount of protection/restoration work. Both the tax/subsidy and permit styles of mechanisms are designed to ensure that the lowest marginal cost suppliers are the ones that carry out the restoration/protection works. Both are designed to give dynamic incentives for the development of lower cost provision.

There are some important differences to note between the ‘brown’ and ‘green’ applications. Foremost is the difference in property right vestment. In the pollution case, the established application appears to be that those who carry out the pollution control works must pay the marginal costs. However, in the ecosystem protection/restoration case, the norm in the process being established in Australia is for the suppliers to be paid for their efforts. Hence in the brown case, society is seen to have an implicit right to a clean environment and industry has no prior right to carry out its activities. In the green case, landowners have an implicit right to carry out activities that reduce ecosystem protection and society has no prior right to the benefits that an ecosystem offers when it is protected from development.

There are also some key similarities between the brown and green cases. Both applications of market-based instruments are designed to ensure cost effectiveness of supply. However, both applications require the state to collect information about the level of supply that will ensure economic efficiency. In the brown case, the optimal level of pollution must be defined. In the green case, the optimal level of ecosystem protection/restoration must be defined.

3. Values … the missing MBI link

So whilst market-based instruments are designed with the equality of marginal costs across alternative producers in mind, they do not address the overall efficiency condition of equality between marginal benefits and marginal costs. Hence, pollution permits require the specification of an absolute amount of pollution control that is to be achieved. It is through the specification of such a 'cap' on pollution that scarcity of permits is generated and the basis on which a market for permits can operate. Similarly, ecosystem protection permits require the specification of an overall level of restoration/protection activity. This target level – or alternatively, an amount of funding allocated for the purpose – establishes the scarcity of resources available for works and hence forms the basis for a market to be established. Without the setting of these overall amounts, market-based instruments cannot operate.

However, just as in the regulatory regimes designed to be usurped by market-based instruments, the setting of the overall caps and targets has predominantly been the province of government or bureaucratic decision making.

Is the political/bureaucratic process for determining the 'efficient' level of supply likely to provide for marginal benefits to be equated with marginal costs? Political economy suggests to the contrary. The prospects for vested interest groups to pursue rents through the political process are significant. Politicians in their setting of caps and targets have the capacity to 'pay' for political support. Vested interest groups have a demand for the rents available. For instance, conservationist lobby groups would like to see tighter pollution controls and extensive budgets allocated to ecosystem protection. The benefits they achieve from their political lobbying come at a cost to people other than themselves. The price they must pay for these rents relate to their capacity to deliver political support – votes in marginal electorates for example. None of these factors relate to the extent of marginal benefits and costs.

Will bureaucratic processes counteract the distortions likely to arise through the political process? Again, the answer is most likely negative. The incentives that drive bureaucratic behaviour are personal and not necessarily closely aligned with the goals of society as a whole. They may relate to career progression, power maximisation or a desire to achieve their own environmental protection goals and again have little resemblance to the desires of society.

With decisions regarding the setting of market-based instrument caps/targets being taken at the political or bureaucratic level, the real danger is that all of the cost effectiveness advantages of market-based instruments could be overwhelmed by the inefficiencies created through rent seeking.

What is required is a public process of value determination and analysis that avoids the pendulum swings of the political process.

What is required is a transparent process that allows for the marginal benefits and marginal costs of supplying pollution control or ecosystem protection/restoration to be estimated and displayed to the voting public. This information would allow an assessment of what society is willing to pay, for instance, to avoid the damage caused by sulphur dioxide pollution in an industrial region or to secure the protection of an additional thousand hectares of remnant vegetation. These marginal benefit estimates could then be compared with the marginal costs of supplying these services and the logic of the equi-marginal principle applied.

Of course, the decision regarding the overall level of supply will eventually be a political one. However, with information regarding the benefits and costs of proposals being openly available for scrutiny, a greater level of objectivity can be inserted into the political process. Positions taken to supply rents to vested interest groups can be exposed and questioned by those with opposing views.

Proponents of particular cap or target arrangements would be required to demonstrate the validity of their claims with reference to the value information collected.

What can the economist offer in the development of such a process? The answer is value estimation techniques.

4. Estimating values

For both efficiency and cost-effectiveness to be achieved, market-based instruments need to be founded on information regarding the marginal costs and marginal benefits of supply. In most cases, the issue of estimating marginal costs is uncontroversial. Most costs relate to the use of resources for which there are markets that operate within acceptable boundaries of 'failure'. Hence, for a brown example, markets can be interrogated to determine the costs of installing new scrubbing devices on smoke stacks. In the green context, the costs of fencing stock out of a stream reserve can be estimated with reference to labour markets and the prices of wire and posts and the beef profits lost that result. Economics has well established and well accepted set of tools for the estimation of these 'market' costs.

More problematic is the estimation of the benefits side of the ledger. Here, the goods and services involved are often not bought and sold in markets. The high transaction costs associated with their exchange preclude the formation of property rights and hence trade. Hence, for the brown case, the costs associated with higher rates of asthma that are avoided because of cleaner air relate largely to the pain and suffering experienced by those suffering. These are non-marketed values. In the green case, the benefit people enjoy from knowing that a species' survival prospects have been enhanced through the setting aside of an additional thousand hectares of remnant bush from development are also outside the normal operation of a market.

Estimating such non-marketed values is less straightforward because the information on peoples' values is not revealed directly through their actions in markets. Reliance must be placed on techniques that infer values either through indirect market revelations of values (revealed preference techniques) or through questioning people directly about their preferences (stated preference techniques) (Garrod and Willis 1999).

The revealed preference techniques – for example the travel cost method, the hedonic pricing technique and the production function method – are generally regarded as conceptually robust but are limited in the scope of values they are able to estimate. Because they rely on peoples' actions in related markets, they are not able to be used to estimate non-use values.

The stated preference techniques – such as contingent valuation and choice modelling – have been consistently challenged by both economists and non-economists on the basis of their technical capacity and ethical justification. So whilst providing the flexibility in the valuation task to address the full spectrum of value types, doubts have been expressed as to the conceptual rigour of the techniques and even if society should be trying to estimate such values.

Hence, economists have developed techniques specifically to aid in the task of providing transparent information on the relative magnitudes of marginal costs and benefits. However, frustrations remain in their application (Bennett 2003). Policy makers and their advisers remain, to a large extent, unconvinced as to the merits of using non-market valuation techniques. Non-market valuation studies that have been commissioned for policy determination have been sidelined before completion or their results have been ignored, even after international peer review to guarantee the quality of the work being undertaken.

Furthermore, investments in the development of non-market valuation techniques have not kept up with the pace of development in other fields - such as market-based instruments - despite the criticisms levelled at the techniques.

This is despite non-market valuation techniques being subject to a level of investigation well beyond that applied to most economic – and indeed other social science - techniques. Critics of non-market valuation techniques appear to be comfortable with other social science techniques such as public opinion surveys that rely on the expression of peoples' views yet refuse to accept willingness to pay as a legitimate expression of preference. Value estimation techniques that rely on surveys of producers' and consumers' actions in markets are rarely questioned for accuracy and yet the prospect of strategic responses is real. The reliability of statistics collected from market transactions can also be called into question.

Put simply, non-market valuation techniques are subject to many of the same types of data difficulties that face market valuation techniques. However, non-market valuation techniques are called into question more frequently, are subject to more critical comment and are less accepted than are market-based techniques.

One explanation for this 'special treatment' is that policy makers and bureaucrats are unwilling to enter into a process that affords transparency in the setting of overall goals or caps for market-based instruments. To do so diminishes their prospects for enjoying the spoils associated with rent-seeking behaviour. Allowing non-market valuation exercises to demonstrate the extent of the benefits enjoyed by the public from intervention removes a degree of freedom from the decision makers' task. Similarly, vested interest groups are likely to be vocal in their criticism of any form of analysis that sheds objective light on the extent of social values because it presents the danger of a diminished level of influence on decision making.

5. Interaction complexities

The importance of estimating the values that are inherent in the development of market-based instruments becomes even more apparent when some addition complexities are considered. These relate to the interactions between marginal benefits and marginal costs.

First it is essential to recognise that the intervention of the state in controlling pollution or supporting the production of ecosystem protection/restoration does not cause the underpinning problems associated with market failure to disappear. Information inadequacies still occur. Just because market forming institutions such as property rights are not able to reduce transaction costs to levels that allow net benefits to be enjoyed does not imply that the substitute institutions installed by the state will not also generate transaction costs.

It is therefore necessary, in the development of market-based instruments, that transaction costs be included as one element of marginal costs when considering the equi-marginal analysis. Different forms of market-based instruments will have different transaction costs. Furthermore these transaction costs are likely to evolve through time and be affected by the level of production that is set as the cap or target.

The implication for the analysis of market-based instruments is that marginal benefits will need to be estimated not for just one level of production but will rather be required in the form of a value function. Only is this way will the analysis be able to reflect varying cost levels relating to alternative market-based instruments and changing cost structures over time in relation to marginal benefits of provision.

The second complexity relates to the interactions between the two levels of equi-marginal principles. The established modus operandi of market-based instruments involves an initial determination of the cap or target and the subsequent trading process to ensure equality of marginal costs across suppliers. A well recognised advantage of market-based instruments is the incentive they create for innovation in supply. The implication of this incentive property is that the marginal costs of supplying services may well decline over time. This, however, means that the marginal benefits will be greater than the marginal costs at the previously determined cap or target. It will therefore no longer be efficient as a Pareto improvement could be achieved through an increase in the level supplied.

In well functioning markets, this type of interaction and adjustment takes place in response to information flows between buyers and sellers. Where markets don't exist, this type of information flow is slow to emerge and costly to generate. The development of market-based instruments must therefore take into account these information requirements. Functional relationships between levels of provision and values are likely to be helpful in this regard.

Finally it must be noted that the whole process of generating information for the development of market-based instruments creates transaction costs. These costs not only need to be factored into the marginal costs of such instruments but they must also be incurred with an eye on the net benefits they will create. For policy issues that have relatively minor impacts, they may not be worth incurring. However, where significant resource allocation flows are at stake, both efficiency and cost effectiveness concerns will need to be taken into account through the development of a value information base.

6. Conclusions

The purpose of this paper is two fold. The first is to encourage a recognition of the complexity of the processes involved in developing market-based instruments. In particular, it is asserted that the introduction of market-based instruments will not be the panacea for society's natural resource management ills. To the contrary, it is possible that the transaction costs involved in their development and implementation may be in excess of any other net benefits they may be able to create. Furthermore, if the cap or target on which a market-based instrument is founded is defined more as a response to rent seeking than to concerns of equating marginal benefits with marginal costs, an instrument may be only responsible for taking society to an inefficient outcome in the most cost-effective way possible.

The second dimension of the paper focuses on the importance of value information to underpin market-based instruments. A call is made for an injection of non-market values into the policy determination process. If the consensus is that non-market valuation techniques are not up to the task, then the appropriate response is to invest in their further development. For economists to walk away from the task is to open the gate for vested interest groups to grasp onto the development of market-based instruments as a means of securing rents.

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Should equity concerns impose limits on the use of market-based instruments?

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Abstract

A key reason for promoting market-based instruments (MBIs) for environmental policy has been their potential efficiency gains relative to command-and-control and regulatory instruments, whether in terms of resource allocations or implementation and enforcement costs. They epitomise in policy the 'cult of efficiency'. However efficiency is but one of several criteria used to assess policy performance. If others are used, such as distributional equity, how do MBIs compare with other instruments, and how do MBIs compare amongst themselves? Does their performance according to each criterion define their limits? This analysis examines how we can answer these questions; and in particular, how MBIs perform when equity criteria are taken into account.

Keywords: Market-based instruments, efficiency, equity, policy, environment

1. Introduction and background

Market-based instruments (MBIs) are policy instruments that use market forces to achieve policy objectives. In the realm of natural resource and environmental policy, they have recently left the esoteric realm of specialised economics and have come out in the open, out in the public arena of policy debate. This development has been concomitant with the increased importance of environmental policies, notably to manage global warming, pollution, water scarcity and biodiversity issues. Accordingly, the costs of implementing ever more demanding environmental policies are rising, to the point where individuals are beginning to feel the pinch. What MBIs purport to do is to achieve at least cost whatever policy objectives have been chosen. Whence their recent popularity. As such, MBIs are tools to achieve economic efficiency. Indeed, MBIs epitomise the 'cult of efficiency'.

At the same time, concern is rising regarding the possible ethical implications of relying on MBIs to improve environmental management. MBIs specifically involve rights over public goods rather than private goods – rights to pollute, rights to develop, rights to conservation, and so forth. Although MBIs operate in much the same way as markets do in general, the fact that they operate on rights over public goods poses more fundamental issues, and in particular issues of equity over access to resources and the flows of benefits they generate. Unfortunately, like any market, MBIs are not designed to achieve any particular form of equitable distribution. They therefore have no reason to do so, and it is unlikely they will achieve equity by any standards. Their raison d'être is economic efficiency, not distributional equity.

If however, for one reason or another, equity is a concern, then the question arises as to whether such concerns will, or should, impose limits on the use of MBIs. And if so, what is the nature of those limitations. The purpose of this paper is to examine this question. The reader may as well be warned that the question is a difficult one, and that it will be some time yet before a satisfactory answer may be found, if ever. The next section asks "Why equity?", assesses the importance of equity concerns, and delves into the different forms or concepts of equity: "what equity?". Much of the difficulty in analysing equity considerations in economics stems from the fact that there is a multiplicity of competing equity principles, just as there are of justice principles. Economists have traditionally shied away from this, arguing that a lack of consensus on fundamental principles prevented economic analysis from achieving scientific status. As we shall see, this view, marshalled by Robbins in 1935, may be based on an outdated notion of scientificity! A third section presents the results of a quick

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survey carried out for the purpose of this investigation, and which helps nail down the key problem. Section four then proceeds to present three paradigmatic examples of MBIs which pose inescapable equity issues. These examples are used to introduce key issues of equity when using MBIs. Section five draws some lessons for the future and concludes by answering the title question – to the best of the author's current ability! In doing so, it broadens the scope for further economic analysis, drawing the analysis of equity issues away from normativism, which may be a hopeless approach, to bring it closer to the realm of positivistic research.

2. Why equity? – What equity?

2.1 The context in which MBIs are used

2.1.1 Equity over and above efficiency?

Before asking whether equity concerns should impose limits on the use of MBIs, it will be useful to recall the context in which MBIs are used. As mentioned above, the purpose of MBIs is economic efficiency, not equity. However, their efficiency will only be as good as the markets they rely on or that they have created. Markets can fail and lead to inefficient outcomes. Therefore, efficiency may be a sufficient reason to impose limits on the use of MBIs. If an MBI is predicted, in specific circumstances, to reflect poorly functioning markets, then it may be dismissed as a policy tool, at least as a stand-alone tool. For example, water trading markets have been shown, in several cases, to be too thin to work properly and achieve any further efficiency in water allocation than more traditional, regulatory tools. Private water trading in the Murray Darling Basin of eastern Australia is an example, described by Challen (2000). In Europe, and particularly in France, as analysed by Godard (2001), the institutional framework within which MBIs would be made to work is inappropriate and does not allow them to yield their potential efficiency gains. Alternative tools, such as direct negotiations for water scarcity allocations (Thoyer, 2001, 2003), are advantaged.

In light of this, the title question really means: Should equity impose limits over and above efficiency? This does not presume of the type of relationship that might exist between the two criteria. They might be in competition, leading to a trade-off between them, or they might interact and be complementary. At this stage, there seems to be no study clarifying when each might be true and under what conditions.

2.1.2 Equity and types of MBIs

A second point regarding the context in which MBIs are used pertains to their type. MBIs are usually classified into price-based and quantity-based instruments. The former work through government fixing prices and letting economic agents adjust quantities. They include taxes and subsidies. The latter work through government fixing quantities – typically 'caps', and letting economic agents adjust prices, typically through trading. These include tradable permits.

This classification is unsatisfactory for considering equity issues: it misses the key point that MBIs use market forces to achieve their ends, and relate to the role of competition in achieving the final distribution of rights and burdens. This distribution will in turn affect that of current and future costs, benefits and risks. The key question here is to what extent an MBI relies on market competition to achieve efficiency. From this perspective, there are three possible configurations.

Double-sided MBIs – to use an expression analogous to that of double-sided auctions – are exemplified by tradable permits and are such that there is market competition both on the demand and on the supply side. These MBIs can be considered as the 'purest form'. Single-sided MBIs, exemplified by conservation auctions, are such that market competition exists only on one side of the market (in this case on the supply side), while there is pure monopoly (or monopsony) on the other side (here on the demand side). Efficiency in this case is expected to be achieved through the competitive bidding process among agents selling conservation contracts to the government. Finally, zero-sided MBIs, exemplified by taxes and subsidies, do not directly rely on competition to achieve efficiency. The only competition at work is in the (commodity) markets where the agents already operate. These may, or may not, be operating efficiently. As we shall see in section four, each type of MBI raises specific equity issues in relation to efficiency.

2.1.3 Equity, efficiency, and other criteria for assessing policy instruments

Although one may question the merits of MBIs relative to other policy instruments in an exclusive “either/or” framework, it must be remembered that, in practice, a package of instruments are usually implemented together, and that each instrument is used for different purposes. For example, MBIs are usually put forward for efficiency gains and for private information revelation. Command-and-control regulations are often defended for their effectiveness and the degree of control and reliability they might provide. While taxation might be used for purposes as different as revenue generation, incentive for new technology adoption, and even equity if done in a progressive way. As a result, performance criteria will vary. The family of criteria that come under the heading of ‘equity’ (that is, distributional equity) form only one amongst others.

A general overview is provided in Table 1 where policy instruments have been grouped into three broad categories: CAC regulations, incentives and MBIs, and ‘suasion’ instruments, such as education, information and persuasion. As can be seen, even in terms of general tendencies, different policy instruments will perform differently on different criteria. Regarding MBIs, they tend to be efficient, as that is what they are designed for, though of course they are only really efficient if the markets they are associated with function properly. If well designed, they also tend to be reliable, since, to achieve their ends, they rely on agents’ own motivations, such as profit maximization. In terms of effectiveness and cost-effectiveness, the outcome is uncertain: it will depend on the cost for agents to achieve the policy goals. If these costs are high, then MBIs will be either ineffective, if the regulator decides not to pay the agents, or cost-ineffective, if it decides to pay them, but at a high price. In such cases, the regulator might prefer to tackle the source of the high costs, perhaps by first encouraging new technologies that will bring the costs down.

Table 1: Performance criteria for policy instruments

TENDENCIES	Effective-ness	Cost effective-ness	Economic efficiency	Future reliability (riskiness)	Social equity
Regulations, CAC	+	–	–	+	+/–
Incentives, MBIs	+/–	+/–	+	+	?
Suasion	–	+	(0)	–	(0)

Legend:

+	Tends to positively contribute to the criterion
–	Tends to negatively contribute to the criterion
+/–	Will contribute either positively or negatively, depending on the case
(0)	Tends to have no effect on the criterion
?	Effect unknown

With regard to equity, suasion will usually not change the existing distribution of income or access to resources, although some individuals or groups might have easier access to information than others. However, suasion policies typically try to reach everyone. CAC regulations will tend to yield equitable or inequitable outcomes depending on whether equity is written in the policy or not. As for MBIs, it is unclear at this stage how they will perform in terms of some equity criterion. As mentioned earlier, MBIs are not designed for equitable outcomes. The outcome will mainly depend on whether the relationship between efficiency and some form of equity is substitutable or complementary; that is, whether there is a trade-off or a positive interaction.

2.2 Why equity?

If among the several criteria of Table 1 we focus on equity, we may ask: why equity? If with MBIs we are in the business of efficiency then why bother? The answer is a pragmatic one. If a policy is seen as unfair, it may not be implemented: the constituency will not participate and, unless coercion is used, the policy will fail. So we must ask: what use is a potentially more efficient policy that will not be implemented? Like it or not, equity is part of the picture, simply because part of, and perhaps a majority of the constituency are concerned with equity outcomes. In this case, there will be a trade-off between efficiency and participation, or probability of acceptance of the policy.

At this stage, then, it might seem we have run into a conundrum. Because MBIs are not designed to achieve equitable outcomes, however defined, they have no reason to achieve them, and so they are unlikely to do so. But more importantly, MBIs will lead to no more equity than markets generally do. As a result, the issue of MBIs and equity is really no different from that of markets and equity in general. Now the literature in this field is impressive: tons of ink have been spilled over this relationship. What is equally impressive is the lack of any clear statement. Why is that so? Why is the literature so inconclusive? This is a serious shortcoming if equity in any form is an inescapable social and political issue.

As most readers know, the answer lies with the multiplicity of equity principles. Equity is an under-defined concept which really refers to a family of concepts or principles. Or to be more precise, the notion of ‘equity’ refers to the distribution of some quantity among a set of individuals or groups, without specifying the precise distribution rule. Different definitions of equity correspond to different distribution rules, which for some reason are all deemed equitable in some precise way. Cazorla and Toman (2000) review, using previous studies, the different distribution rules referred to in the literature, and come up with twelve (12) different notions of equity. These are shown in Table 2.

Table 2: Alternative equity criteria for climate change policy

Equity principle	*Interpretation*	*Implied allocation rule*
CATEGORY A: ENDOWMENT EQUITY. Allocating costs.		
Egalitarian	People have equal rights to use atmospheric resources	Reduce emissions in proportion to population, or **equal per capita** emissions
Ability to pay	Equalize abatement costs across nations according to economic circumstances.	Net cost proportions are inversely correlated with **per capita GDP**.
Sovereignty	Current rate of emissions constitutes a status quo right now.	Reduce emissions proportionally across all countries to **maintain relative emission levels** between them ("grandfathering").
Maximin	Maximize the net benefit to the poorest nations.	Distribute the majority of abatement costs to wealthier nations.
CATEGORY B: OUTCOME EQUITY. Allocating net benefits.		
Horizontal equity	Similar economic circumstances have similar emission rights and burden sharing responsibilities.	Equalise net welfare change across countries so that net cost of abatement as a % of GDP is the same for each country.
Vertical equity	The greater the ability to pay, the greater the economic burden.	Set each country's emissions reduction so that net cost of abatement **grows relative to GDP**.
Pareto compensation	'Winners' should compensate 'losers' so that both are better off.	Share abatement costs so that no nation suffers a net loss of welfare.
CATEGORY C: PROCESS EQUITY.		
Market justice	Make greater use of markets.	Create tradable permits to achieve lowest net world cost for emissions abatement.
Consensus	Seek a political solution that promotes stability.	Distribute abatement costs (power weighted) so the **majority** of nations are **satisfied**.
Sovereign bargaining	Principles of fairness emerge endogenously as result of multi-stage bargaining.	Distribute abatement costs according to equity principles that result from international bargaining and negotiation over time.
CATEGORY D Polluter pays principle	Allocate abatement burden corres-ponding to emissions - may include historical emissions.	Share abatement costs across countries **in proportion to emission levels.**
CATEGORY E Kantian allocation rule	Each country chooses an abatement level at least as large as the **uniform** abatement level it would like **all** countries to undertake.	Differentiate by country's preferred world abatement, possibly in tiers or groups.

Source: Cazorla and Toman, 2000.

The reader is referred to the paper by Cazorla and Toman (2000) as well as to Rose and Kverndokk (1999), for a discussion of these twelve equity principles and how they translate into specific distribution (or allocation) rules. Here I would only like to focus on their inter-relationships. Firstly, these notions of equity are essentially static. They consider a distribution problem at a specific point in time, given a quantity at that point in time. Although some of them (such as the vertical equity principle) can be given dynamic extensions, most of them do not consider how the distribution rule should address a quantity to be distributed that is changing over time. The aforementioned authors also examine the empirical consequences of applying one or the other of these equity principles. Their results are shown in Table 3. What we can learn from their exercise is that some criteria, namely egalitarianism and consensus, tend to produce rather extreme distributions, while other criteria, such as sovereignty, vertical equity and horizontal equity (as well as ability to pay, maximin and Pareto compensation), tend to produce less extreme outcomes. This raises a very important point, which is illustrated by the heated debates on how greenhouse gas emission restrictions should be distributed amongst countries: should decision makers focus on the philosophical justification of the principles themselves, or on the pragmatic outcomes they produce, or somehow on both? For example, the two equity principles of sovereignty and vertical equity seem to be worlds apart from the point of view of their philosophical foundations, but they can produce, as per Table 3, relatively similar outcomes. How does one choose between what may be called “value fundamentalism” and what may be called “outcome pragmatism”?

Table 3: Costs of different allocation rules in 2020, PV in $10^9 \times$ 1990 dollars

Country or area	Sovereignty	Egalitarian	Horizontal	Vertical	Consensus
US	44	355	52	96	121
Canada & EU	18	30	156	38	19
China	23	–109	8	0.1	43
Africa	8	– 226	5	0.1	100
SE Asia	13	346	11	0.1	– 119

Source: Cazorla & Toman, 2000. (Only part of the original table is shown.)

2.3 What equity?

Given the reality of several (apparently) competing equity principles, how does one choose amongst them? This question may be interpreted in two ways, normatively and positively. Normatively, one looks for a meta-principle that would allow us to choose amongst the twelve equity principles. Positively, one observes how different individuals, groups or communities choose between them, and in what circumstances. Let us consider each of the two approaches in turn.

From a normative standpoint, there has been an attempt to find basic meta-principles in the field of justice, a concept that encompasses the notion of equity. Elster (1992, 1993) proposes two such meta-principles, which he calls “ethical presentism” and “ethical individualism”. Ethical presentism holds that past practices are irrelevant to distribution in the present, except if they have left ‘morally relevant’ and ‘causally efficacious’ traces in the present. I shall leave aside this meta-principle here, and focus on the second one.

Ethical individualism purports that justice (and therefore equity) should be attached to individual human beings, reflecting humans as ends in themselves rather than as means to other ends, where for instance the individual is sacrificed to society as a whole or to the Hobbesian State – a principle which should guarantee against totalitarianism. Two direct consequences follow. One, theories of justice (and therefore of equity) should allocate goods among individuals. Two, this allocation should be made on the basis of information about individuals, rather than aggregates.

On the face of it, Elster's principle of "ethical individualism" would seem to exclude efficiency – the Pareto criterion in the list of twelve – as a valid equity principle. Efficiency focuses on social welfare as a whole, on the sum total of individual welfare, rather than on every individual's welfare taken separately. This depends on whether one accepts this meta-principle of Elster or not. Whatever one's choice, Elster raises the question of the nature of the relationship between the concepts of efficiency and equity. If one accepts Elster's meta-principle, then efficiency and equity are antagonistic in principle, and their relationship is in terms of a trade-off. If one does not accept Elster's meta-principle, then one is led to Julian Le Grand's (1991) position, whereby Pareto efficiency is just a special form of equity, a form that may be called 'collective equity", as opposed to "individual equity". From Le Grand's standpoint, talking of a trade-off between efficiency and equity is meaningless. It is no different than considering any two equity principles from the list of twelve in Table 2.

This brings us to the crux of the problem. As far as we know, there is no way to rationally prefer one equity principle over another. From a normative point of view, all twelve of them are equally justifiable. Or to be more precise, they are all equally justifiable now or then. Depending on circumstances, one may appeal to different equity principles. This may seem as rationalistic anathema, a sign of pure arbitrariness. But to my knowledge, there is only one study that has examined in some detail exactly how the choice of equity principle by specific decision makers varies with specific circumstances. It is the study by Konow in 2001 – 'Fair and square: the four sides of distributive justice' – in which he examines the role of context, an issue we shall examine below. This leads us away from the normative approach and into the positive approach; but before doing so, some consequences from the 'undecidability' of equity criteria follow that we must point out.

Amartya Sen has defined equity as equality of something. Equality of income, of rights, of opportunity, of reward per unit effort, and so on. His question, "equality of what?", will suffer from the undecidability problem, as there are many candidates for the equality relationship. This in turn has direct consequences for the choice of a social welfare function (SWF), and much of Sen's work deals in one way or another with this issue. However, he ends up doing no better than anyone else: as long as one considers the problem from a normative standpoint, one is faced with the "now or then equal justifiability" of each of the twelve equity criteria. Multi-criteria analysis tries to escape this trap by pretending to tilt towards the positive approach, since the weightings of the different criteria emerge from a social consensus process: from discussions around the table. However, even this process represents one of the twelve equity criteria, an example of 'process equity' (see category C in Table 2).

To conclude, the normative approach has so far led to a logical impasse. It may be that we do not yet know how to think through the normative problem in a way that will allow us to escape the merry-go-round of competing equity principles. Or it may be that the problem has not yet been sufficiently studied from an empirical point of view, whether from a social or a psychological perspective.

This leads us to the second approach, the positive approach, where the problem is to understand how different decision makers choose equity criteria to make distributive decisions. In order to illustrate the problem in reference to MBIs, I have carried out a quick survey of several colleague economists on the issue of allocating greenhouse gas emission restrictions across countries. Although the sample was very small, it was sufficient to demonstrate the wide variations in choice of criteria – a rather remarkable result.

3. A quick survey on allocating GHG emission restrictions across countries

After a short introduction to the Kyoto protocol, four questions were put to respondents. Each question was preceded by an example using specific countries, for the sake of concreteness. The first question asked whether emission restrictions should be based on total national emissions, or on per capita emissions. The second question focused on increases relative to some past point of reference (say 1990 emissions), and opposed increases in absolute terms, measured in tonnes of CO_2 equivalents, to increases in relative terms, measured in percentage points. The third question was similar to the first, but opposed total national emissions to emissions per dollar of national GDP. The fourth question carried on from the second and asked whether restrictions should be based on total cumulated emissions over the long term, reflective of the nations development history, or on current or recent emissions, reflecting the nation's current development path. Respondents were asked to choose one alternative in each question and to explain their choice. All the colleagues sampled were, on purpose, natural resource or environmental economists.

The motivations behind this survey design were the following. The choice of the four questions in that particular order was meant to expose the tensions existing between the different questions. At the same time, the formulation of each question was meant to give expression to the tensions existing within each question. These choices were made in order to identify people's multiple standards of value (if such were the case) and to thereby elucidate the multi-dimensional nature of the problem.

Remarkably, given the very small size of the sample, on all questions the result was never far from a 50-50 split. Even more remarkable were the motivations, or justifications, given for each response. The criteria invoked were not solely, or even mainly, related to a notion of equity. Out of the eight (8) identifiable principles, only three (3) had clear equity connections. In what follows, it is worth referring to the criteria shown in Table 1.

The principles invoked may be grouped into three categories. The first consists of the three principles of effectiveness, pragmatism, and ethical presentism (as Elster called it), which have nothing to do with equity. Effectiveness referred to the actual impact of GHG emissions on the planet, leading the respondent to choose total emissions over emissions per capita or per dollar GDP, absolute increases over relative increases, and long term accumulated emissions over recent or current ones. Pragmatism referred to issues of measurability and whether an international consensus could be reached or not. Pragmatism, for example, argues against using long term accumulated emissions on the grounds, firstly, that they will be hard to measure and, secondly, that it will even more difficult to agree on a common starting date from which to count emissions. The ethical presentism principle considers in this context past emissions to represent a sunk cost to the global community, and therefore, as all sunk costs, that they should not enter the accounting equation.

The second category included the three principles of deterrence, avoidance of moral arbitrariness, and disutility of change. The deterrence principle was invoked to avoid creating perverse incentives. For instance, using the emissions per capita principle was seen to possibly influence a country's population strategy, while the emission per dollar GDP principle might tempt powerful countries to export their more polluting industries into weaker or poorer nations. Reference to national aggregates was seen as reflecting moral arbitrariness, since national boundaries were the result of the vagaries of history. The fact that some countries were large, populated or richly endowed with natural resources was seen to be a random variable. The implication is that a distribution principle cannot be based on a random variable, something which reflects the deeper principle of accountability, to be examined below. The third principle, put forth by a renowned agricultural economist, was that of disutility of change. The idea here is that the disutility of changing habits, namely reducing, or changing the pattern of, consumption is greater than that of not acquiring new habits, namely those of richer more developed countries. The relationship of these three principles with equity, if it exists, remains unclear.

The third category included the principles of equal opportunity, "ethical presentism" (as Elster has called it), and environmental debt. Equal opportunity referred to developing countries being allowed today the same possibilities of economic development as the more developed countries have had in the past, largely thanks to their unconstrained emissions generated by less efficient technology and accelerated growth. Obviously, the choice influences one's decision to account for a country's past emissions or not. The other principle, environmental debt, is also related to past emissions, and considers them to have been generated at a cost to other countries, in the form of direct externalities, and that now is the time to pay up. These two principles are clearly related to notions of equity. Equal opportunity reflects the principle of horizontal equity: treat alike entities in a like manner. Environmental debt reflects both a polluter pays and a compensation principle

Efficiency was not once invoked as an allocation principle – an interesting fact, given the identity of the respondents. Also worth noting was the fact that only women expressed the tensions they felt in answering the questions, for example that they had difficulty maintaining consistency in their answers to the first two questions. In comparison, men seemed to show a degree of "ethical blindness". But of course no conclusion can be drawn yet from this quasi anecdotal evidence. More importantly, it seems that references to different distribution principles reflect different points of view, different angles from which the question is considered. If this is the case, then further empirical investigations using the techniques of experimental psychology should be carried out. Then some correspondence may be discovered between specific points of view, or perceptions, and choice of distribution principles. Then the equity choice might turn out to correspond to a specific point of view, or aspect of the question. It is like trying to comprehend a three-dimensional object with a two-dimensional viewing technique. These investigations could lead to more efficient negotiations and bargaining strategies on Kyoto type issues.

We shall now focus our attention to how MBIs can generate equity issues, and, given the weakness of current theoretical progress, we shall do so using three typical examples. Each example represents one of the three categories of MBIs mentioned in section 2.1: two-sided, one-sided and zero-sided MBIs. Each example will generate specific equity issues.

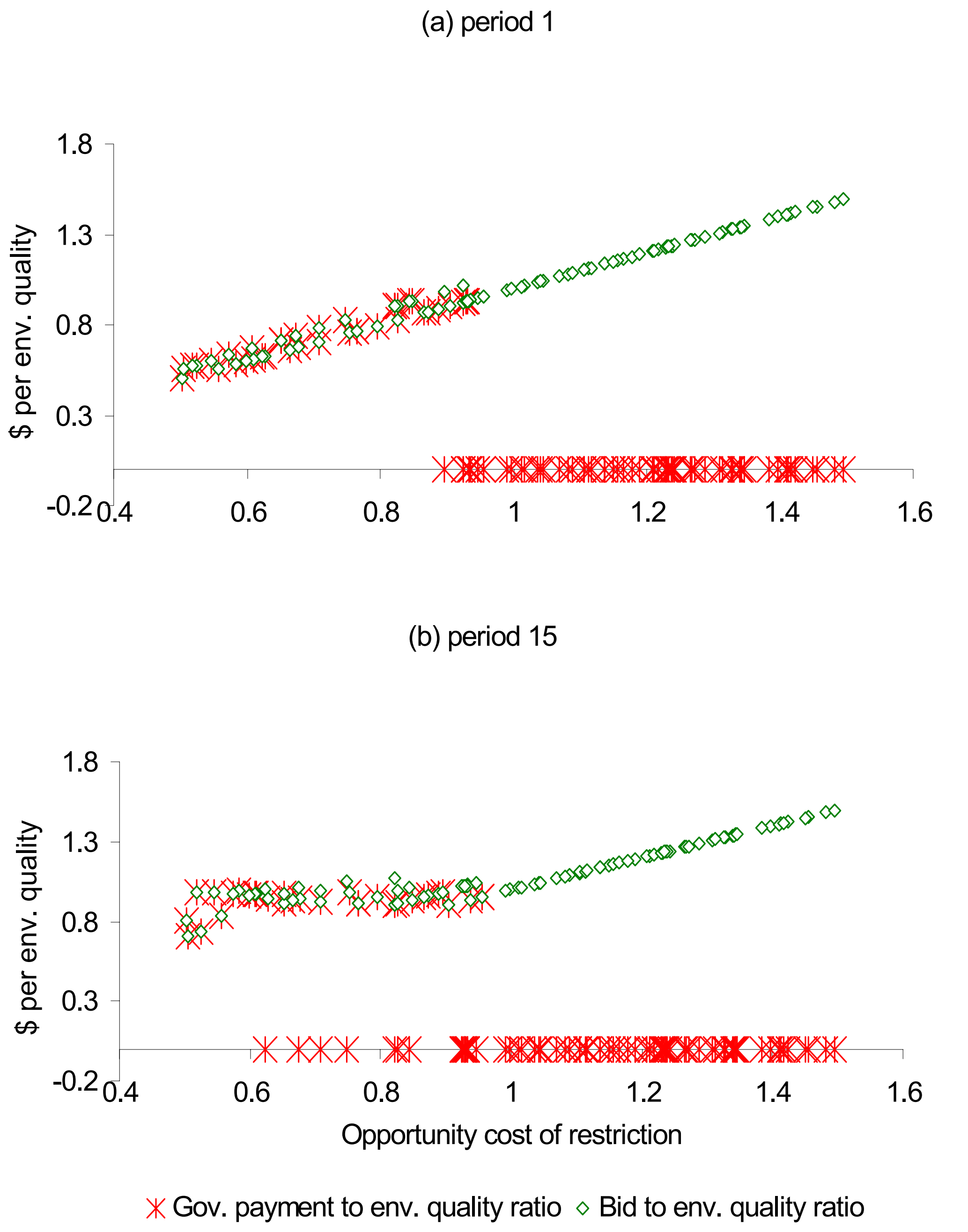
4. MBIs and equity: three examples

4.1 Example 1: Auctioning conservation contracts: a one-sided MBI

In reference to Latacz-Lohmann and van den Hamsvoort's work (1997, 1998), and to the Bush Tender experience in the state of Victoria (Stoneham et al., 2000, 2002), Hailu and Schilizzi (2003 a,b) have been investigating the auctioning of conservation contracts to landholders. In particular, they have examined what happens when auctions are repeatedly held and bidders can learn over time from previous outcomes. The traditional setting is a one-off, static auction, where bidders make decisions based only upon a priori expectations. In this case, the authors were interested in knowing what happens when auction dynamics are introduced.

The auction setting is the following. Government, or its representative agency, is interested in buying conservation services from a fixed population of landholders. After having specified the nature and amount of work to be done with each, the payment for the work is to be determined via an auction mechanism – in this case, a first price sealed-bid auction. Government will have also rated, and scored, the ecological value of the land areas landholders are putting up for conservation. When bids are in, government ranks the bids in descending order, according to a benefit to bid ratio – where the benefit is measured by the ecological scoring system, until the budget is exhausted (or alternatively, until the pre-specified number of contracts is signed). Bidders therefore have to compete for contracts. Bidders all start from different positions, as their direct and opportunity costs for carrying out the conservation work vary. Those who can do it more cheaply, and have good enough ecological value to offer, have higher chances of obtaining contracts. Because auctions are repeated, bidders learn over time from their own results, and they adjust their next bid according to some specific rule (using a form of the Roth-Erev algorithm). This is an example of what we called a one-sided MBI.

Figure 1: Distributions of bid and government rates for periods 1 and 15.



This study was carried out using dynamic multi-agent modelling and computer simulations. This technique allows to explicitly account for agent heterogeneity, and to observe not only aggregate outcomes, but also individual outcomes, a feature of value for efficiency-equity investigations. Results relevant to our concern are given in Figure 1 (a) and (b). The two diagrams help explain the outcomes of the learning process. The opportunity cost of involvement for the bidders is indicated on the x-axis. Contracting bidders start by bidding (and getting paid) different prices, reflecting their individual opportunity costs. The program payment rates are marked by asterisks in Figures 1(a) and 1(b). In the first period the bid to environmental quality rates for the 41 winners fall in the range of 0.50 to 0.93 (see Figure 1(a)). But these differences in bid rates disappear over time. The spread in these prices is reduced as the infra-marginal bids catch up with the marginal winning bid, eventually forming a narrow band of bid rates ranging from 0.90 to 0.99, as shown in Figure 1(b) (for the 15th period). Just above this narrow band of 28 winning bids for that round is another band of 'active', but currently not selected, competitors. These two narrow bands represent the two components of the 'active' bidders, some of whom replace each other from one period to the next – generating a "basket of crabs" effect.

What comes out of this study are two related trends with equity and efficiency implications. One is that bidder learning and marking-up (or down) of their bids end up crowding out legitimate competitors, while the other is that government payments increase over and above true opportunity costs. Informational rents increase to more than 20% within the first two rounds and continue to increase slightly for some time. More precisely, 44% of the bidders never obtain contracts. Of course, most of these, though not all, are those with higher costs. But the key point is that the total cost of the 41 lowest cost bidders is within reach of the government's fixed budget; however, the auction mechanism only allows the hiring of the services of 28 bidders. This difference of 13 potential winners may be seen as an inequity effect induced by the market-based mechanism used. 32% legitimate competitors are crowded out.

Another point is that the inequity effect is intimately linked with an inefficiency effect. It is because the repeated auction, as modeled in this example, is inefficient – due to information rents being extracted by winning bidders – that inequity arises. The form of equity involved here, in reference to the list of twelve in Table 2, is horizontal equity. That is, like people should be treated in a like manner; in this case, given equal opportunities to compete.

This study thus illustrates two issues regarding equity and efficiency. Firstly, an MBI can easily under-achieve its potential efficiency gains. Secondly, inefficiency can generate inequity. In this case, there are three aspects: rent extraction from the government, crowding out of legitimate competitors, and formation of an exclusive closed-shop effect, whereby only a subgroup of bidders are ever allowed to compete for contracts. The corresponding equity principles are undue rewards to rent seekers, which reflects a principle of accountability to be seen hereafter, horizontal equity linked to a right to compete for those whom the government's budget could hire, and an egalitarian principle linked to equal opportunity to compete. At the bottom of this process lie the initial differences, the heterogeneity between bidders. The repeated auction mechanism appears to be a process that amplifies such initial differences, however small initially. This in itself raises an equity issue. Should an MBI 'conserve', rather than amplify, initial inequalities? Indeed, should it reduce them?

This question goes deeper than one might think. It raises the general problem of how dynamic processes affect initial differences. In physics and astrophysics, a frequently observed rule is that physical processes, left to themselves, tend over time to amplify initial differences. For example, galaxies are understood to have emerged from tiny ripples in the early structure of the universe. Likewise, in psychology, slight tendencies in childhood, left to themselves, will develop into marked differences in interaction with the environment. In economics, an interesting paper written by Bouchaud and Mézard (2000) describes, using a simple model, how wealth distribution tends spontaneously to concentrate over time, leading to increasingly inequitable distributions. Of course, progressive taxation, but also increased free trading, can counter this tendency and maintain inequality within bounds. There is much room for work on this fascinating problem which would interest much of market economics.

4.2 Example 2: Farm level impacts of greenhouse emissions policy: a zero-sided MBI

Flugge and Schilizzi (2003) examine a greenhouse gas restriction policy and how it could affect certain agricultural regions in Western Australia. Two versions of the policy are examined, quantitative restrictions and a tax on the amount of CO_2 equivalents emitted. Here we shall focus on the tax. The policy is assumed to be nationwide, and two different agricultural regions are examined (see Figure 2): the Great Southern Region (GSR), which is livestock dominant, and the Eastern Wheatbelt Region (EWR), which is crop dominant. The initial motivation for this distinction was the fact that livestock, in particular sheep and cattle, contribute significantly to global warming through methane emissions, whose CO_2 equivalence ratio is 21 to 1 (that is, one unit of methane contributes 21 times more to global warming than one unit of CO_2). By contrast, dryland crop production contributes very small amounts.

The differences in farming systems are due to regional soil and climate discrepancies. The EWR is drier and has sandier soils than the GSR, but at the same time, has less land prone to waterlogging and, as a proportion of farm area, to salinity. As a result, a much larger proportion of land in the EWR can carry crops: the average farm can crop up to about 90% of its land. By contrast, an average farm can only crop 10 to 20% of its land in the GSR. Most of it is in pasture and carries sheep. Another feature is that an average EWR farm has a greater variety of soil types with a better spread in terms of individual shares of farm area than an average GSR farm. This gives the EWR farm more flexibility to adjust to a CO_2 restriction policy than an GSR farm. As it turns out, this difference in flexibility happens to be crucial to the way in which farms can respond to a CO_2 restriction policy.

In order to examine a typical farm's response to a CO_2 restriction policy, a whole-farm linear-programming model was used, MIDAS. As described in Kingwell and Pannel (1987) and Pannell (1996), MIDAS (Model of an Integrated Dryland Agricultural System) is a steady-state bio-economic model that integrates the agronomy and the economics of farm management, and includes interactions between farm enterprises and soil types. Farms are assumed to maximise profits over the length of a crop rotation (averaging four years), and in this study, farms are modelled as minimising the cost of the restriction policy by readjusting their farm plan. Although the study also included trees as carbon sinks to offset carbon emissions, we shall not take this aspect into account here. Figure 2 shows the regional extent of the two MIDAS models, one for each region.

Figure 3 shows one of the outcomes of the study. The GSR farm is much more vulnerable, economically, than an EWR farm to a CO_2 taxation policy. The former will hit zero profits at a tax rate of A$46 per tonne of CO_2-equivalent emitted on a yearly basis, while the latter will be able, on average, to make a profit up to a tax rate of A$78/tonne, nearly twice the GSR figure. This means that, should the tax be of the order of $50 a tonne, the GSR farms would be in dire straights while the EWR farms could survive. Lower tax rates would in any case create more difficulties in one region than in the other. The main reason behind this is the fact that one region (the GSR) has fewer options than the other to switch to less CO_2-intensive systems. This lack of flexibility is mainly due to agro-climatic differences, something beyond the control of farmers in the region. Because of this, the government will be faced with the question of helping the disadvantaged region to survive or let it go under, subject to a complete rehaul of agriculture in that area, for example, a conversion to woody perennials such as trees. In practice, such a conversion is not unthinkable, but it would entail replacing current farmers with another category of landholders, leaving open the question of what would become of the current farmers. Clearly, this raises equity issues.

Figure 2: Versions of MIDAS for different regions of the West Australian wheatbelt.

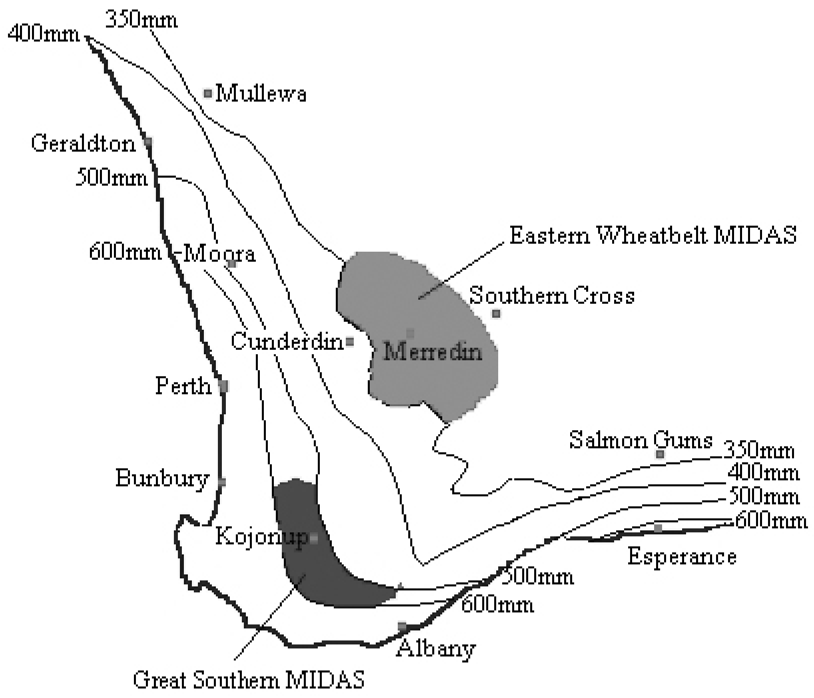
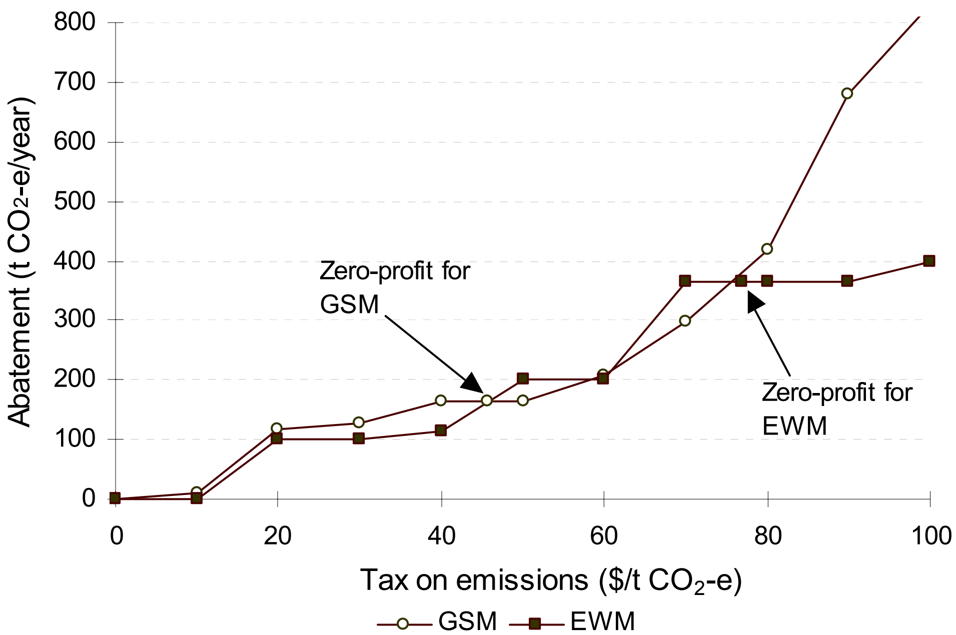


Figure 3: Total farm abatement at each tax rate for GSM and EWM farms.



This example illustrates the equity foundations put forth by Konow in his 2001 paper. Rather than the different notions of equity shown in Table 2, Konow focuses on the foundations of equity as a justice principle. He identifies three: accountability, efficiency, and needs. The accountability principle is related to individual equity; the efficiency principle is related to collective equity; and the needs principle is related to the right to live, to survival. In the example above, we may ask on what basis the government would bail out regions who couldn't adapt to a greenhouse restriction policy? If, as previously mentioned, one agrees that soil and climate differences are beyond the control of farmers – accounting for the investments they could have made in the past to limit the consequences – then the principle of accountability would demand that they cannot equitably be left to shoulder all the burden of their situation: the government must help, at least to allow for a transition of some sort.

Konow (2001) derives these three foundational principles from experimental studies and empirical observations. He concludes two things. One, that people will use all three of them jointly, but with different weightings. Two, that the accountability principle, at least in societies of western culture, will trump the other two principles, so that the best model to describe people's use of these principles in the West is a weighted average between the accountability principle and a composite of all three – a distinction he calls 'specific justice' and 'generic justice'. The 'reported justice' he observes in surveys is a combination of these two.

The next point is that the specific weighting varies not only across people, but for the same person across circumstances. Here he proposes the fourth 'corner' of his justice square: context, and suggests that the notion of justice, and therefore equity, is context-dependent, but not context-specific. To quote, "The chief reason that justice has remained an elusive concept is because the greatest challenge to formulating and verifying a positive theory of justice is related to issues of context. One aspect of context is the relative importance attached to each of the three justice principles in a particular situation." This distinction appears to be an important one. Context-specificity implies that there are no general principles. Considering the list of twelve in Table 2, a decision maker would take his pick given his strategic positioning in the decision problem – a situation diametrically opposed to John Rawls' (1971) 'original position', described as deciding behind a 'veil of ignorance'. This somewhat cynical view is one taken by the economist Peyton Young, when he writes "Equity is a complex idea that resists simple formulations. It is strongly shaped by cultural values, by precedent, and by the specific types of goods and burdens being distributed. To understand what equity means in a given situation we must therefore look at the contextual details" [H. Peyton Young, 1994, p. xii].

Konow opposes context-dependence to context-specificity by suggesting, on the base of empirical analyses, that justice and equity principles do exist, but different contexts lead to different interpretations of these principles. However, Konow does not provide a full account of how different aspects of context determine such interpretations. Arguably, this would require an extensive and laborious program of empirical investigations. At any rate, Konow's work appears to bring us to the frontier of research in this area. No doubt there is much yet to be done.

4.3 Example 3: Tradable permits: a two-sided MBI

In the field of tradable permits, the question of the initial allocation of permits raises important equity and efficiency issues. In particular, the choice between grandfathering and auctioning the initial allocations raises a whole suite of issues. These are summarized in Table 4, taken from an unpublished OECD document. The table considers the possible objections to grandfathering and the possible solutions to these objections. A similar table could be made for auctioning. As can be seen, both options have positive and negative implications, and this explains why the issue is as yet unresolved and the subject of ongoing debate. The question we ask here is, what are the criteria and principles involved?

Table 4: Grandfathering of permits: objections and possible solutions

OBJECTION	POSSIBLE SOLUTIONS
Does not treat existing firms and newcomers alike	Initial issue of permits lower than the actual desired level of emission; Subsidise" newcomers with these reserve permits; Environmental carrying capacity is scarce, therefore, should the number of permits be absorbed, no further issues can be made.
Does not adhere to "polluter-pays-principle"	Depends on the number of permits issued; Treatment of permits in future (e.g. decreasing, auctioned, etc.) as per programme design will determine the long-run effect.
Revenue losses occur	Combine instrument with environmental tax initially; Resource management is not prime source for fiscal revenue.
Large windfall gains are possible	Taxes to capture the economic rent can be Institutionalized.
Will not lead to as much efficiency (low transaction costs as under auctions).	Transaction cost is still lower than other instruments; Motivate the participation of players
Will not lead to as much dynamic efficiency (abatement innovations) as under auctions.	Can be controlled by declining number of permits; Favourable royalty arrangements on patented innovations. Reciprocal relationship - the more uncertain a system (i.e. auctioning), the less will be spent on innovation.
Creates artificial barriers to entry and can lead to monopolistic power and discriminating practices to newcomers.	Constraints on banking opportunities can be placed; Compulsory auctions can be held; Should a firm close down, its permits could be bought; If not "grandfathered" then carbon leakage can occur and manufacturers will move to other countries.

Source: Unpublished OECD document.

One can identify four such principles in Table 4. These are: fairness to newcomers into the industry; the polluter pays principle; competitiveness of domestic industries with other countries if no global agreement exists on the initial allocation; and efficiency arguments. Fairness to newcomers and competitiveness with other countries both instantiate the principle of horizontal equity: treat like entities in a like manner. Both it and the polluter pays principle are founded on the accountability principle. Newcomers cannot control for the fact they are newcomers: their position must be considered as a random variable. By contrast, polluters are accountable for the pollution they generate. The efficiency arguments against grandfathering include monopolistic power, dynamic inefficiency and the loss of innovative drive for new technologies, and static inefficiency associated with lower transaction costs.

Over and above criteria for initial allocations, this example highlights the deeper problem of equity targets. There are three possible targets: initial states, intermediate processes, and final states. Initial states include endowments and entitlements. Processes include negotiations, markets, and administrative decision making. Final states include distributional outcomes and efficiency. The obvious question then is, which stage should equity target, and should it target all stages? If so, how?

Robert Nozick (1974) has an indirect answer in terms of a justice chain principle. In the more general terms of justice, he identifies justice in initial appropriation, justice in subsequent transfers, and justice in rectification of any of the above. Nozick then suggests that an allocation will be just if the initial allocation is itself just, all subsequent transfers are just, and any rectification to the initial allocation and to subsequent transfers is also just. Translated in terms of equity, this would require that all initial endowments, entitlements etc. be equitable, that all processes used to decide these endowments and entitlements be themselves equitable, and that the final distributions be also equitable. Whether the same equity principle, or principles, should preside over all these stages is as yet a question open to further research. But certainly everything that has been said until now, in terms of equity criteria and foundational principles, could apply to each of the three targets. As may be painfully obvious, much work is still needed to clarify our thinking on these matters.

5. Lessons and conclusions

5.1 Lessons

From the above three examples, what can we learn regarding the use of equity as a criterion for evaluating the performance of MBIs, over and above economic efficiency? Firstly, we saw (example 1) that efficiency and equity criteria can interact and be complementary. In other words, the use of an MBI will be inequitable, in a certain very precise sense, because it is inefficient. The lesson here is, equity and efficiency do not necessarily relate in terms of a trade-off.

Secondly, we saw (our survey) that different equity criteria generate inner tensions between them. Invoking one in one circumstance may conflict with the need to invoke another in another circumstance. This problem has not yet, to our knowledge at least, been studied in the economics literature, though work by psychologists no doubt exists. However, this is not solely a psychological problem, but also a cultural and a logical one. The precise conditions underlying the nature of the need for consistency across decisions has not yet been properly researched in this context. There is something there we genuinely do not understand and cannot conceptualise.

Thirdly, it appears, mostly on empirical grounds (see Konow's work), that different evaluation criteria, including equity and efficiency criteria, need to be combined in some way. This raises the question of which combination principle ought to be used. This leads us to the forefront of research in this field, and I shall therefore only be able to hint at several avenues of research.

The easiest combination principle, and one favoured by economists until now, is a linear combination of criteria, a weighted average. This static approach underlies much of the literature on the choice of social welfare functions. Of course, the question then becomes how the weighting should itself be chosen. From a normative point of view, this regression, potentially ad infinitum, poses the problem of the inescapability of the ultimate criterion, not a very satisfactory prospect. From a logical point of view, we have the choice between two topologies. If we assume a standard topology, each criterion must itself be justified on the basis of a more fundamental criterion, a process which indeed leads to the ultimate criterion problem. But if, following Godard's (1999) analysis, we assume a Möbius strip topology, as he does in order to relate the anthropocentric and ecocentric views in environmental valuation, then the problem of the ultimate criterion disappears. The Möbius strip topology refers to the twisted slip of paper that has only one side, rather than two, and where any point on the paper can be made to continuously communicate with any other: the slip of paper has no 'edge'. In the example analysed by Godard, ecocentrism underlies all human values in that without the supporting functions of Mother Nature, no human activity, including valuation, would be possible. At the same time, anthropocentrism underlies our appreciation of nature, no matter how highly or how little we value it.

Multi-criteria analysis purports to circumvent the problem by allowing the weighting to emerge from a social consensus, from discussions around the table. However, this is relying on a specific equity principle, that of process equity, namely consensus equity (number 9 in Table 2). Although acceptable, it is not the only one acceptable, as we are now well aware, and so multi-criteria analysis does not really help in this regard.

A second approach to the combination problem is what one may call dynamic transitioning. Rather than considering the different equity criteria all at once, as if in competition with each other, one considers them in succession, in correspondence with the sequence of circumstances. An example of this is Young and Shi's (2003) dynamic duty of care approach. In a nutshell, they suggest that the use of MBIs, as well as other policy instruments, should be made to work within clear definitions of rights and duties, in particular of environmental duty of care. However, the level of care should not be fixed, but increase over time. In this way, the compensation problem linked to the payment to landholders for conservation work would be a temporary scheme, rather than a permanent one, and would pay for the costs of transition (see Challen, 2000, on the economics of transition costs following changes in property right structure). The logic of dynamic transitioning with performance criteria is yet to be studied.

A third approach might be in terms of invariance or symmetry principles, an approach favoured in physics. The idea here is that, if several equity criteria appear to be equally justifiable, then one can look for an allocation rule that will be invariant to these criteria. We know from physics that such invariance rules may be very hard to find, and when they are found, that they can be quite subtle in their formulation (see for example the concept of gauge symmetry in particle physics). The problem then is, however, that if the allocation rule is too subtle, it will not be implementable from a practical point of view. Game theory and mechanism design theory offer similar cases. For example, the Groves-Ledyard mechanism is an ingenious one for solving the voluntary provision of public goods by private agents, but it is too subtle to be implementable in practice. At any rate, this approach would require some fundamental mathematical analysis of the structure of the problem.

On the pragmatic side, however, when several equity criteria, possibly upheld by different competing groups of people, are in the balance, there seems to be an over-arching principle governing the choice process: that to avoid conflict, war, and to seek consensus. This is usually done in a very primitive way, on a trial and error and feel-your-way-through basis, provided that whoever is leading the process has the collective good as a goal. This is far from being guaranteed. The policy maker may represent private interests within the polity. The balancing of private and public interests reflects the problem of balancing individual and collective equity criteria – the major difficulty in balancing out efficiency, a collective equity criterion, and distributive justice, an individual equity criterion.

5.2 Unresolved problems

In conclusion, we must humbly acknowledge that we probably still do not know how to think, how to conceptualize the collective versus individual equity problem that underlies much of the tensions between equity criteria. The philosopher Hegel, in his Phenomenology of Mind (1807), and later in his Philosophy of Right (1821), suggested we think dialectically between the individual and the collective. Should we go back and read Hegel for a fresh start? His thinking was very innovative for his time, as it was inherently dynamic and included time as an active factor.

Another unresolved problem, which runs through most of the economic literature, is the scandal of the optional principle of diminishing marginal utility. In my view, its resolution is tied up with the questions we have reviewed in this paper, though a rigorous analysis of this linkage needs to be done. Economists are well aware of this thorn in the discipline's side, where, for example, DMU is used to justify a positive discount rate for increasing future consumption, while it is ignored in the cost-benefit analysis that incorporates that discount rate – a rather stark example of internal contradiction.

Perhaps to make any progress on the analysis of equity in allocation problems, some serious inter-disciplinary work is necessary. Economists may need to seriously work with behavioural scientists, anthropologists, analytical philosophers, and perhaps mathematicians, to name a few.

5.3 Conclusions

A reminder is in order. What use is a potentially more efficient policy instrument that will not be adopted by the collective because of equity issues, political issues, or otherwise? A market-based instrument may offer potential efficiency gains compared to a more traditional command-and-control regulatory instrument, but this potential may remain unrealized if its implementation raises equity or political issues. Godard (2001) is one author who has analysed why MBIs are so much more popular in the USA than they are in continental Europe. The differences in social security systems could well follow the same pattern. It may be that Europeans have a different sense of equity than Americans have – they may be referring, because of historical reasons or otherwise, to different equity principles. The existence of institutional structures which allow the introduction of MBIs in the USA more easily than they do in Europe also raises questions as to the nature and pace of institutional change, and how perceptions of equity influence this change. Whatever the case may be, equity considerations directly affect the acceptance of MBIs by the constituency.

So, should equity concerns impose limits on the use of MBIs? The answer is yes, but no differently than efficiency concerns may also impose limits. Also, equity concerns will also impose limits on other policy instruments, just as the will on MBIs. Finally, equity concerns over the use of MBIs are no different than those over markets in general.

What then is the nature of those limits? If we adopt a normative approach, the limits will be, so to speak, endogenous: they will stem from the decision-maker’s own sense of equity and, more generally, of ethics. From a positivistic point of view, these limits can come in two forms, depending on whether MBIs are implemented in a liberal or in a coercive manner. In a liberal context, such limits will be in the form of the probability of acceptance, or adoption, of the policy instrument. In this case there will be a trade-off between the efficiency gains expected from the MBI and the probability of its acceptance by the community. The policy maker can then compare the ‘expected efficiency gains’ of different policy instruments in terms of the potential efficiency gains multiplied by the probability of acceptance. As an example, Challen (2000) examines the thinness of water trading markets in the Murray Darling Basin of eastern Australia as a cause of their inefficiency. Market thinness reflects a lack of adoption by private agents of the tradable permit opportunities. Of course, other criteria than equity will be at work.

In a coercive context, potential efficiency gains from MBIs can be offset by political risks, in terms of lost votes and/or social unrest, which itself generates economic costs. A World Bank document (Huber et al., 1998) reviews the problems that Latin America has been facing when trying to implement MBIs. Equity issues were present in most of the cases. An important difference here is whether one considers political risks to the specific government in place, or to society as a whole. In the first case, we are dealing largely with private interests, in which case, from an ethical point of view, it may be argued that the social benefits, in terms of efficiency gains, are worth more to society than the political risks to a military junta or other form of undemocratic government. But this leads us to the joint problem of market failure and government failure, a different topic altogether.

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Where do market-based mechanisms fit in the policy mix? An economic analysis

Loris Strappazzon, Gary Stoneham and Nicola Lansdell[1]

1. 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,

[1] Department of Primary Industries, Victoria. Views expressed in this paper are those of the authors and not necessarily those of the Department. Use of any results from this paper should clearly attribute the work to the authors and not the Department. This paper is an amended version of the Department of Primary Industries Working paper, *A Transaction Cost Economics Approach to Considering Environmental Policy* (ISBN, 1 74106 630 1), by the same authors.

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 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 to 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 a 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, transaction costs are subsumed 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. We summarise in Section 7.

2. 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.

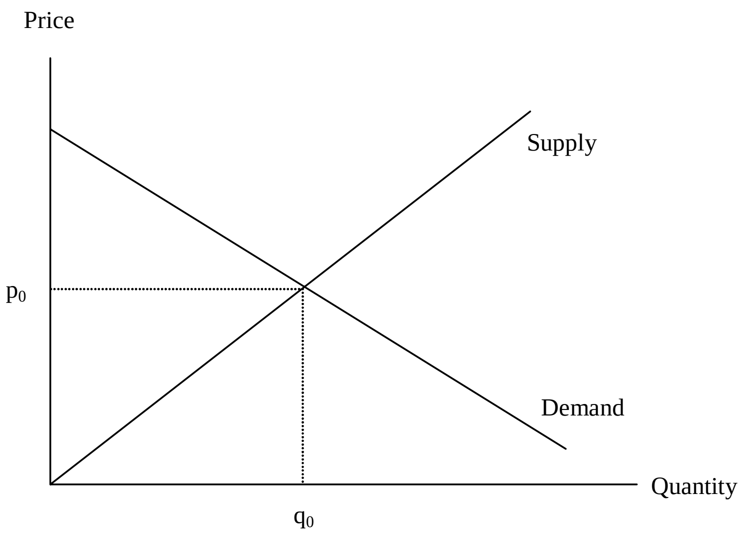
3. Efficiency and the demand for environmental goods

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 q_0 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[2]. 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 effect (at least implicitly) 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).

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 - both 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.

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

3.3.1 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 1965). 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.

3.3.2 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[3]. 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’)[4].

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[3] 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.

[4] In the public sector, there may be instances where the '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.

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 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. 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

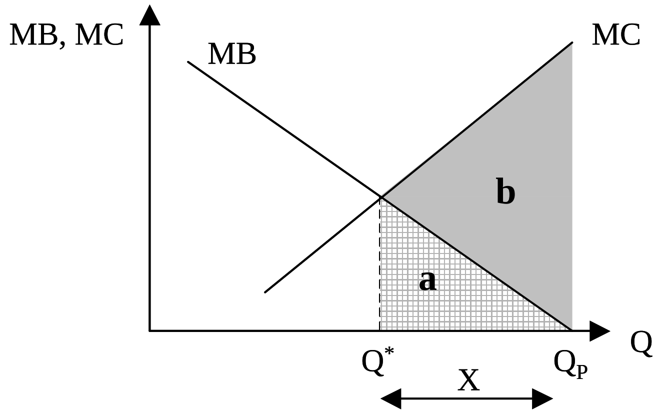

Figure 2 illustrates how bargaining may achieve the efficient level of biodiversity conservation. MB is the marginal benefit to the community of conserving biodiversity, or the amount that the community is willing to pay for biodiversity conservation. MC is the marginal cost, borne by landholders, of 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[5]. McKelvey and Page (2000) find that the Coase theorem is not supported in an experimental setting when there is asymmetric information. Strappazzon et al. (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.

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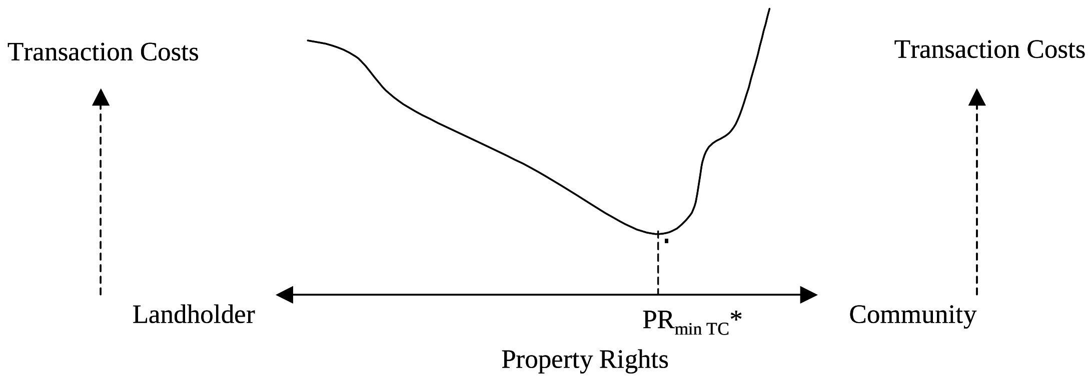
[5] Sometimes asymmetric information is presented as just another transaction cost (e.g. Williamson 1985) and sometimes not (e.g. McKelvey and Page 2000).

4.2.1 The framework: Considering the total transaction cost curve

Imagine that a government is hoping to secure some level of environmental good, QT. 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 QT 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 QT



If the initial property rights are allocated entirely to landholders there will be transaction costs associated with the community paying landholders to conserve QT. 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 QT 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 QT 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

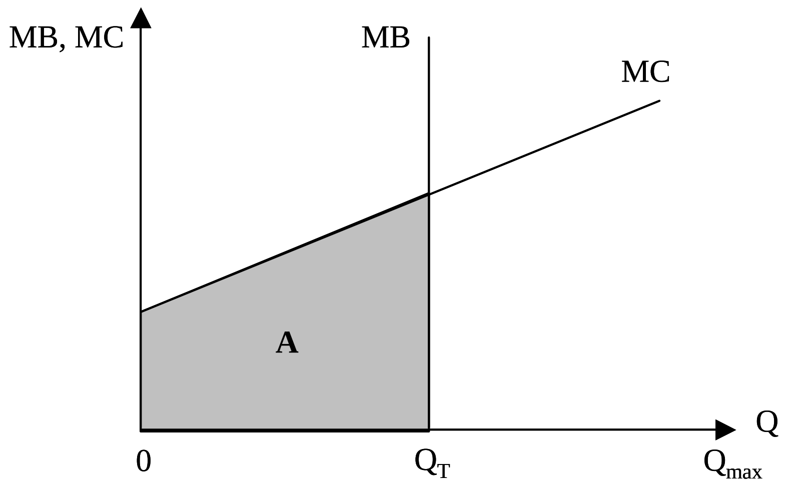
We can use an example to trace through some of the ways that transaction costs may differ with alternative property right allocations. In this section, we use the example of allocating property rights when an environmental good has an irreversible threshold level. The irreversibility problem occurs when (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 in part 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

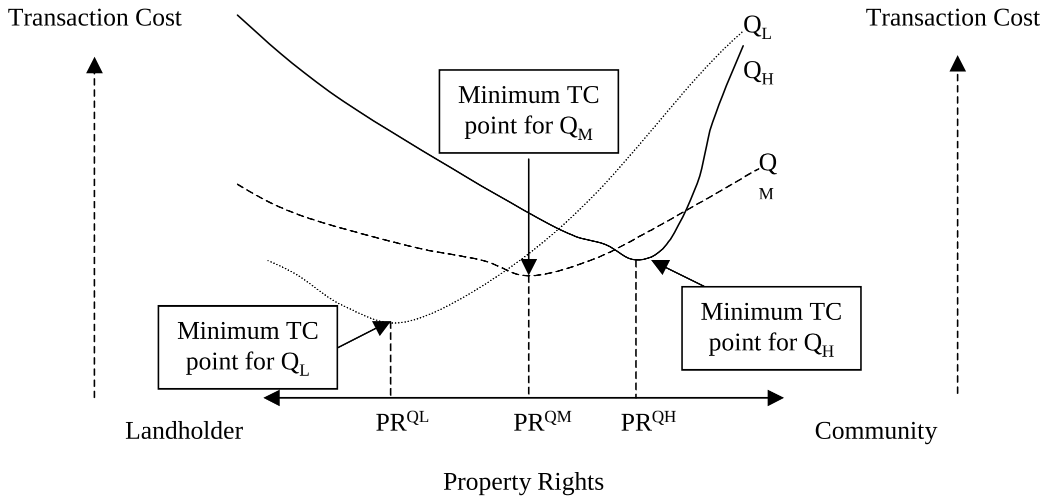


Figure 5 illustrates, hypothetically, the way that transaction costs for three different levels of biodiversity conservation - a high level (Q_H), a medium level (Q_M) and a low level (Q_L) - may vary for different initial property right allocations. For example, the Q_H curve illustrates that if a high 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[6].

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.

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

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

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. 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. 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[7].

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.

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 prices. 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.

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

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 approach has been used by the Victorian government to procure services for biodiversity improvement and maintenance. This approach is called BushTender. The 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 assessed 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[8].

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.

5.4 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.

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[8] 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.

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 vegetation 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.

5.5 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 environmental 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 inadequate 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 might reveal the demand for offsets.

5.6 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.

5.7 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. 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[9]. As landholders become familiar with these activities, the costs associated with conducting them may decrease.

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.

[9] 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 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. These loops 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-labelling 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 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[10].

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[11].

[10] Although the government needs to be clear that it may sacrifice efficiency in order to do this.

[11] Information asymmetries and non-standard benefits are discussed in Appendix 1.

7. 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; and,
- 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.

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 and about the portfolio of mechanisms. 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 A: 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.

A1 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 fulfilment 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.

A2 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.

A3 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 B: The demand for offsets

Implementing an offset program requires an agency to analyse information on the demand for clearing (by developers), and facilitate 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.

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 q0. For example, the agency might break q0 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 $Q_0 = Q_L + Q_H$.

Session 4: Closing plenary session

Market-based tools for environmental management: Where do they fit and where to next?

Stuart Whitten and Mike Young[1]

Abstract

Eighteen papers are presented in this volume relating to MBI theory, design and experience. In this paper we synthesise some of the key lessons that emerge from these papers and the discussion at the symposium in which they were presented. A key conclusion is that MBIs offer both great promises, but also potential pitfalls. Their promise can be achieved while avoiding many of the pitfalls by paying careful attention to MBI design focusing on: property rights; risk and who bears it; flexibility of action; equity implications; and, the evolution of instruments through time. Careful design is no panacea however, as there remain a number of areas of conceptual or practical design that are yet to be sufficiently addressed to provide guidance.

1. Introduction

The papers in this volume cover a wide range of topics relating to market-based (MBIs) and market-like instruments (MLIs). They include overviews of the Australian and International experience, Australian MBI case study examples, tools and methods for MBI design and application, and, important considerations in MBI application such as equity. Our goal in this paper is to draw some broad conclusions from the papers in this volume and from the plenary discussions at the symposium in which they were presented.

The focus of MBI development and implementation can be summarised by paraphrasing Chaudhri in this volume:

> *How do we get the **right** intervention at the **right** location at the **least** cost, so as to facilitate optimal environmental management in a particular region?*

However, MBIs are only one tool out of a menu of policy options for achieving “optimal” environmental management, including no specific policy intervention. MBIs are policy interventions that encourage behavioural change through market signals. But not all MBIs are effective or desirable. Those that are effective and efficient are likely to encourage behavioural change that is:

- the intent of the policy rather than raising revenue from the instrument;
- embedded in instrument design (as opposed to bolted onto the end of a policy) therefore providing for compliance flexibility and incentives for innovation; and,
- achievable in practice thus allowing the gains from trade and potential cost-efficiencies to be accessed in heterogenous communities.

In this paper we draw some broad conclusions from the papers and discussion at the 6th Annual AARES Symposium on Market-Based Tools for Environmental Management about designing effective and desirable MBI policy interventions. In the next section we identify some of the promise that MBIs show for achieving environmental management goals more effectively and efficiently than traditional methods, as well as some of the perils and pitfalls that await over-zealous or poorly

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[1] The authors’ affiliations are respectively: CSIRO Sustainable Ecosystems and CSIRO Land and Water. This paper draws on the presentation made by Mike Young at the 2003 AARES Symposium. The authors would like to acknowledge the assistance of Mandy Yialeloglou in preparing the paper.

considered applications. Some of the important design issues in MBIs are reflected on in the third section including types of MBIs, the necessary conceptual and institutional underpinnings, and the importance of information. Finally, we identify some of the conceptual and design frontiers in MBI development and application, particularly in Australia.

2. Promises and pitfalls

Many claims have been made about the potential for MBIs to achieve environmental targets at low cost across Australia. Some of those made at the AARES symposium include:

- MBIs can make problems go away;
- reality is not a special case (meaning economic theory can be applied directly to real world problems);
- MBIs are conceptually simple and based on a “back to basics” approach; and,
- MBIs are guilt free, waste free & envy free.

Often these claims are made in conjunction with commentary about the paucity of government support that is forthcoming to achieve desired outcomes through other policy instruments. The implication is that MBIs are somehow a cure-all for environmental problems.

However, it is timely to review this assessment of MBIs in view of the pitfalls of poor or inappropriate MBI design and application. These pitfalls are reflected in concerns about MBIs including:

- the potential impact of market failures within MBIs due to few trades or the potential for market dominance by individual players;
- the risks in designing MBIs and whether they will achieve target outcomes;
- the difficulty and complexity of property rights issues within MBIs, particularly where the interaction with existing rights may cause perverse outcomes (for example water market impacts on sleeper rights); and,
- concerns about the equity impacts of competition in MBIs.

In discussing the promises and pitfalls of MBIs it is worthwhile to revisit the definition of market-based instruments as ‘policy tools that encourage behaviour through market signals rather than through explicit directives.’ The implication is that MBIs are reliant on competition in a market place in order to efficiently achieve the desired outcome. Along with this reliance on competition there are a number of implied, but not necessarily required, assumptions about the nature of the instrument. For example, MBIs are commonly assumed to involve lots of sellers and buyers, regular transactions (‘sales every week’) and lots of information being available. However, MBI’s, and the form of the competition that is invoked, take many forms including (Schlizzi this volume):

- double-sided MBIs such as tradable permits;
- single-sided MBIs such as conservation auctions; and,
- no-sided MBIs such as taxes and flat rate subsidies.

Of these forms only double-sided MBIs show full resemblance to the common perception.

The reliance of MBIs on competition is the source of both the promise and the pitfalls. Competition is the source of the potential economic efficiencies and cost-effectiveness in achieving policy goals. The absence of competition, or misdirected competition, is the source of market failures and MBI pitfalls. Because of these attributes MBIs will tend to be most promising and effective where there is substantial conflict in resource use as a result of differing values in use. Alternatively, MBIs will tend to be most promising where there are substantial variations in compliance costs. This is because these cost differentials are revealed in the trades within markets. The reallocations that arise through the trades in markets are also one source of MBIs attractiveness to governments. The market performs the detailed allocative process without the information problem that faces government in trying to allocate resources.

Competitive markets for environmental outcomes do not arise spontaneously – a point that was emphasised by many presenters at the symposium. Rather, effective MBIs arise from good design processes that include a regulatory and enforcement framework. Hence, good government is required to create and support effective MBIs. The importance of strong design in creating effective MBIs has been recognised in the development and funding of the National Market Based Instrument Pilot Program under the National Action Plan for Salinity and Water Quality. This program is funding 11 MBI pilot projects that are shown in Table 2.1.

Table 2.1: Pilot MBIs funded under the National Action Plan for Salinity and Water Quality

Market Title	Market Type	Region
Multiple outcome auction of land-use change	Auction	Goulburn Broken, VIC
Tradeable net recharge contracts in Coleambally Irrigation Area	Cap & Trade	Lachlan-Murrumbidgee, NSW
Farming Finance: Creating positive land-use change with a natural resource management leverage fund.	Revolving leverage fund	Lachlan-Murrumbidgee, NSW; South Coast, WA.
Auction for landscape recovery	Auction	Avon, WA
Cap & trade for salinity: Property rights and private abatement activities, a laboratory experiment market.	Cap & trade	Lower Murray, VIC/SA
Catchment Care – developing an auction process for biodiversity gains and water quality outcomes	Auction	Mt Lofty-Kangaroo Island, SA
Green off-sets for sustainable regional development	Offsets	Namoi-Gwydir/ Macquarie-Castlereagh/ Murray, NSW
Establishing east-west landscape corridors in the southern Desert Uplands	Auction	Burdekin-Fitzroy, QLD
Establishing the potential for off-set trading in the lower Fitzroy	Cap & trade	Burdekin-Fitzroy, QLD
Recharge credit trade	Baseline & credit	Avoca-Loddon-Campaspe, VIC

Source: http://www.napswq.gov.au/about/mbi/projects.html

The importance of good design was also reflected in the comments of participants at the symposium about MBI development and application such as:

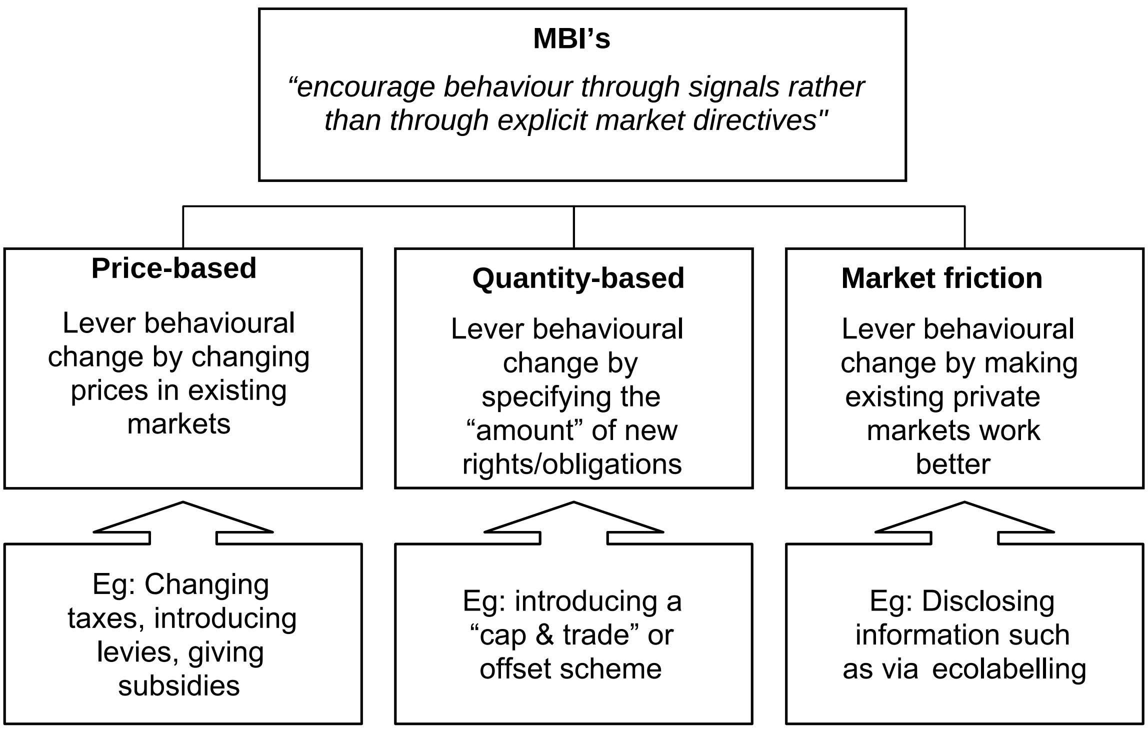
- thinking is cheap;
- don't rush (but also recognise the costs of moving too slowly),
- while MBIs offer promise they are not a panacea; and,
- even where policy tools are poorly considered we should seek to 'waste money wisely'.

That is, the most efficient and effective outcome should be designed given the constraints.

3. Designing market-based tools

Good instrument design is essential in obtaining the desired behavioural change. Instrument design is focused as much on avoiding MBI pitfalls as on achieving their promise. MBIs may be designed to change behaviour by changing prices, specifying quantity, or reducing friction in existing markets, as summarised in Figure 3.1. In theory both price-based and quantity-based approaches are equivalent, but in practice many factors influence the relative outcome including the relative uncertainties in the impact of different measures and relative design difficulties. In general price-based mechanisms provide more certainty as to the compliance costs of the MBI while quantity based-mechanisms provide more certainty as to the environmental outcome. The difficulty is that there are normally cost-benefit trade-offs in setting both price and quantity outcomes as noted by Bennett in this volume.

Figure 3.1: Types of market-based instruments



There will also be considerations about the nature of the behavioural change that is desired. Is the instrument designed to push undesirable behaviour away or pull behaviour towards some specific action? For example, a cap and trade program on emissions pushes emitting behaviour away while a conservation auction pulls behaviour towards the conservation outcome. 'Push' changes will allow or encourage new behaviours to be discovered while 'pull' changes tend to require a behavioural action. These two drive very different innovation strategies. Pushing away from undesirable behaviour encourages broad innovation to find new ways of using resources while pulling behaviour towards a desired point encourages innovation that finds cheaper ways of reaching that point.

Whichever MBI is selected a number of critical design issues will arise with respect to property rights, equity considerations, distribution of risk, availability of key information, incorporating flexibility, and, the potential for MBIs to evolve given that they are designed within existing institutional and social constraints. In many cases these design issues are interrelated. For example, designing a market to incorporate information deficiencies may necessitate designing a market that is able to cope with evolving property rights in response to new information. In the remainder of this section we discuss each of these briefly in turn.

3.1 Property rights and MBIs

Property rights underpin MBIs because they specify a benefit (often termed the entitlement), who can access that benefit (the allocation), and any corresponding duties (or obligations) that access would entail. Property rights are a much-misunderstood concept because there are often different bundles of rights associated with differing ownership or property right statuses. For example, Ostrom and Schlager (1996) divide the benefits associated with various ownership statuses as shown in Table 3.1.

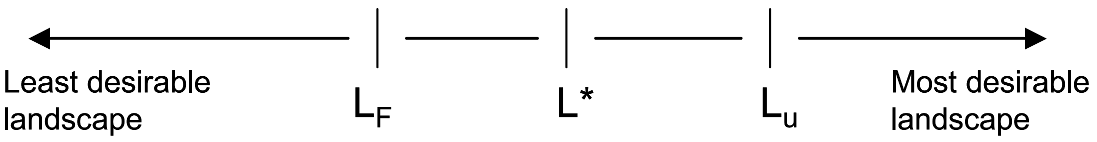
Table 3.1: Bundles of rights associated with ownership positions

Right or Benefit	**Ownership status**				
	Owner	Proprietor	Claimant	Authorised user	Authorised entrant
Access	X	X	X	X	X
Withdrawal	X	X	X	X	
Management	X	X	X		
Exclusion	X	X			
Alienation	X				

Source: Ostrom and Schlager (1996, p. 133)

Of particular concern in the design of many environmental MBIs are the obligations that are associated with particular bundles of rights, often expressed as the ‘duty of care’ that is required in order to access part or all of the benefits available under the rights owned. The existing ‘duty of care’ effectively provides the baseline from which the MBI is intended to leverage behavioural change. That is, behaviour compliant with the ‘duty of care’ is expected regardless of the MBI. However, there is often much debate over where the duty of care lies, with different right or benefit holders seeing the most appropriate duty in differing places as shown in Figure 3.2 from Bromley (1997). In Figure 3.2 the actual ‘duty of care’ expected of farmers with respect to their landscape management is designated L^*. However, farmers may perceive the appropriate level as below this level (say L_F), while urban interests may consider that a higher level is appropriate (say L_U).

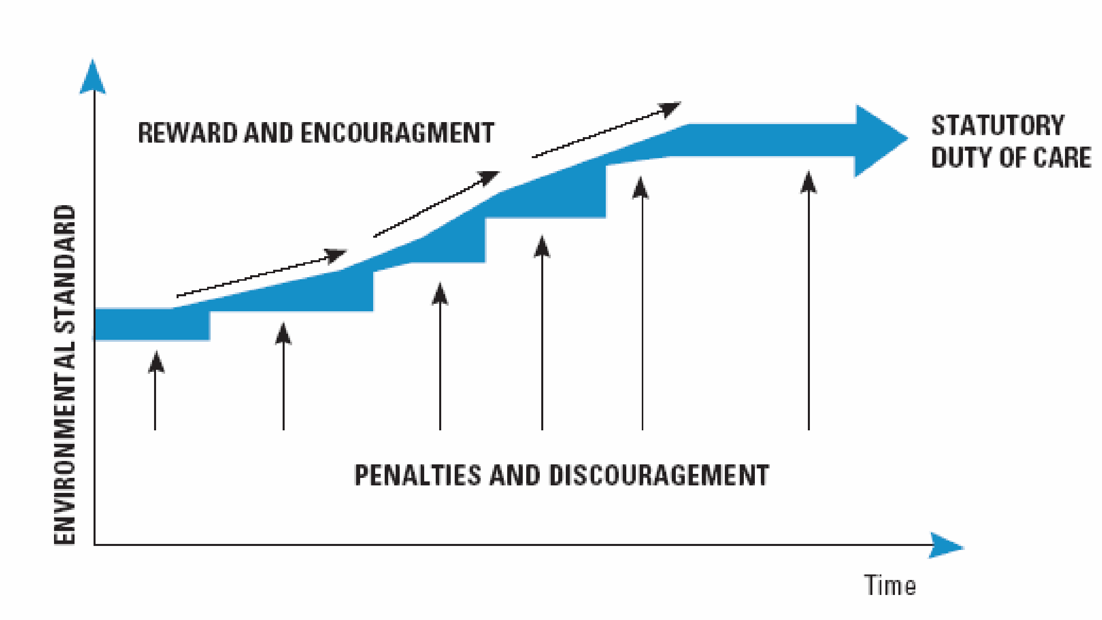
Figure 3.2: Potential distribution of perceptions with respect to property rights



Source: Bromley 1997, p. 37.

A related concept is the role that MBIs play if the requisite 'duty of care' changes in response to changing community expectations.[2] Consider for example Figure 3.3. MBIs may be one effective mechanism for the 'reward and encouragement' supporting changes to the statutory duty of care.

Figure 3.3: Potential changes in 'duty of care' through time



Source: Young, Shi and Crosthwaite (2003, p. 16).

3.2 Equity considerations in MBI design

Equity is a multifaceted concept as discussed by Schilizzi in this volume. Depending on the context equity may refer to equality in access, treatment, outcome, or some amalgam of these and other attributes. However, MBIs are designed to increase efficiency in resource allocation and there is no reason to expect that the outcome will be equitable whatever the definition. Efficiency is essentially a distribution free concept. So why consider equity at all? Because considerations other than efficiency *are* taken into account when deciding whether to implement an MBI and what form it will take. As Stavins (2000) notes: 'policy instruments that appear impeccable from the vantage point of research institutions, but consistently prove infeasible in real-world political institutions, can hardly be considered "optimal".' Or paraphrasing Hahn, Olmstead and Stavins (2003): both the efficiency and cost-effectiveness criteria may be hard to swallow when the distributional impacts of MBIs are highly skewed. Put simply, if equity forms part of the decision equation then it is part of the design equation as well.

So what can MBI design do to consider or incorporate equity? Many facets of equity are in fact automatically considered within the design process although it may not be stated as such. For example, equity of access is often considered against the costs of expanding the scope of the MBI. Similarly, equity of treatment within MBIs is often a fundamental principle. For example, small water licence holders are treated the same as large licence holders.

Equity of outcome is a more complex issue, whether it requires that MBI participants be no worse off than before or a more stringent condition. While economists have tended to indicate that equity of outcome should be dealt with through alternative mechanisms, the fundamental question of the usefulness of a MBI that is not adopted remains.

[2] It should be noted that any unstated future changes in the requisite duty of care may increase the sovereign risk associated with MBIs and thus their relative effectiveness and efficiency.

3.3 Risk, information and MBIs

Risk and information are discussed together because they are directly linked: the greater the information available the less the risk and uncertainty. This fundamental principle extends to all policy options and to all types of risk and uncertainty. MBIs are often perceived as risky because they are relatively new mechanisms about which many policy practitioners know relatively little. However, MBIs have a fundamental advantage over most other instruments when they are well designed because they are powerful in revealing information through the behaviour of participants in the created market. MBIs can be termed information efficient because of the information revealed in the market processes.

The general conclusion about the risk efficiency of markets should be tempered somewhat by noting that most command and control regulatory schemes are negotiated outcomes that are low cost. The information that is revealed in the negotiation process is similar to that revealed in the market process and means that in some circumstances the negotiated regulatory outcome is at least as efficient as the market outcome. Furthermore, all instruments remain subject to risk and uncertainty. This risk can be moderated through careful design and testing in advance. However, the information revelation within markets can ease parts of the design burden and mean that while MBIs can perform poorly they will often perform better than an alternative instrument designed with similar information.

3.4 Incorporating flexibility

The incorporation of flexibility into MBI design is a crucial element in capturing widest possible range of gains from trade and encouraging future innovation. Designing to incorporate flexibility should particularly consider the degree of heterogeneity in the costs of pollution abatement or service production, and the spatial nature of the issue targeted.

Heterogeneity (or divergences) in the costs of alternative producers is essential to achieving the gains from trade that are necessary for MBIs to work well, and more importantly are a key condition for MBIs to outperform alternative instruments (Stavins 2000). In order to maximise the potential gains from trade a wide range of potential and actual producers should be included in the MBI. For example, inclusion of both point and non-point sources in the nutrient trading examples provided by Faeth (2000) is a key element in the extent of the available gains from trade. However, there is an important caveat: broadening the market may come at a cost, either in design terms or in transacting within the market. Specifically, the greater the degree to which the actions are substitutable will determine the degree to which they can be considered within alternative MBI designs.

While flexibility in the scope of actions included within MBIs is important to achieving the gains from trade, the spatial impacts of changes in actions should also be considered to ensure that localised “hot spots” or other perverse outcomes do not occur. As Stavins (2000) notes, the greater the degree of mixing or the greater the uniformity of impact, the more attractive a MBI will be. For example, if biodiversity is relatively uniform across a landscape then a more flexible MBI design may be used to capture the gains from trade across a broad area. However, if biodiversity is concentrated in specific parts of the landscape a more complex and less flexible mechanism may be required with potentially fewer gains from trade. However, the very variability of biodiversity across landscapes may reflect heterogeneity in costs and reflect the potential for an MBI to access gains from trade.

The flexibility offered by the design of certain MBIs in the face of other economic factors may also be a strong reason for their adoption over alternative options. For example, consider the impacts of a cap and trade permit system versus a tax system per Stavins (2000). Under a tax system the aggregate environmental target will change as the economy grows (total emissions grow) or due to the impacts of inflation (costs of unit tax fall as proportion of total costs). Conversely with technical innovation under a tax system the aggregate environmental outcome will improve. In each case the cap and trade system will maintain a set outcome.

3.5 Designing for future MBI evolution

MBIs are not static instruments and like all policy are likely to need modification in the future in order to continue to meet the needs of society. These modifications may be easier if the MBI is designed to evolve through time. There are at least three dimensions that MBIs may need to evolve within. As noted previously, considerations other than equity may mean that regulation evolves into a MBI through time rather than simply creating the MBI. Second, the baseline within MBIs may change through time. Finally, the desired mix of outcomes that the MBI impacts on may change, necessitating a different form of MBI or even multiple MBIs.

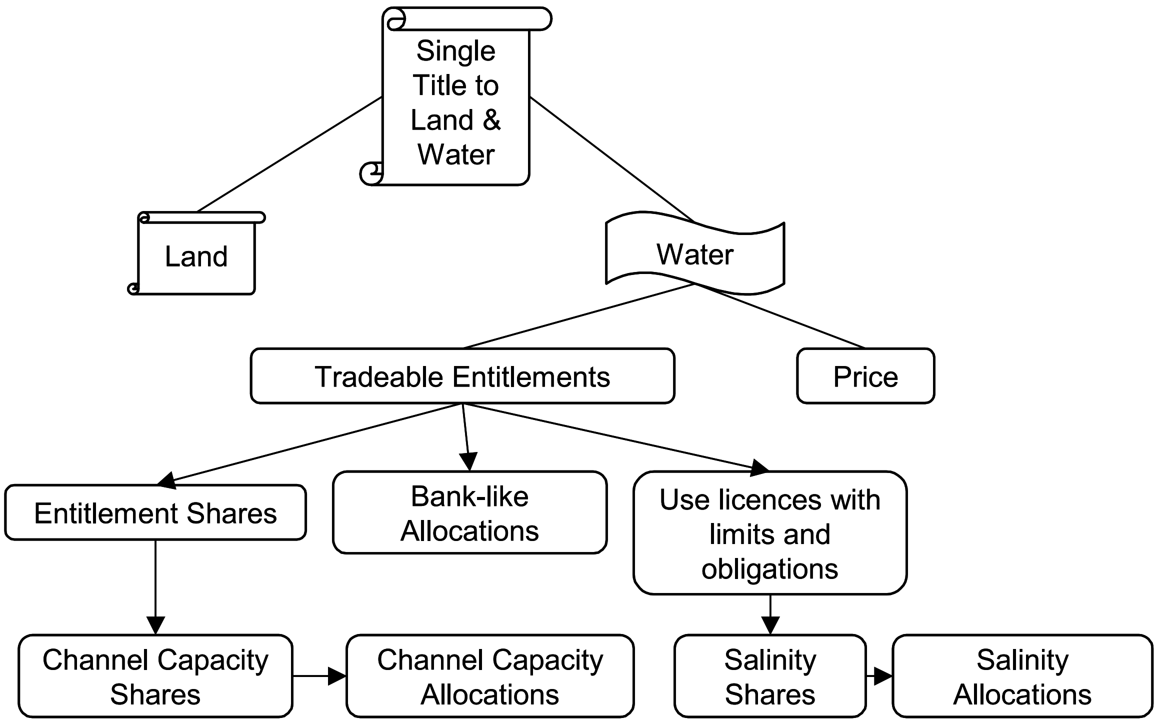
MBIs often evolve through time rather than being designed and adopted as a once-off change in environmental management. This is particularly the case as most environmental legislation within which MBIs are created, or which MBIs are added onto, was enacted before MBIs became widespread (see the discussion in Hockenstein, Stavins and Whitehead 1997). For example, consider the evolution of the Hunter River Salinity Trading Scheme from regulations on discharges to the Hunter River through a trial MBI and finally to a legislated MBI. Hence, policy interventions can be designed to set instruments on a path towards increased efficiency through continued policy evolution rather than as a once off change.

The baseline target outcome may change for many MBIs through time due to changes in tastes, relative scarcity and other factors. Consider for example the evolution of 'duty of care' shown in Figure 3.3. Any MBI designed to achieve the desired environmental standard in these circumstances will need to be able to incorporate a continually shifting baseline without unduly compromising other aspects of the instrument. A similar, though not strictly equivalent, example is the adjustments to water markets to account for the variation in available stocks due to climatic variations through time. Hence, water allocations are measured as a share of available water rather than a fixed volume.

Usually rights bundles comprise a number of potential benefits and obligations. A more complex example of one bundle of rights is shown in Figure 3.4, that relating to water in managed irrigation areas. In this example an irrigation licence (or share) held as part of an irrigation area entitlement currently implies access to a specified share of the water allocation, access to the delivery system, and the right to discharge water into a shared aquifer that may eventually deliver salt and water back to the river system. Potentially each of these benefits can be separated just as the water licences have been severed from a single title to land and water.

Despite the fact that at least some aspects of most MBIs evolve through time, and the potential improvements to theoretical efficiency that may result, many stakeholders do not view this as a positive. Instead stakeholders are often concerned about the lack of predictability in MBIs and the potential 'that the rules of the game will be changed in midstream' (Hockenstein, Stavins and Whitehead 1997).

Figure 3.4: Potential unbundling of property rights as institutions evolve



4. Conceptual and design frontiers

The recent focus on MBI design and implementation within Australia and overseas has done much to identify good design principles and develop effective MBIs. This research has also contributed to identifying what we don't know about MBI design and application, both in terms of conceptual and theoretical frontiers and in terms of practical design.

4.1 Conceptual frontiers

A large body of economic theory has been built up focusing on the behaviour of individuals and firms in differing types of markets. However, a large proportion of this literature deals with '*homo economicus*' or rational economic man in a strict profit maximising setting. Recently, however, there has been a renewed focus on the importance of the institutional context of decision-making through via an emphasis on transaction costs and institutions through the 'new institutional economics' driven by Ronald Coase, Oliver Williamson and others. The new institutional economics stresses the importance of understanding behaviour within the institutional context that it is generated. Other emerging streams of theory within evolutionary economics are also helping to understand the evolution of institutions and the response of individuals to institutions. Yet despite this renewed focus on human-institutional relationships our understanding of human behaviour in response to different instruments is incomplete. A more complete understanding of human response would help in designing more effective and acceptable MBI frameworks. Such an understanding may also assist in understanding how equity trade-offs should be incorporated into instrument design.

In a similar vein we also know that institutions are not isolated. New institutions generate feedback into the community in which they are embedded. They change expectations about what is acceptable behaviour and may change the allocation of entitlements and corresponding duties. However, little is understood about the nature of this feedback and what it means for institutional design, or more generally for the way future instruments are considered.

A further related area is the evolution of instruments through time. Evolutionary economics is starting to provide some theory for understanding institutional change, but this is in an embryonic stage and much is yet to be learnt. Similarly little is known about how different instruments should be mixed through time to achieve an optimal outcome, particularly given that no instrument operates in isolation but instead will inevitably generate feedbacks to and from other instruments.

While there are many other areas in which the conceptual framework is weak the final area considered here is governance. It is generally assumed that the governance of MBIs will fall to formal government institutions. However, this need not be the case. For example, The MarketPlace Company manages trades and the register for the national Renewable Energy Certificates program (RECs). While there is evidence to suggest that there are efficiency gains from specialised private sector providers undertaking such roles there is little theory to suggest whether there are limits or other governance issues related to private sector provision.

4.2 Design frontiers

Even where the conceptual framework is robust there remain many areas of instrument design that can either be improved or about which relatively little is known. This is particularly the case when the internal structures of many government agencies and firms are not equipped to cope with MBIs (Hockenstein, Stavins and Whitehead 1997). We have identified nine areas for which either little is known or for which design can be much improved:

1. Robust instrument design: to date most MBIs have been largely designed on a case by case basis. However, it likely that there are clear components or modules and rule structures that are applicable in most circumstances.
2. Instrument financing: who should pay for the design, implementation and ongoing management of the MBI? How should these payments be structured so as to provide ongoing incentives for efficiency within the organisational structures needed to manage the institution?
3. Instrument nesting: many environmental issues will require more than one instrument to achieve the desired outcome. In these cases how are MBIs nested with other instruments, or with other MBIs?
4. Instrument sequencing: related to instrument nesting, which instruments should be implemented first? How should instruments be sequenced to encourage evolution towards more efficient MBIs in the future?
5. Instrument delivery: Should MBIs be delivered by regional NRM organisations, through local or state government, private sector providers, specific organisations created for their delivery or some mix of the above? Should the delivery vehicle differ for different issues or in different locations?
6. Design trade-off and compromise: Most instruments will require some trade-offs in design to meet other goals, but what can be traded-off without compromising the efficiency and effectiveness of the instrument?
7. Development process: what path should development and implementation take? Who should be involved and at what level?
8. Enforcement: What rules and regulations are needed to ensure effective MBIs? How should these be drawn up and who should enforce them?
9. Evaluation: What needs to be done to identify whether the MBI is effective and has achieved the goals that were set? Who should undertake this process?

5. Conclusions

The papers in this volume cover the underlying theory, practical application and case studies, and broader context of MBIs for natural resource management in Australia. These papers highlight the successes in MBI application to date in Australia, as well as the essential concepts and issues in their design and implementation. Despite the apparent promise offered by MBIs many potential pitfalls remain in their application. These pitfalls can be minimised by good MBI design, particularly with respect to:

- setting appropriate property right structures;
- taking into account the implications of equity concerns as a fundamental element of whether the instrument so designed would be politically and socially acceptable;
- designing MBIs to account for risk and an absence of information, but also considering the implications of these constraints for alternative instruments;
- incorporating flexibility in order to maximise the gains from trade yet achieve the desired environmental outcome; and,
- account for potential instrument evolution but consider the implications for sovereign risk to participants and uncertainty to communities that may result.

Despite the potential for good MBI design to minimise the potential pitfalls many conceptual and practical design issues remain to be solved. Conceptual issues include a more complete understanding of human behaviour in alternative institutions as well as a more complete understanding of the evolution and integration of different institutional mixes through time and across the community. Among the many design issues that remain some of the most important relate to cost effective instrument design and delivery, both in a narrow single-MBI sense, and in a broader environmental policy environment made up of many instruments that generate feedbacks and behavioural change in other neighbouring instrument environments.

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Appendix 1: Lessons for Australian MBI development

Contributed Poster Paper Abstracts

Papers are in alphabetical order and those selected for oral presentation are marked **.

** Possibilities to use market based tools for management of phosphorus pollution from point and non-point sources in a watershed

Authors: Tihomir Ancev (University of Sydney); Arthur L. Stoecker (Oklahoma State University)

Point source municipal and industrial pollution and non-point source agricultural pollution attributed to organic fertilization is a serious environmental problem for surface water quality. In particular, excess phosphorus loading can cause eutrohication of rivers and lakes and compromise beneficial water uses. There are various policies for regulating phosphorus pollution at a watershed level. Market based mechanisms are potentially effective and economically efficient for this purpose.

The objective of the paper is to present a method that can be used to determine the optimal cap on phosphorus pollution in a watershed, the demand for tradable permits by point and non-point sources and the expected trade in pollution rights between the point and the non-point sources as well as among the non-point agricultural sources of phosphorus loading in a watershed.

Soil and Water Assessment Tool (SWAT) was used as a biophysical computer model to simulate the biological and hydrological parameters for the Eucha-Spavinaw Watershed, Oklahoma in the Ozark region of the U.S. The results from the model were integrated in a mathematical programming optimization framework. The mathematical program was used to determine the optimally allowable phosphorus loading in the watershed and to determine the optimal allocation of tradable rights for phosphorus emission between the point and the non-point sources, and among the non-point sources. Willingness-to-pay for tradable permits was determined for each agricultural enterprise in the watershed and for the point source. Implicit price of the tradable permits on the watershed level was derived.

The Murray-Darling basin in Australia has been seriously affected by eutrophication in the early and mid 1990's. This threat is still very much present. External phosphorus loading in the basin is mainly generated at the point sources but the contribution of agricultural non-point sources has been also noted and investigated. The methodology outlined in the present paper can be directly applied to various catchments in the basin to determine the economically optimal distribution of phosphorus abatement between point and non-point sources.

The main contribution of the paper is the derivation of optimal phosphorus loading in a catchment using high level of spatial detail and the presentation of expected direction of potential trades in phosphorus emission permits. The main implications are that the patterns of trade in phosphorus pollution permits will depend on the cost of the available abatement technologies and practices to the point and non-point sources.

Feasibility of using tradable permits is discussed from a transaction costs perspective. In particular, the paper discusses the possibility to establish markets for permits within individual catchments. Transaction costs of establishing such markets may be substantial, especially in the presence of multitude of heterogeneous point and non-point sources. If there are relatively few agents, the transaction costs will be reduced, but the danger of thin markets will still persist.

Keywords: pollution, agriculture, phosphorus, tradable permits.

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** Land management tenders on the Liverpool Plains

Authors: Di Bentley (Liverpool Plains Land Management Committee); Warwick Moss (WWF-Australia)

The Liverpool Plains Land Management Committee (LPLMC) is a community based organization working in the 1.2 million hectare Liverpool Plains Catchment on the Namoi River in northern NSW.

Having undertaken extensive research and planning, it is now implementing its catchment plan, the Liverpool Plains Catchment Investment Strategy (LPCIS) which combines research based biophysical knowledge with landholder expertise to recommend management actions (specific to different parts of the landscape) to overcome six major natural resource issues.

In implementing its Strategy, the LPLMC is exploring different methods of paying farmers for the public good component of various on-ground works. These methods include Natural Resource Auctions, called Land Management Tenders (LMT's), in which it collaborated with WWF- Australia. Two rounds of these Tenders have now been completed, purchasing biodiversity, salinity and water quality benefits on 8,000 hectares of country. Conducting the LMT's presented an interesting set of challenges for a community committee and an NGO in the development of communication strategies, environmental benefits indices, assessment processes and management agreements. The poster will emphasise that lessons learnt from community based trials can provide usefully different perspectives from government administered trials.

LMT's have proved valuable in overcoming some of the traditional problems associated with funding the amelioration of natural resource problems like salinity. They have been well received by landholders.

The LPLMC is currently working with Environmental Management Systems (EMS). Using EMS, it is attempting to link the implementation of its Investment Strategy to landholder incentives provided through accreditation, product differentiation and market access.

Keywords: community committee; Liverpool Plains, NSW; auctions; biodiversity, salinity, water quality

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Auction for landscape recovery in southwest Australia.

Author: Michel Burton (University of Western Australia); Jane Madgwick

This project is one of the MBI pilots, and has started in mid-2003. As such the poster will outline what is the intent rather than any specific outcomes.

The pilot will evaluate conservation auctions as a landscape recovery mechanism through a cross-sectoral government-community partnership, coordinated through the Avon Catchment Council.

The pilot will build on and complement the development and trial of a Salinity Investment Framework and Framework for Biodiversity Target Setting in the Avon Basin and identify auction design requirements relevant to the whole Basin and other fragmented, salinising landscapes of high biodiversity value. We will draw conclusions on the cost-effectiveness, "key success factors" and "key impediments" of the auction approach with regard to achieving environmental outcomes linked to the NAPSWQ and regional plan targets.

A particular feature of the pilot is the intention to compare two alternative bid selection methodologies within the auction approach, an Environmental Benefits Index and the Systematic Conservation Planning approach incorporating a selection algorithm to iteratively assess the complementarily of successive bids (in terms of marginal gains in biodiversity) in relationship to others.

The poster will focus on the specific issues associated with the management of biodiversity in the region; auction design; the SCP approach to evaluating bids and a general overview of the planned project process.

Keywords: WA; biodiversity; auction; Systematic Conservation Planning; Environmental Benefits Index

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BushBroker: A broker for biodiversity credits

Author: Michael Crowe (Department of Sustainability and Environment)

The BushTender trials conducted in Victoria offered landholders the opportunity to bid for the price of their management services that improve the quality and extent of native vegetation. Under BushTender agreements, sites will generate known gains at costs that have been set competitively through a market mechanism.

Victoria's Native Vegetation Management Framework requires that losses associated with vegetation clearing be offset. Difficulties arise where the gains required for offsetting cannot be generated by proponents on their own property. In these situations offsets generated elsewhere could be available for purchase by proponents.

There may also be other parties interested in purchasing biodiversity credits. This could include philanthropic organisations seeking to enhance biodiversity conservation and businesses seeking market advantage.

There is a beneficial role for a broker to facilitate and oversee these types of exchange. The resultant funds would be returned for further investment in biodiversity conservation through BushTender or equivalent programs. Without a broker providing a central clearing house, developers would have difficulty in locating suitable offsets and in negotiating satisfactory deals with credit providers in a timely manner.

A project to examine the feasibility of establishing a broker to administer trading in biodiversity credits has been undertaken. The main issues addressed in the feasibility study included:

- the legal requirements for creating and trading biodiversity credits;
- the legal and administrative arrangements for the long-term security of the credits;
- the options for the type of entity best-suited for the broker role;
- the level and sources of demand for biodiversity credits in Victoria; and,
- the pricing of credits including transaction costs and allowances for stewardship.

The cost-effectiveness of the broker will ultimately be tested by the willingness of proponents to use its services, rather than to seek third-party offset through their own resources.

The proposed role of the broker is similar to some other models (eg wetlands mitigation in the US), however there are unique features including credit supply through auctions and discrimination of biodiversity types.

Keywords: Victoria, biodiversity, credits, broker, trading

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** Green offsets for sustainable regional development

Author: Carolyn Davis (NSW EPA)

Green offsets are designed to achieve environment protection while allowing for sustainable development. Environmental impacts of a new or expanding existing development can be offset by taking action to cut other sources of pollution or impact nearby. That way the overall pollution level stays the same or is even reduced. The main economic principle underpinning this form of market-based instrument is the reduction of environmental impact at least cost.

Offsets are being explored through a project Green Offsets for Sustainable Regional Development - to implement three salinity offset proposals in the Western Regions of NSW. Licensed premises will be able to offset their emissions by investing in works that reduce salinity from diffuse sources, and so cost-effectively reduce salt loads to stressed rivers in the Murray-Darling Basin (in Gwydir, Murray, and Macquarie/Hunter catchments). The three premises considering offsets are Ulan Coal Mine, Norske Skog Paper Mill and spa baths in Moree.

The offset pilots will be early cases for verifying how salinity offsets can deliver both environmental and economic outcomes, using the environment protection licensing framework. A key challenge is to ensure environmental outcomes are achieved while keeping implementation simple and cost effective. The project will address this by developing, testing and refining when offsets can be used; establishing sound contractual arrangements for their use; and developing protocols for monitoring their application.

Keywords: Western NSW, offsets, salinity

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Water = Ecology + Money: Community management of environmental water for wetlands.

Author: Paula D’Santos (NSW Department of Planning, Infrastructure and Natural Resources)

Between 1999 to 2003, an exciting trial program which uses an environmental water allocation as a management tool, has delivered significant ecological benefits for wetlands within NSW. The NSW Murray Wetlands Working Group (MWWG) - an independent, community-based, wetland conservation group - has been managing 30,000 megalitres (ML) of environmental water on behalf of the NSW Government. The program is aimed at improving and rehabilitating degraded wetland ecosystems along the Murray and Lower Murray-Darling catchments in NSW.

The 30,000 ML was derived through infrastructure improvements during the privatisation of a large irrigation company in southern-central NSW and funded by the NSW Government.

To date the environmental water allocation has been used to:

- extend a natural flood event through the Barmah-Millewa Forest and ensured a successful bird-breeding event for more than 30,000 colonial waterbirds;
- water a remnant stand of Common Reeds (Phragmites australis) within the Werai Forest, and enhance the understanding of the Forest’s commence-to-flow levels and flooding paths;
- water approximately 120 isolated floodplain wetlands on private properties within southern-central NSW. This project has developed partnerships between the MWWG, a local irrigation company and 89 private landholders; and
- generate funds for environmental on-ground works and/or programs for wetlands via trading on the temporary water transfer market.

The management of the environmental water allocation by a community-based group is unprecedented in Australia and has proved to be highly successful. The group’s utilisation and management of the water is being used as a model for similar initiatives around Australia.

Keywords: Murray & Lower Murray-Darling, NSW, environmental allocation, trade, wetland ecology.

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** Cap and Trade for Salinity: Property rights and private abatement, a laboratory experiment market

Authors: Charlotte Duke (DPI Victoria), Byron Pakula (DPI Victoria), Lata Gangadharan (University of Melbourne) and Tim Cason (Purdue University)

This pilot will use experimental economic methods to estimate the cost effectiveness of a Cap and Trade approach to manage salinity concentrations from irrigated agriculture within the lower Murray NAP region Victoria; specifically Nyah to the South Australian Border.

Experimental Economic methods will be used to illustrate to national, state and regional policy makers, the cost differences between the salinity levy currently employed in the region and a Cap and Trade mechanism.

The salinity levy will be implemented in the laboratory as the experiment control. The Cap and Trade mechanism will be implemented as a treatment. Students from the University of Melbourne and Purdue University USA, and irrigators from the region will make production decisions in the laboratory under the economic incentives created by the different policy mechanisms. The experimental results will then be analysed to estimate the cost differences between the two policy mechanisms to help achieve the Salinity target at Morgan.

The project team is comprised of Experimental Economic Specialists from the Economic Theory Centre Melbourne University and Purdue University USA, who have extensive experience in using economic experiments for policy development. The team also includes hydrological modellers from DPI Victoria, to estimate cause and effect relationships between irrigation practices and river salt concentrations. Cause and effect relationships are one of the main information requirements for a MBI. The pilot is being lead by economists from DPI Victoria. Together, this team has conducted two experiments in 2000 and 2001 to inform the design of Bush Tender and Nutrient Trading in Port Phillip Bay.

Initial experimental results will be available to Natural Resource Management Committee and jurisdictions involved in achieving the National Action Plan by November 2003.

Keywords: Lower Murray NAP Region Victoria, Cap and Trade, Experimental Economics, Irrigation Salinity Impacts, Hydrology Cause and Effect Relationships.

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Enterprise based conservation - conservation as a commercial land use

Author: Ed Fessey (Brewarrina Regional Vegetation Committee)

To address equity in relation to the cost of conservation on privately managed land Brewarrina Regional Vegetation Committee has developed a market-based solution to conservation, termed ‘Enterprise Based Conservation’. Brewarrina Regional Vegetation Committee is a state government appointed community-based group within the Western Division of New South Wales.

Enterprise Based Conservation promotes conservation as a legitimate commercial land use. To date landholders and the broader community have primarily recognised production values in agricultural enterprises. Enterprise Based Conservation allows conservation to have a productive value and be a competitive enterprise to agriculture. The landholder outcome from entering this scheme is conservation of native vegetation, referred to as the ‘primary product’. ‘Secondary products’ include reduced salinity, improved water quality, soil stability and biodiversity conservation.

To help determine the eligibility criteria, conservation management conditions, mechanisms for allocating funds and the administrative framework for Enterprise Based Conservation, a pilot program has been established in the Western Division by WEST 2000 Plus. Within the pilot program conservation landuse will be for a five year term, however if Enterprise Based Conservation is implemented the conservation landuse would be permanent.

Enterprise Based Conservation is best suited to the conservation of existing native vegetation rather than regeneration or rehabilitation. The rangelands were chosen for the pilot program due to the unmodified nature of the landscape. This scheme could be applied to remnant native vegetation across any landscape.

Under Enterprise Based Conservation landholders voluntarily manage an area for conservation purposes and receive an economic return comparable to the value of the production that would have been generated from the conventional landuse. Economic returns are received from an independent and self-generating conservation fund. The interest gained from money borrowed from the fund sustains the dividend, monitoring and administrative costs.

Long-term conservation will result from a short-term investment by the Government to establish a conservation fund. Estimates of a one-off cost of $500M have been made to conserve 10% of the rangelands of Australia. To initiate Enterprise Based Conservation financial and administrative support is required from Government or private industry. In the longer term, conservation products would trade on the free market in competition with other commodity production.

Keywords: Conservation, alternative enterprise, conservation fund, Western Division.

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** Get more out of cost sharing with risk ranking and cooperative action

Authors: Jeff Connor (CSIRO PERU), Leonie Scriven (Earth Tech Engineering), Steven Gatti (Onkaparinga Catchment Water Management Board)

This pilot focuses on developing a cost effective way to allocate funds for on ground works using tendering by catchment management Boards in the Mount Lofty Ranges and Greater Adelaide region. It builds on innovative biodiversity and water quality risk assessment methodologies already in use in the area.

Two cost effectiveness issues related to allocation of cost sharing funds will be investigated. One focus will be using a risk reduction methodology to rank the importance of on ground works actions/locations. The goal is to improve targeting of high risk sites for action.

The other design issue addressed is the need to understand the potential for increased returns per cost sharing dollar through the use of tendering rules designed to encourage cooperation among landholders (and between landholders and volunteers). Tendering approaches will be piloted that involve an educational process of making coalitions of landholders and others interested in conservation aware of the risk reduction value of cross property actions. Groups will then be asked to prepare bids for programs of work to be evaluated with a protocol that rewards cross property cooperation based on its risk reduction value. This ranking procedure will be clearly communicated to potential bidders. To evaluate the potential value of tender protocols to encourage cooperation, results from these tendering rounds will be compared with results from past cost-sharing or tendering with less explicit emphasis on cross property actions.

Keywords: water quality, Mount Lofty Ranges, tendering, cooperation, risk reduction

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** Assessing the applicability of economic policy instruments for dryland salinity management in Western Australia

Author: Tennille W Graham (The University of Western Australia)

The application of economic policy instruments for environmental management often fail to consider such problems as, transaction costs and imperfect information, which can impact on the selection and implementation of these tools. Economic policy instruments have been identified as an alternative method (apart from suasive and regulation methods) to manage dryland salinity in Western Australia. This research will investigate (a) the potential scope for market-based tools for dryland salinity management by identifying the occurrence or non-occurrence of market failure from negative externalities caused by salinity and (b) the practical applicability of specific instruments considering the level of transaction costs and the extent of imperfect information.

The case study chosen for the research is the Date Creek Subcatchment, located in the Blackwood River Catchment, experiencing land and water salinity. Market-based solutions are potentially applicable to this area because i) it is judged that market failure is likely to exist, due to the presence of high-value public assets under threat from salinity, and ii) the existence of a local groundwater system, which means that treatments are more likely to be effective in protecting those assets.

First and second best policy approaches will be investigated in this research. The methodology used is a dynamic optimisation model based at the catchment level.

Keywords: Dryland salinity, Blackwood Catchment, transaction costs, policy instruments, market-based instruments.

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** Utilizing contingent claims to improve livestock waste management

Authors: Ben M. Gramig (University of Kentucky), Jerry R. Skees, (University of Kentucky) and Agricultural Risk Management Consulting and GlobalAgRisk), J. Roy Black, (Michigan State University)

The United States Department of Agriculture Risk Management Agency is currently supporting research and development of market-based instruments to address environmental and public health concerns from large livestock production facilities, known as Concentrated Animal Feeding Operations (CAFOs). As part of this initiative, this paper proposes the use of a class of index-based contingent claims contracts in conjunction with third-party auditing to improve the management of CAFOs. Society has continually attempted to alter the property rights governing CAFOs through traditional regulatory measures designed under a "polluter pays" approach to pollution control. While livestock waste management continues to be a source of great public scrutiny, it is not clear whether managers of CAFOs respond more to regulations or the threat of lawsuits from citizen groups. In either case, the individual farmer has greater incentives to reduce the risk of a problem. The premise of this proposal is that producers will reduce the risk of failure of their systems more quickly when the regulator is the insurance underwriter rather than a government entity. By packaging a waste hauling option into insurance-like contracts that include independent third-party auditors, one may be able to devise solutions that mitigate risk and prevent individual failure problems.

The application of the proposed instruments may provide an optimal set of incentives for environmental managers in a number of industries which pose information asymmetry problems for regulators and are subject to high transaction costs. As markets for environmental goods mature, the potential role for these MBIs could be significant in addressing issues more pertinent to Australia—water quality trading for NPS pollution, water market efficiency, and salinisation are possibilities.

Keywords: USA, water quality, public health, contingent claims, third-party auditing

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NSW Environmental Services Scheme – new income streams for farmers

Authors: Keith Uebel, Dugald Black and Alastair Grieve (NSW Department of Infrastructure, Planning and Natural Resources and State Forests of NSW)

In a move to provide greater recognition for the environmental services produced on-farm, the NSW Government has selected 25 landholders to take part in the Environmental Services Scheme. Land use changes on the properties involved are being funded through an investment of $2 million from the NSW Salinity Strategy’s Environmental Services Investment Fund.

The aim of the Environmental Services Scheme is to look at some of the practical issues that will arise in the development of a market to support the environmental services produced on-farm. These include the costs associated with including environmental services within rural production, how to define and create ownership of the services produced, and the types of financial, contractual and incentive arrangements necessary.

The project will focus on environmental services related to salinity control, remediation of coastal acid sulfate soils, carbon sequestration, biodiversity enhancement, soil retention and water quality improvement. The properties represent a range of locations, enterprise types, land use changes and environmental and production benefits. They were selected in a two stage, competitive bid process. Activities include improving pasture management and establishment, planting new forests, managing regeneration of native vegetation, replanting riverbank vegetation, or re-establishing wetlands all with the potential to generate environmental services.

The scheme is currently being implemented. Twenty contracts with landholders to a total value of $1.7 million were signed involving 9,000 hectares of land use change. Work to implement land use changes commenced on these properties and the first income stream payments totaling over $600,000 were made. The approach appears to have been remarkably effective in encouraging land use change, with average costs around $150/ha for enduring land use change.

Selection of the successful properties used a composite Environmental Benefits Index comprising component indices. Specific property level “estimators” for each environmental service were developed based on biophysical models. Index toolkits for these services are now available in a menu-based spreadsheet format, and are being incorporated into a single platform under the Land Use Options Simulator - a spatially-based model allowing field staff & landholders to run different land use change scenarios at a property level to predict environmental service and traditional agricultural production impacts.

The indices are valuable for use in making investment decisions about land use change and environmental improvement works at a number of levels. They can be applied at a property scale, but use a consistent framework so that the environmental benefit generated by on-ground actions in different landscapes can be compared in a transparent and consistent fashion.

Keywords: NSW, Ecosystem Services, Environmental Benefits Index

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Auctioning habitat links & carbon sinks - an MBI for carbon sink establishment in Victoria.

Authors: Jack Holden (Department of Sustainability & Environment, Victoria)

Increased carbon dioxide emissions are a major contributor to global climate change. Vegetation sinks may provide, cost-effective, offsets for these emissions. Victoria’s “Greenhouse Sinks” project will procure management contracts from landholders that establish permanent vegetation.

The objective of establishing this revegetation is to provide both biodiversity improvements and carbon storage in a “sink”.

A concurrent objective of the project is to reward the better and most innovative landholders by auctioning these contracts. The lowest price bidder (in $/tonne CO_2 storage) will be contracted first, followed by the next lowest price bid, and then the next et al. A reserve price mechanism may be incorporated into the auctions.

The auction process should also maximise the amount of carbon storage and biodiversity improvements for each invested dollar.

An eligible landholder will have a cleared site that occurs in a biodiversity preferred part of the landscape (eg. riparian zones, buffering a rare plant community or linking two remnants).

Victoria's Department of Sustainability and Environment (DSE) is the project manager. DSE will call for expressions of interest from landholders and a then field inspection will be conducted by a DSE representative.

The carbon and biodiversity values of the site will be assessed and revealed. Bids can then be submitted based on this information, revegetation costs, land opportunity cost and expected future value of a carbon sink.

Contract monitoring and performance based payments will then continue for a number of years with successful bidders. Auctions are scheduled to begin in early 2004.

Keywords: Auctions, Carbon Sinks, Revegetation, Biodiversity, Victoria

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** Selecting market based instruments to drive change in natural resource management

Authors: M. Leth and J. Johnson (Department of Primary Industries, Victoria)

Selection and implementation of market based instruments has tended to focus on designing a mechanism and searching for a decisional situation in which to advance it. However, this approach fails to consider the complexities of natural resource management. Market based instruments, like all policy instruments must not only consider the regional specifics of market failure, but must also address the policy, regional and on-ground objectives and the drivers and barriers to change at the farm and institutional levels. Failure to consider this complex interaction limits the success of any policy instrument to achieve the desired change.

If market based instruments are to be considered as an effective solution to meet the required natural resource outcome, a sound selection and design process is required. Through research undertaken in northern Victoria (Keeble and Johnson, 2002) a generic decision support framework has been developed to provide stakeholders at the regional scale with a systematic and interdisciplinary approach to select and design an appropriate policy instrument or package of instruments to meet the on-ground, regional and policy objectives.

The generic decision support framework is innovative in it's approach to market based instruments by scoping the issue, reviewing the current situation, assessing the opportunities and selecting and designing the most appropriate policy instrument or package of instruments to achieve targeted outcomes. Using a multiple case study approach, the generic decision support framework is being trialed in collaboration with the Goulburn-Broken, North Central and Mallee Catchment Management Authorities in biodiversity and water use efficiency issues in the 2003-2004 financial year.

Keywords: northern Victoria, water use efficiency, biodiversity, generic decision support framework, interdisciplinary approach.

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** Experience with market-based approaches to climate change regulation in the Australian electricity industry

Authors: Iain MacGill, Karel Nolles and Hugh Outhred (The University of NSW)

This poster outlines some recent developments in market-based instruments for regulating greenhouse emissions in the Australian electricity industry. In particular, we describe the policy objectives, market design and experiences to date with four schemes:

1. The Federal Mandatory Renewable Energy Target (MRET),.
2. The NSW Greenhouse Benchmarks Scheme.
3. Queensland's 13% Gas Scheme.
4. Government accredited Green Power.

Key design issues are shown to include the:

- numerous abstractions and design choices that are required when implementing such market-based tools, and the potential impact of such choices on a scheme's effectiveness and efficiency,
- challenges of setting appropriate baselines in 'baseline and credit' schemes, and the moral hazards that can arise in this process,
- potential for different policy measures to interact in ways that reduce their respective environmental effectiveness,
- 'market for lemons' risks with markets for tradable instruments that have measurement, verification and fungibility challenges as 'poor quality' yet low-cost projects crowd out more expensive yet 'high quality' activities, and
- challenges in creating transparent, liquid markets for these schemes that allow efficient price discovery and risk management by participants.

The mixed performance of these schemes within the Australian Electricity Industry to date illustrates the need for great care in designing such market-based approaches to environmental regulation.

Keywords: electricity, climate change, regulation, market design, baselines

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** Establishing east-west landscape corridors in the southern Desert Uplands.

Authors: Juliana McCosker (Qld Environment Protection Agency), John Rolfe (Central Queensland University), Stuart Whitten (CSIRO)

The Desert Uplands bioregion is in central-western Queensland and is approximately the same size as Tasmania. Rapid land development in the southern part of the bioregion is fragmenting the landscape. To minimise risks of long-term biodiversity losses, strategic east-west vegetation corridors, approximately 10 kilometers in width, should be established. Agreements with 10 to 12 landholders are needed for each vegetation corridor. The challenge is to select the most cost-effective corridors across the region given that a number of potential routes exist, biodiversity values vary between options, and landholder choices are inter-related.

This project outlines the potential use of market based instruments (MBIs) to establish corridors. MBI's to be evaluated include competitive tendering and iterative negotiation rounds, as well as within-property transfers of vegetation clearing permits. The key theoretical issue of interest is how to design an efficient auction system to allocate potential funding for a corridor. Bids from

landholders need to be cooperative (so that corridors line up across properties) but competitive (so that funding is allocated efficiently).

Different auction mechanisms and information frameworks will be tested in the project with applications of experimental economic techniques. Groups of landholders will be invited to participate in trading games using dummy properties that have been created for the purpose. The purpose of the project is to recommend appropriate mechanisms for establishing corridors.

The key stakeholders are:- the landholders, represented by the Desert Uplands Build-up and Development Committee (DUBDC), the Queensland Environmental Protection Agency (EPA) and Natural Resources and Mines (NRM), Central Queensland University (CQU) and CSIRO.

Keywords: Vegetation corridors, market based instruments, auction design, experimental economics.

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Market based incentives and improving the management of floodplain wetlands in the Murrumbidgee River, NSW

Author: Patricia Murray (Department of Infrastructure, Planning and Natural Resources)

It is estimated that worldwide wetlands annually provide $4.9 trillion (US) worth of ecosystem services, yet they have experienced some of the greatest impacts of all ecosystems. Wetlands have been used by stock, drained for cropping and urban development, and used for stormwater control. There has been little effort in quantifying how many wetlands and to what extent they are affected by the various impacts. Without such information it is difficult to estimate the cost of wetland restoration. This four year study in the Murrumbidgee River catchment, NSW, differs from others because it will establish the extent and types of impacts on floodplain wetlands. Management options will be developed for the impacts identified and some management options will be trialed to establish their effectiveness. A cost benefit analysis will be done on the identified management options and a range of incentives will be developed through consultation with landholders and the community. The project began in 2003 and incentives as yet have not been identified, but they may include indirect market-based incentives such as salinity or biodiversity credits. One consideration might be to use the credits to reduce farm holder debt through reduction in loans. The major impediment will be the acceptance of such incentives by the financial institutions and the federal government as the effectiveness of the incentives demands a long-term commitment by banks and the government.

Keywords: Murrumbidgee Catchment; wetlands; management; incentives

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Lessons on the design and implementation of renewable energy, greenpower and greenhouse emissions abatement markets from the financial markets.

Author: Karel Nolles (Australian Financial Markets Association)

The use of markets to facilitate least cost implementation of environmental policy has become relatively popular. These environmental markets have however generally been implemented by government agencies different from those agencies traditionally associated with the oversight and management of financial markets.

This paper suggests that some key lessons from the design and performance of financial markets have not been heeded in the design of many environmental markets, and that substantial improvement in the performance of environmental markets could be achieved by borrowing techniques and structures from the management and regulation of financial markets. In particular this applies in the areas of:

- release of timely information to the market and market transparency;
- comprehension by governments of the impact of risk on market performance;

- the adoption of some Reserve Bank style targets and market interventions;
- understanding the linkages between spot markets and forward markets; and,
- the important interrelationships between Over The Counter and Exchange Based trading.

The ability to enter into forward contracts and other financial instruments is a key risk management tool. In particular this paper discusses the difficulties experienced in environmental markets when the risks are essentially unhedgable due to poor market structure.

The paper ends with a set of dot-point recommendations about lessons to be learned from the financial markets for those planning to implement an environmental market.

Keywords: Financial Markets, Forward and Spot trading, Impacts of risk and uncertainity, appropriateness of MBI's

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** Market based instruments for ecosystem services in the Murrindindi Shire of Victoria

Authors: Wendy Proctor, Stuart Whitten and Dave Shelton (CSIRO)

The Murrindindi Shire is an attractive and growing area for lifestyle developments and hobby farming. The growth in these landuses is negatively impacting on important ecosystem services (e.g. water quality and wildlife habitat) in the Murrundindi Shire and Goulburn Broken Catchment. The use of development offsets may alleviate future development pressures on ecosystem services whilst providing flexibility to developers. These outcomes may also be achieved at significantly lower costs than restricting management options to on-site actions. Computer based experiments will be undertaken to test some of the assumptions of local government authorities using market instruments to alleviate development pressures on the environment. The techniques of Experimental Economics will be employed along with the help of local developers and landholders in the shire enlisted to take part in the experiments. The scheme will involve defining suitable 'offsets' that would apply to specified impacts of rural development such as those involving water quality and biodiversity. An action that damages ecosystem services on one site would be allowed to be undertaken as long as a separate activity to increase ecosystem services (the offset) is undertaken at the same site or elsewhere. Credits would be issued to reflect amount of offset activity undertaken. Development could only be undertaken once the required credits are obtained and a development permit issued.

The property right/offset/credit structure is provided by the local government development planning and permit framework The scheme would involve a non-tradeable mechanism where the property right to the offset action is only traded once (i.e. when the permit is issued). Important insights will be gained from testing these different possibilities such as the measurement and exchange rate regimes employed, the definition of the credits, the type of offsetting actions required and the institutional and legal frameworks necessary to make such a scheme successful.

Keywords: offsets, residential development, ecosystem services, non-tradeable mechanism, Murrindindi Shire – Goulburn Broken Catchment.

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** Trading salt and water: developing tradable property rights for dryland salinity management using an experimental approach

Authors: Wendy Proctor, Stuart Whitten and Dave Shelton (CSIRO)

This project will develop a tradable property rights structure based on identifying salinity 'credits' to aid in addressing the external impacts of dryland salinity. The framework will be developed using experimental economics to identify critical market parameters such as the detailed specification of the property rights and credits involved, the nature and levels of uncertainty related to the necessary salinity information and methods to incorporate spatial and temporal variation in the impacts of management changes. Recently completed hydrological and salt yield modelling in the Goulburn Broken catchment in Victoria and Simmons Creek sub-catchment of Billabong Creek in NSW provides sufficiently detailed biophysical modelling to experimentally trial a property right based solution in these regions.

The experiments will involve stakeholders (remunerated for their involvement) participating in a computer based virtual market and trading salinity credits based on their own farm statistics. The credits issued would be based upon the biophysical modelling undertaken and the experiments would determine such things as the incentives and necessary rules for trading to take place, the threshold level of uncertainty above which participants will not trade, the best form of the instrument involved, the necessary institutional and legal requirements and the potential environmental outcomes for the region. The key outcome will be a framework for a flexible (in terms of not enforcing uniform standards across properties) market based mechanism achieved at lower cost than on-ground studies, that will combat the increasing problem of dryland salinity in agricultural regions of Australia.

Keywords: dryland salinity, tradable property rights, experimental economics, Goulburn Broken, Billabong Creek

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** Establishing the potential for offset trading in the lower Fitzroy River.

Authors: John Rolfe, Jill Windle (Central Queensland University), Stuart Whitten (CSIRO)

The Fitzroy River basin is Australia's second largest externally draining basin. Water quality is impacted by both non-point source and point sources, including irrigation, grazing, dryland farming, industry and urban sources. Additional irrigation and industry development is likely to impact further on water quality.

This project will explore the potential use of cap-and-trade pollution permits to cap emissions in the lower Fitzroy when new irrigation and industry developments take place. As well, the potential supply of offset actions from landholders in a particular sub-catchment will be modelled, and the potential for trade within the lower Fitzroy catchment will be evaluated.

The challenges are to determine the amount of bio-physical data needed, the appropriate trading rules, how a pilot can be established over discrete areas/industries in the basin, and what incentives are needed to make enterprises/industries participate. Opportunities for a trading mechanism will be established over the two year project.

A key part of the pilot will be to trial a different mechanism for conducting laboratory exercises. Choice experiments will be used to identify the relevant supply and demand schedules, and interactions between the two will then be modelled. 'Real life' participants will be involved in the Fitzoy Basin experiments, so more realistic evaluations should be possible.

The key stakeholders in the project are Queensland University (CQU), CSIRO, Fitzroy Basin Association (FBA) and Central Queensland Regional Organisation of Councils.

Keywords: Water quality, offsets, choice experiments, cap-and-trade mechanisms.

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Defining the Bios: an objective basis for biodiversity market systems

Authors: James M. Shields and Elisabeth Larsen (NSW State Forests)

We put forward that it is necessary to establish a universal biological unit that reflects the species diversity, population density (abundance or biomass), genetic uniqueness, and relative rarity of ecosystems and thus provide the substantive material necessary for market systems that include biodiversity. A scientific expression which captures the entities and relationships within biodiversity can be based on the structure of the food web, the inter-relationships of biological entities, and the connectivity and condition of ecosystems. Therefore, given the tools for describing diversity, abundance, taxonomic significance, and relativity rarity ("conservation status"), of an area, a unit for the Bios (B) value for that area could be described by the equation set out in our poster. We use the equation in specific and general terms to describe natural resource management with clear positive outcomes.

The lack of this basic definition has been the source of many difficulties in setting up systems that provide financial reward for positive biodiversity management. In essence, the systems proposed have not provided a clear and universal description of the relevant biological entity in a manner that is transparent, objective and permanent. We apply the Bios equation to a biodiversity transaction in forest ecosystems in NSW, where the variables are manipulated to achieve a positive outcome in ecological, economic and social terms. Further uses for the basic Bios unit are provide in global terms. The clear need for and utility of a definition and unit that reflects the general terms of biodiversity is expressed in these examples.

Keywords: measuring biodiversity, bios equation.

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** Multiple-outcome auction of land-use change

Authors: Gary Stoneham, Loris Strappazzon, Nicola Lansdell, Mark Eigenraam , Craig Beverly and Arthur Ha (DPI Victoria), Peter Bardsley and Vivek Chaudhri (University of Melbourne)

This pilot will auction conservation contracts to landholders. It follows an initial pilot auction of habitat conservation contracts (BushTender) but will now include several dimensions of the environment including salinity, water quality, water quantity as well as biodiversity. This pilot will draw on contemporary ideas in economics to: determine the auction format, develop efficient contract design and to select an optimal set of contracts. The pilot will also apply new landscape modelling techniques developed at the Rutherglen Research Institute to estimate the impact of potential land-use changes on salinity, water quality and water quantity. This scientific capability extends the methods already developed for assessing the impact of land-use change in biodiversity.

The auction will be conducted in the Goulburn Broken and North Central Catchments of Victoria with field-based activities planned for the first half of 2004. Results of the pilot will be available in the second half of 2004.

The project team is comprised of economists in the Department of Primary Industries, Victoria; academic economists from the University of Melbourne's Economic Theory Centre; ecologists from the Department of Sustainability and Environment, Victoria and hydrologists from the Rutherglen Research Institute, DPI Victoria.

Keywords: Auction, contract design, multiple outcomes, Goulburn Broken CMA, North Central CMA.

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** Tradable recharge credits in Coleambally Irrigation Area

Authors: Stuart Whitten; Drew Collins; Dave Shelton, Wendy Proctor; David Robinson and Shahbaz Khan, (CSIRO)

Irrigated agriculture in Australia often leads to excessive recharge of regional groundwater systems causing salinity and water-logging. In turn, salinity and water-logging impose a range of costs on individual landowners, their neighbours and the wider community. These impacts are primarily reduced agricultural productivity, damage to ecosystems and degradation of local and off-site infrastructure. As these costs are largely external to landowners they are not fully included in their management decisions.

This pilot MBI will test a trading mechanism for recharge credits via the implementation of recharge contracts. Recharge credits will internalise costs associated with recharge to groundwater systems. Irrigators may reduce their costs of meeting recharge targets via creating or purchasing credits that reduce recharge through perennial vegetation, engineered solutions or changing crop rotations. Credits may only be created within the irrigation area, but may be created either on-farm or off-farm.

Key impediments to the creation of the credit market that will need to be overcome include:

- defining and allocating irrigator recharge credit responsibilities (through individual farm water supply contracts);
- sufficient knowledge to estimate paddock scale recharge (via SWAGMAN recharge models); and,
- potentially few viable strategies to create recharge credits

Flexibility will also need to be incorporated into the instrument in order to ensure the system is robust to climatic and other shocks. This project is the only MBI pilot aimed at managing salinity from ‘existing’ irrigation as defined under the MDBC Salinity and Drainage Scheme pre-1988 benchmark.

The pilot will operate in the Coleambally Irrigation Area in the mid to lower Murrumbidgee Catchment and will involve irrigators, the Coleambally Irrigation Cooperative Limited (CICL), CSIRO and government agencies.

Keywords: Murrumbidgee Catchment, Coleambally Irrigation Area, cap and trade incorporating offsets, irrigation salinity management

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Appendix 2: Glossary of Market-based Instrument Terms

This glossary has been compiled from Gangadharan and Duke (2002)[1], the Resources For the Future Internet glossary of economic terms[2], the National Action Plan for Salinity and Water Quality (2002)[3] and Murtough, Aretino and Matysek (2002)[4].

Abatement: the reduction of the degree or intensity of emissions.

Asymmetric information: A situation where there is a significant imbalance in the amount of information available to parties to a potential transaction.

Auction: A mechanism for selling or purchasing property or supplying services whereby buyers/suppliers bid for the right to buy property or supply services. Auctions determine who gets what on the basis of bids submitted by potential buyers/suppliers.

Banking: entails saving emissions permits for future use.

Baseline and credit: Improvements from a stated and measurable baseline generate credits that can then be sold to those who are not able to achieve the baseline or cannot cost-effectively achieve the baseline.

Beneficiary pays: Pricing principle where those who benefit from an action pay for the portion of the benefits they receive.

Benefits index: A weighted index used to classify and rank the environmental benefits offered by competing actions. Examples include the Biodiversity Benefits Index used to rank land offered for conservation under the Victorian BushTender trial and the Environmental Benefits Index used to classify and rank land offered under the US Conservation Reserve Program.

Bid: a bid is an offer to buy or sell property rights depending on the market context.

Bubble: refers to the idea that emissions reductions anywhere within a specific area count toward compliance. For example, if a plant with multiple emissions sources is treated as being "under an emissions bubble," regulators assess only the total emissions of the plant, not the emissions of each individual source, in determining compliance.

Call Auction: a call auction, or a clearing house auction, is a uniform price auction in which buyers and sellers submit bids/offers simultaneously. The market clearing price is determined by the intersection of the demand and supply functions obtained by arraying the bids and offers in order.

Call: a call is an offer to buy a permit

Cap and trade systems: An allowable overall level of pollution or limit to the use of a resource is established and allocated among entities in the form of permits/quotas, which can be traded.

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[1] Gangadharan, L. and Duke, C. (2002) *The Role of Laboratory Instruments in the Demonstration and Design of Market-Based Instruments*, Department of Natural Resources and Environment Working Paper.

[2] http://www.weathervane.rff.org/glossary/index.html

[3] NAPSWQ (2002) Investigating New Approaches: A review of Natural Resource Management Pilots and Programs in Australia that Use Market-based Instruments.

Available at: http://www.napswq.gov.au/about/mbi/index.html

[4] Murtough, G., Aretino, B. and Matysek, A. (2002) *Creating Markets for Ecosystem Services*, Productivity Commission Staff Research Paper. Ausinfo, Canberra.

Carbon sequestration: generally refers to capturing carbon – in a carbon sink, such as the oceans, or a terrestrial sink such as forests or soils – so as to keep the carbon out of the atmosphere.

Command and Control: refers to the use of regulations to enforce specific actions or planning approaches to achieve environmental goals. It often involves the installation and use of specific types of equipment or actions to reduce emissions. For example, governments could legislate to force factories to achieve some benchmark greenhouse emission standard.

Covenants: Legal instruments attached to title deeds of ownership, which limit an owner's right to use or trade his or her property.

Discriminative Price Auction: an auction that attempts to discriminate between units traded by paying different prices for different units.

Double Auction: both buyers and sellers submit bids and offers publicly. Bids are raised and offers lowered in a sequential manner. Both buyers and sellers can confirm contracts.

Eco-labelling: labelling of products in a way that identifies a link between the product and increased ecosystem sustainability.

Emissions: are pollutants released into the air or waterways from industrial processes, households or transportation vehicles. *Air emissions* pertain to atmospheric air pollution; *water emissions* refer to pollutants released into waterways.

Emission taxes: are taxes levied on air or water emissions, usually on a per ton basis. Emission taxes provide incentives for firms and households to reduce their emissions and therefore are a means by which pollution can be controlled. The greater the level of the emissions tax, the greater the incentive to reduce emissions.

Emissions trading is an economic incentive-based alternative to command-and-control regulation. In an emissions trading program, sources of a particular pollutant are given permits to release a specified amount of the pollutant. The government issues only a limited number of permits consistent with the desired level of emissions. The owners of the permits may keep them and release the pollutants, or reduce their emissions and sell the permits. The fact that the permits have value as an item to be sold or traded gives the owner an incentive to reduce their emissions.

Exogenous: A change or shock that is determined outside of the system or market that is being considered.

Externalities: occur when the activity of one person has an inadvertent impact on the well-being of another person. Many aspects of environmental degradation, such as air pollution, global warming, loss of wilderness, and contamination of water bodies, are viewed as externalities of economic transactions.

Free-ride: To benefit from a good or a service without contributing to the cost of its provision.

Grandfathering: of emissions permits is a method by which rights may be allocated among emitters and firms in or to establish a trading regime according to their historical emissions. Supporters of this method of emissions trading assert that this would be administratively simple but some critics argue that this method would reward firms with high historical emissions and unfairly complicate entry into markets by new firms and emitters.

Heterogenous/Heterogeneity: is the degree of difference between individuals or firms that could otherwise be viewed as a uniform group. For example, a group of farmers may have widely differing areas of remnant vegetation thus displaying heterogeneity with respect to native vegetation retained.

Leakage: refers to emissions abatement achieved in one location that is offset by increased emissions in unregulated locations.

Market-based instruments and trading schemes: Market-based instruments are regulations that encourage behaviour through market signals rather than through explicit directives regarding pollution control levels or methods. Trading-based schemes are a subset of market-based instruments that focus on instruments involving trading. They include cap and trade schemes, auctions and information disclosure. However, they do not include taxes and subsidies.

Market failure: Individuals acting in their own private interest produce and outcome that is inefficient in the sense that it is possible to make somebody better off without making others worse off.

Non-point source or diffuse pollution: Pollution that may be diffuse and for which it is difficult to identify and monitor the precise source. For example, pollutants linked to runoff from agricultural land.

Offsets: A policy that allows a party to undertake an action that creates pollution or reduces ecosystem services if they also undertake (or purchase from another) a separate action that reduces pollution or increases ecosystem services by at least the same amount.

Open Outcry: like pit trading on a stock exchange.

Point source pollution: Pollution which can be traced to an easily identifiable, source. For example, a group of irrigators sharing a drain could be treated as point source.

Polluter pays: is the principle which states that those who cause industrial pollution should offset its effects by compensating for the damage incurred, or by taking precautionary measures to avoid creating pollution.

Property rights: Rights that govern the use and ownership of a resource – most commonly associated with the use and ownership of land. Property rights should be: well defined; freely transferable; enforceable; and secure over the long term.

Sealed Bid: the bids and the offers are private information, only the subject who submitted the bid(offer) knows the price and quantity. Successful bids and offers, and their respective prices and quantities, will often be revealed at the end of a trading period.

Sovereign risk: The likelihood that future government decisions will diminish the value of a property right.

Tradable emissions permits: are used in an environmental regulatory scheme where the sources of the pollutant to be regulated (most often an air pollutant) are given permits to release a specified number of tons of the pollutant. The government issues only a limited number of permits consistent with the desired level of emissions. The owners of the permits may keep them and release the pollutants, or reduce their emissions and sell the permits. The fact that the permits have value as an item to be sold gives the owner an incentive to reduce their emissions.

Transaction costs: The costs associated with buying and selling, such as those associated with collecting information and processing trades.

Uniform Price Auction: an auction in which all units are traded at the same price where demand and supply intersect.

Wetland banking: An arrangement that allows a party to substantially alter a wetland if they purchase credits earned by another party for the protection, restoration and/or enhancement of another wetland. These credits are purchased from an intermediary known as a wetland bank.