

**Basin-level Riverine Environmental Management: Institutional issues**

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**Abstract**

There is a perception that Australian governments need to commit more resources to improving the environmental quality of the Murray River. There are a number of completed reports and processes under way examining alternative institutional arrangements that may improve environmental outcomes in the Murray River. Generally, these reports provide little (if any) economic rationale for one arrangement versus another.

This paper considers, from an economic perspective, incorporating an environmental manager within current Murray-Darling Basin Commission institutional arrangements. In it, we suggest that there may be a role for a body that focuses on riverine outcomes that are of benefit to the environment. We posit a role and a set of rules by which the body could operate and its position within current institutional structures. In doing so, the paper considers the following: incentives faced by the body, reporting arrangements, public-good games, and organisational culture and compliance.

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<sup>1</sup> The views expressed in this paper are those of the authors; and not the Department of Primary Industries, nor the State Government of Victoria.

## **1 Executive Summary**

Institutional arrangements are the rules, customs, culture, and other intangibles that affect the way that players interact. Hence institutional arrangements are vital in terms of affecting the outcomes that prevail in an economic system.

For approximately one hundred years the movement of water in the Murray River has been governed by an inter-state agreement. This agreement was originally set up to ensure to that an adequate level of water reached South Australia for the purpose of consumptive and productive use. The current version of this agreement is called the Murray Darling Basin Agreement (hereafter the Agreement) administered by the Murray Darling Basin Commission (hereafter the Commission).

The Commission is structured so that it is headed by a group of Ministers from each of the 'contracting governments'—the Ministerial Council. The Council sets strategic directions. Under the Council sit Commissioners who are generally senior public sector personnel from the contracting governments. Commissioners theoretically confer with, and implement the decisions of, the Council. In practice, decisions made by Council and the Commission are implemented by a group called the "Commission Office": public servants that are funded by the contracting governments. The Office generally provides information to the Commissioners and the Council about project choice and selection. This is a key part of the institutional arrangements that govern the outcomes achieved in the basin.

There has been a change in preferences by Australians who now demand more environmental goods: they want the Murray Darling Basin Commission (or some body) to protect and enhance the environmental goods associated with the basin. Recently, there has been a lot of public debate about the institutional arrangements associated with the Commission. Much of the current analysis suggests new institutional arrangements that will achieve 'one river - one environment'. In other words, the aim has been to examine institutional arrangements that may provide the best possible riverine environment in the basin at least cost.

Recent literature on institutional arrangements (DSE 2003, Wentworth 2003, MDBC 2003) has been focused on two areas, water sourcing to address over allocation (later

to be used as flows for the environment) and environmental management. In this document, we focus on the institutional arrangements required to support the implementation of environmental management (ie. an environmental manager).

The writings to date regarding the environmental manager have argued there should be an entity that would focus on acquiring environmental goods for the basin as a whole, with the exception of the Green Paper DSE (2003), which focuses on Victoria. A number of papers discussing options (Keysworth, 2004, pers. com.) have advocated that the environmental manager be set up as a business unit, with its own board, under the Agreement. The environmental manager would report directly to Council, or via the Commission. These papers have generally analysed the institutional arrangements from a legal perspective. The economic issues associated with changes in institutional arrangements have received less attention. We will consider the economic issues associated with changes in institutional arrangements.

There are two main strands of economic theory that are applicable to the problem of institutional arrangements in the basin: principal-agent theory and public good theory.

Principal agent theory examines the way that a leader or principal provides incentives to a sub-ordinate or agent. The arrangement that governs this interaction is often thought of as a 'contract'. But the term 'contract' is used broadly, and it could mean any item that governs the rules of interaction (e.g. legislation). Principal-agent theory assumes that the information available to the principal and the agent is a key part of the way that the players will interact (referred to as the game).

In the context of the MDB there is not a single principal, but multiple principals—Council members. This introduces complexity to the problem because the aims of these principals are not necessarily consistent: each Minister is concerned with their own portfolio in their own State. This causes a tension that we consider in more depth below.

The agent in this situation is the environmental manager. The principals must agree to rules that will govern the way that the environmental manager acts, and hence the outcomes that result.

From an economic perspective, there are two issues associated with this game. First, the principal may not hold all the relevant information. Second, the divergent interests of each principal may make it difficult for the Council to decide what the

purpose of the environmental manager is. This may lead to the Council to giving the environmental manager a vague mandate. For instance, Part 1 of the Murray Darling Basin Agreement states:

*“The purpose of this Agreement is to promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of water, land and other environmental resources of the Murray-Darling Basin (MDBA 1992, p. 8).”*

From this purpose, it is not clear what is meant by “equitable, efficient and sustainable use of water, land and other environmental resources”. It is fair to surmise that Council members do not have a consensus on what the purpose means on the ground; as a result, the mandate of the agreement could be said to be vague.

The lack of a precise mandate may not be a problem if the management of the environmental group can produce a mission that is acceptable to her employees. An acceptable mission could be derived from a discipline’s focus; eg, economists focus on economic efficiency, hydrologists on water and sociologists on social structures and adjustment. For example, assume the above mandate is applicable to the environmental manager and the manager wants to develop a mission that motivates its economists. A possible mission may be “to help design projects that deliver the greatest environmental benefits (according to a pre-defined metric) at least cost”.

The incentives of the environmental manager and its staff cannot be tied to environmental outcomes in any meaningful way because of scientific uncertainty about the relationship between actions and environmental outcomes. This means the use of powerful incentives such as tying remuneration to environmental outcome will have, at best, weak incentive effects. Lower powered incentives such as career concerns and professionalism are more effective for public servants working in environmental management. Also, missions may be process- or input-oriented rather than outcome oriented.

None of the above measures guarantee that the environmental manager will do business in a way that ensures it focuses on environmental outcomes at least cost. However, if it did, what would it mean for the Commission?

Rather than being a silver bullet, it would cause, or bring to the fore, tension inherent in the structure of the Agreement. The Agreement ostensibly brings together the

contracting governments to promote basin-wide outcomes. However, the parties to the agreement have different aims and therefore different opinions regarding project choice and selection. Hence, the Council and Commissioners may not be very satisfied with a group of projects presented by the environmental manager that focused exclusively on basin-wide environmental outcomes. Given that the Commissioners and Council have to approve the implementation of projects (often via unanimous vote) this could cause the problem of many of the environmental manager's suggested projects being rejected.

To date, this tension has been relieved via jockeying about projects; ie, state representatives working with the office provide information about the options for projects, and decide on the mix of projects. Since cost shares are determined before projects are selected the members may focus on selecting projects that deliver benefits to their constituencies. In order to be successful at this, Council members (or their representatives) have an incentive to find information or generate research that supports arguments for projects that deliver benefits to their respective jurisdictions. The end result of such 'jockeying' may be a portfolio of projects that would reflect members' interests rather than the basin's. An impartial project selector focusing on basin-wide outcomes (ostensibly the environmental manager) might choose a very different group of projects. It is difficult to determine whether the current allocation of projects is efficient or effective because the jockeying process is not transparent.

As stated above, if an environmental manager succeeded in generating a group of projects that focused on basin-wide outcomes this would cause a tension for the Commissioners and Council. This tension could be resolved by using a public goods contribution approach. This problem is analogous to the public good problem because a project may provide benefits to each and every state. Yet each member may receive other private (constituency's) benefits from a given project. No member has an incentive to reveal the total benefits to his State: he has an incentive to free ride on the contributions of others.

There are a number of public goods mechanisms that could provide members with an incentive to truthfully reveal their marginal benefit from a project and to contribute to the funding of such projects. The exact form of such a mechanism in this context would require further research. However, we canvass a few possibilities in this report.

One of the mechanisms that we examine in this report is the Smith Auction. Using such an approach would have each State bid the amount that it would want to contribute to a project<sup>2</sup>. If the total contributions cover the cost of the project, then the project may proceed, and surplus funds are returned. If total contributions are less than the project cost then the players are told this, and allowed to bid again (and raise contributions if they desire).

On top of this 'contribution' phase could be added a voting procedure. That is, after each player had settled on their contribution (and where total contributions were greater than cost) then each player would be asked to vote. Each player could vote yes or no, and the voting rule could be unanimity (such as in the Smith auction 1979), or majority rule, etc. If this voting process used a unanimity rule, it may provide added security for the Commissioners and Council, and thereby help engender commitment to the process. However, it would also increase inefficiency from an economics perspective (see Banks et al. 1988).

Broadly, this contribution mechanism would mean that any one project, or group of projects, could have varying shares contributed by each state. This could be implemented under the current arrangement, even though the broad shares are fixed<sup>3</sup>: each state could 'draw down' on its broad contribution over time.

This system may mean that (say) one State draws down its total contribution prior to others. This could be good from an incentive point of view. It probably means that the State liked the early projects, and the State can then decide whether it wants to contribute more than its predetermined share. This could be appropriate because there is no reason why the initial amount (based on the fixed cost shares), selected with very little information, was efficient. If the relevant State decides not to contribute any more funding, then it will place zero for bids thereafter, and the projects selected will be those where the remaining States receive sufficient benefit.

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<sup>2</sup> The project is one of many contained in a portfolio of projects developed by the environmental manager.

<sup>3</sup> Currently the contributions to the running of the MDBC are fixed and contained within the Agreement and its schedules.

Since State representatives have to contribute an explicit amount of funding to project areas, they have an incentive to demand information about the projects they are contributing to. This should place discipline on the environmental manager to estimate the effects of projects up-front. The revelation of this information, if used in conjunction with other processes, could improve dynamic efficiency: there would be learning by the players about the goods being procured, and about their cost. This should help the players be more aware of the trade-offs involved and should improve future decision-making.

The mechanism would also provide an incentive for the Council members to undertake research to calculate State-specific benefits from projects (eg. the links of a project to State tourism). In this case, the Council members would have to contribute to the project to receive those (State-specific) benefits. The mechanism forces them to reveal their willingness to pay (albeit imperfectly) for a project to receive the private benefits. However, the environmental manager need not be concerned with these benefits: they are sorted out in the functioning of the mechanism. Hence the environmental manager undertakes work with respect to basin-wide outcomes and leaves work regarding State-specific benefits to the Council members. In the current system these two get mixed together in the one process.

Using such a mechanism, unlike the current one of negotiations, would be more transparent for a number of reasons. The environmental manager would be required to provide scientifically based metrics (at least in the long term) that determine the benefits of projects to the basin. Each State's contribution to a project would be public information. Project selection is based on benefit per dollar contributed to improving the efficiency of resource allocation. Finally, the projects chosen are available for others to scrutinise and judge the efficacy of the mechanism – the selection process is transparent.

## **2 Background**

The drought over the past couple of years for both dryland and irrigated agriculture has focused the attention of both the community and government on the need to better manage our scarce water resources. Several low rainfall years in a row have reduced water storages to critically low levels. This has resulted in reduced water allocations to the irrigation sector and the riverine environment.

Low storage levels threaten the aquatic health and tourism prospects of the storages. In turn, the low volumes of water released are primarily for use by the irrigation sector, with the river system receiving little additional flow above that for delivery to the sector. The low storage levels and river flows have raised concerns about the health of the riverine system.

Increasing public concern for the environment has resulted in a flurry of activity over the past 12 months. We have seen the release of a number of reports and initiatives, The Living Murray, COAG Communique, Blue Print for a National Water Plan and the Victorian Green paper that discuss the issue and propose alternatives for achieving riverine improvements (see Appendix I for summary).

The reports highlight a number of issues: the need for improved water accounting, sourcing water to address over allocation and increase environmental flows, water property rights and trade reform, and the need for explicit environmental management (institutional reform).

Improved water accounting is necessary whether attempting to improve water use for the environment or consumption. To generate the greatest benefit from water allocation and use requires understanding the quantum and type (surface or ground) of water available and its location. However, it is the nature of how the water is used that will result in environmental benefit. We do not see water accounting as a solution to riverine environmental problems but as necessary for its achievement.

In order to reform property rights and trade also requires clear water accounting procedures. Again, these reforms are not a solution in themselves but a necessary step towards being able to manage the environment. It is important to note that the sequencing of reforms will have an impact on both the cost and efficacy of achieving

environmental improvements. Reducing the over allocation problem without understanding the extent (therefore the need for water accounting) and without a well functioning market will have a greater impact on current water users.

We see water sourcing as a temporary task: the aim is to claw-back water over-allocated in the MDB (COAG Communique 2003). This claw-back may be achieved by a variety of means. Once the relevant amount of water is clawed-back, the water sourcing function would cease. Using elaborate changes in institutional arrangements to source water seems misguided: it would be costly to undertake the changes in institutional arrangements if the function were to disappear within the short term, like 1 to 5 years. Beyond the initial claw-back, the environmental manager should do any other water sourcing since this will be *one* of the tools in the manager's toolkit. The so-called "environmental manager" could source water if need be, but this would not necessarily be the focus, or even an important, activity. More importantly would be the role of the environmental manager in determining release strategies for any water clawed back. We see the environmental management function as on-going, or at least long term (at least 10 to 15 years). In this document we focus on environmental management.

## **2.1 Basin-level Environmental Management**

We assume that some institutional reform will take place with the aim of improving environmental outcomes in the Basin. This paper discusses issues that need to be considered for reform and the possible benefits that may arise from the use of economic mechanisms for the allocation of resources.

The problem of environmental management at the basin level presents a number of challenges. Central to the nature of the problem is the jointness of the actions and outcomes. For instance, an action taken on the Goulburn River Victoria would have beneficial outcomes for both Victoria, and via the Murray River, for NSW and SA. It could even be argued that others might benefit by knowing that an environmental asset exists for their future use (existence value) and thus derive a benefit.

We assume that to manage the MDB for riverine improvement requires actions be delivered in a coordinated manner. Therefore, there is a need for a group and a process or mechanism to coordinate activities.

For approximately one hundred years the movement of water in the Murray River has been governed by an inter-state agreement. This agreement was originally set up to ensure to that an adequate level of water reached South Australia for the purpose of consumptive and productive uses. The current version of this agreement is called the Murray Darling Basin Agreement (hereafter the Agreement). This is a key part of the institutional arrangements that govern the outcomes achieved in the basin.

The important players in the Agreement are:

- Ministerial Council, which is made up of Ministers from each of the 'contracting governments'
- The Commission, made up of a group of Commissioners, also representative of the contracting governments, who are often senior public sector personnel; and
- The Commission Office ("the Office") that involves a group of staff supporting the Council and Commission. The Office has two broad areas: natural resource management; and River Murray Water.

Currently the Agreement has some key features in terms of the way that decisions are made.

- Broad areas of work must be approved by Council and Commission using a unanimous vote;
- Fixed cost shares are often allocated to broad areas of work. For example, \$150 million has been allocated to the "Implementation Program" with each State contributing a certain amount.
- Negotiations between State representatives, often facilitated and informed by the Commission Office, are undertaken to choose specific projects within a broad work area.

The question is how or what system could bring the interests of all players together to achieve the goal of improved riverine health at the basin level, 'one river - one environment'.

A number of options have been considered for alternative institutional arrangements for water sourcing and environmental management (Keysworth, 2004, pers. com.). It is argued each role would require different skill sets and there is a potential conflict of

interest in merging the roles. As noted above we consider the role of water sourcing as short term and not requiring institutional reform. However, the analysis provided for each option for the environmental manager is very relevant.

The options advocate that the environmental manager be set up as a business unit, with its own board, under the MDB Agreement. The environmental manager would report directly to Council, or via the Commission. The authors have generally analysed the institutional arrangements from a legal perspective. The economic issues associated with changes in institutional arrangements have received less attention. This paper considers the economic issues of institutional arrangements.

This paper considers the issue of establishing an environmental manager within the constraints of the MDB agreement. There are two main strands of economic theory that are applicable to the problem of institutional arrangements in the basin: principal-agent (or incentive) theory and public good theory.

In section 3 we discuss the internal and external incentives of an environmental management agency. In section 4 we consider economic mechanisms that could be employed to efficiently allocate resources to projects for the improvement of environmental outcomes in the Basin. Finally we conclude with further research and summary of the paper.

### 3 Internal and External Incentives of the Environmental Manager

The incentives of the environmental manager can be analysed by thinking of the interactions of the players as a game, specifically a principal-agent game. We will consider two games here.

The first is the *external* game where the environmental manager as the agent interacts with its multiple ‘masters’ or principals (ie, the members of the Council and their representatives on the Commission)<sup>4</sup>.

For the environmental manager to maximise basin-wide environmental benefits, it must be given incentives by its principals. However, the principals may not have preferences congruent with basin-wide environmental benefits. Instead we will assume that the principals only care about their jurisdiction’s (or parochial) objectives that may or may not conflict with basin-wide environmental benefits. As a result, the environmental manager may not have strong incentives to maximise basin-wide environmental benefits. We will call the incentives given to the environmental manager *external incentives*.

The second type of principal-agent game we will discuss is an *internal* game within the environmental manager’s agency<sup>5</sup>. This is a game between the management (principal) of the agency and its staff (agents). The game is how a public sector manager can induce costly effort from staff when the link between effort and outcome is uncertain. As we shall see, this problem is not as straight forward as in the private sector because remuneration cannot be directly linked to outcome. When we analyse

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<sup>4</sup> We assume that a Council member, her representative on the Commission and their staff are one *principal* of the environmental manager. Effectively, we are assuming away any strategic interactions between the Council member, their representative on the Commission and their staff; ie, they have identical preferences and therefore identical incentives. Hence, when we refer to principal we are referring to the Council member and assume the representative is an extension of the member.

<sup>5</sup> When we refer to ‘the agency’, we are referring to the ‘environmental manager agency’ (or ‘environmental manager’ as an entity).

the internal principal-agent game, we will discuss the *internal incentives* needed to achieve management's objectives.

In the next section we will first discuss internal incentives of the environmental manager and how to structure such incentives assuming the mandated objective is to maximise basin-wide environmental benefits. Then in the following section we will discuss the external incentives of the environmental manager and how these may distort its behaviour in maximising basin-wide environmental benefits. We will then summarise the main points of this discussion and highlight areas that require further research.

### **3.1 Internal Incentives**

Internal incentives are rewards or punishments administered by the agency's management for achieving its internal goals or "missions". A mission may be congruent with the environmental manager's mandated objective of maximising basin-wide environmental benefits. However, as Wilson (1989) shows for US government agencies, there may not be perfect congruence between an agent's mandate and its mission. This may not be due to moral hazard<sup>6</sup> or bureaucratic expansionism<sup>7</sup> but instead may be attributed to an agency's management interpreting its mandate to provide incentives to its employees to perform (Dewatripont *et al.* 1999b). Internal incentives also include (but are not exclusive to) the career concerns of employees (ie, employment in the environmental manager as a signal of talent to an external labour market) and the degree of professionalism (or specialisation) of the environmental manager's workforce.

According to Wilson (1989), US government agencies are given vague mandates that often encompass multiple objectives. This observation also seems applicable to Australian government agencies, specifically the organisation of environmental

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<sup>6</sup> 'Moral hazard' in principal-agent theory refers to when an agent's actions are unobservable to the principal such as working hard in the office (ie, expending costly effort) and the possibility that the agent may not do so (Laffont and Martimort 2002).

<sup>7</sup> 'Bureaucratic expansionism' explanations theorise that bureaucracies exploit their monopoly power not by generating monopoly powers but by maximising the four P's (power, prestige, pay and promotion) through inefficiently high bureaucratic activity (Cullis and Jones 1992).

manager. Wilson provides evidence that government agencies interpret these vague mandates to provide objectives to focus resources and effort. For example, the US Department of Agriculture interpreted its mandate of “feed the nation” to mean its operational activities should be to “help farmers”. The management of the agency’s (ie, the environmental manager) interpretation of vague mandates is what we shall call it’s “mission”; this allows the agency to more clearly define activities and objectives to focus the organisation’s resources in an efficient manner.

Setting a mission has incentive benefits by providing employees with a sense of purpose (Dewatripont *et al.* 1999b). This is valuable for management because a widely accepted mission provides employees incentives to expend costly effort without the use of ‘high-powered’<sup>8</sup> incentives or costly monitoring by management (Laffont and Martimort 2002). Government remuneration rules and the nature of the benefits generated by government agencies (ie, external benefits that cannot be fully captured by individual or organisations) prevent managers from using high-powered incentives. Monitoring is also costly in government agencies because of the non-verifiable<sup>9</sup> nature of the benefits produced. Non-verifiability is especially problematic for the environmental manager because of the diffuse nature of many environmental problems and scientific uncertainty of the determinants and outcomes of environmental problems.

The agency’s staff need to be made accountable for their actions to induce effort. What we mean by accountability is the ability of management to measure staff performance. However, accountability for output (or outcome) may not be possible if the output is non-observable and/or non-verifiable. A more useful way of ensuring the accountability of the environmental manager’s employees may be to focus on process rather than output. According to Wilson (1989), this is quite a common way of monitoring government agencies that have non-verifiable and/or non-observable outputs. In the case of the agency, this may mean focusing on costs inputs and

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<sup>8</sup> ‘High powered’ incentives refers to linking an agent’s reward explicitly with performance or outcome (Laffont and Martimort 2002).

<sup>9</sup> ‘Non-verifiability’ refers to the lack of clear link between an agent’s actions and an observed outcome. When an action is non-verifiable, the link between action and the desired outcome cannot be proven to a third party (eg, a law judge) (Laffont and Martimort 2002).

processes rather than the agency's unknown contribution to environmental improvement.

Agency's missions are statements of critical objectives and provide an implicit measure of employees' performances. Assuming there is a positive link between ability and observable performance relative to the agency's mission, a potential employer will infer that a higher observed performance will *probably* imply higher ability (Dewatripont *et al.* 1999b). As a result, missions ease the information asymmetry in regard to a potential employee's ability by providing a metric to measure performance and, by implication, ability. This implies that missions have information revelation properties of an employee's ability.

Missions can reveal how talented an employee is depending on how many activities an agency undertakes. However, there is a tradeoff between the number of activities and incentives; the more activities the agency undertakes the weaker the incentive to exert effort. This is because the less focused the mission (ie, the more activities the mission defines) the less accountable is the agency, which results in lower incentives for effort, lower performance and diminishing the incentive effect of career concerns (Dewatripont *et al.* 1999b). Conversely, the more focused the agency is, the more accountable the agency is which means career concerns have a stronger incentive effect.

How does a sense of mission provide employees with incentives to expend effort? There are two complementary ways missions can provide incentives for effort: career concerns and professionalism. Career concerns are implicit incentives such as promotions or future employment in the public or private sector; such concerns motivate public sector employees to exert costly effort (Tirole 1994; Dewatripont *et al.* 1999a). By exerting costly effort, a public sector employee improves future career prospects despite asymmetric information by sending a 'noisy' signal<sup>10</sup>; there is hidden information because the labour market (whether external or internal) does not know an employee's ability.

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<sup>10</sup> Another way of seeing this is that career concerns induce effort from a public servant in order to 'fool' the labour market about his ability (Dewatripont *et al.* 1999b).

Professionalism improves the incentive effects of missions, especially if the mission is congruent with a professional discipline's training. For example, Wilson (1989) describes how the Tennessee Valley Authority's mission of producing electricity was congruent with engineer's training. "Professionals" (or "specialists") are employees who are members of a discipline that has defined standards of professional conduct. For example, economists are trained to solve economic problems by finding the most socially efficient solution to the problem; this allows an agency's economists to be evaluated according to economists' professional standards (eg, through peer reviewed journals). Professionalism provides additional incentives for employees to exert costly effort in order to gain approval of their peers. If the goals of a professional discipline are congruent with the agency's mission, then professionals are more likely to expend effort.

Professionalism and career concerns are complementary. As we explained above, professionals seek approval from their external peers. External peers may also be potential employers in an external labour market so expending effort may be consistent with an employee's professional and career concerns. However, this may depend on the congruence of the agency's mission and professional conduct; if there is dissonance between the mission and accepted professional conduct, professional employees may not be motivated to work for goals that their peers find unacceptable. For example, there may be a dissonance between the US Department of Agriculture's mission of helping farmers and its economists because economics training emphasises maximising social efficiency rather than providing industry specific assistance. Furthermore, this dissonance may diminish the incentive effects of career concerns because professional peers may view working in dissonant agencies as a signal of low ability and, therefore, would be less likely to recommend such employees.

How specialised the agency's workforce is has implications for the diligence of its employees. Consider the following simple example<sup>11</sup>, there are two types of employees an agency could employ to perform two tasks  $\alpha$  and  $\beta$ : a generalist 'bureaucrat' or a 'specialist' professional. The bureaucrat can perform both activities at the same marginal cost  $c_b$ . The professional can only perform task  $\alpha$  of these activities at marginal cost  $c_p$  where  $c_b \leq c_p$  but cannot perform task  $\beta$  at any cost. The

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<sup>11</sup> This example is adapted from Dewatripont *et al.* (1999b).

agency can choose to monitor its employees at constant cost  $\mu$ . Bureaucrats require monitoring because their time may be split between different activities; ie, there is lack of focus. Specialist professionals do not require monitoring because they can only do one task which means moral hazard can be easily detected *ex post*. Moral hazard can also be detected with bureaucrats but it is more costly because there is more than one task to monitor. The agency may prefer to hire the specialist even if the bureaucrat is more efficient (ie, if  $c_b < c_p$ ), because monitoring costs are lower and moral hazard is eliminated. This is a very simple example, but it illustrates the gains from focusing the agency's mission and employing specialist professionals. Incentive problems with asymmetric information are likely to be eased significantly by focusing the agency's mission as narrowly as possible. However, this depends on whether or not the benefits of the agency's output is uncertain or not. If the benefits are highly uncertain, then it is efficient to hire the bureaucrat rather than the specialist (Dewatripont *et al.* 1999b). The implication of this for agency design is that a generalist organisation is more appropriate for environmental management than the use of specialists. However, we can use Dewatripont *et al.* (1999b) argument to implement specialisation within the organisation through 'compartmentalising' expertise to lower monitoring costs.

Given this discussion, we consider the design of Murray-Darling basin environmental manager agency. The benefits from environmental management are uncertain and non-verifiable at best, due to the diffuse nature of the basin's environmental problems (eg, salinity) and scientific uncertainty. This implies that structuring incentives to motivate the environmental manager's employees to expend costly effort may be difficult because of a lack of appropriate performance metric. However, this could be overcome by choosing a mission that is widely accepted by the environmental manager's employees. As we pointed out, a mission is more likely to be accepted if the mission is congruent with the environmental manager's professional employees training. For example, the environmental manager may want to manage the Murray-Darling basin's riverine resources in an ecologically sustainable but socially efficient manner. This may sound vague due to the lack of agreement in the academic community as to what 'ecologically sustainable' and 'socially efficient' means. However, these two concepts are foundations of two disciplines: ecological sciences and economics respectively. The problem of a vague mission could be overcome by

hiring predominantly ecologists and economists; ie, the agency could be designed as a mixed professional/specialist agency with a focus on the ecology and economics of the management of the basin's riverine resources using our compartmentalisation argument. By specialising the environmental manager's activities, this will allow the environmental manager to encourage greater effort from its staff while minimising costly monitoring. Implicit in this discussion is the use of career concerns to provide incentives; this is required because it is not feasible to use high-powered incentives. Career concerns can be used as incentives by professionalising the environmental manager and encouraging staff to publicise their work. In summary, the environmental manager could be designed to provide optimal incentives for staff to perform by setting an appropriate mission, professionalism and using career concerns.

### **3.2 External Incentives**

From an economic perspective, there are several issues associated with the external game.

First, principal agent theory is explicit about the fact that a principal does not have all the relevant information. In theory, the principals direct the environmental manager to act. In practice, the principals do not have enough information to direct the environmental manager about projects. Rather, the principals rely on the environmental manager to explain problems and suggest solutions. This is akin to the model of Jensen and Meckling 1998, who analyse the role of information in an organisation and consider the appropriate level of decision making.

Second, even if each principal had good information about what she wanted the environmental manager to do, she would find it difficult to force her position on the rest of the Council. The principals will have different aims, and hence the ability of the 'multiple principals' to write very specific or clear guidelines will be hindered. As Dixit 2000 points out, this will result in a vague mandate for the agent. We have discussed how a vague mandate from its principals affects the internal structure of the environmental manager in 'Internal Incentives'.

In this section we will discuss how external players, principally the environmental manager's principals, can influence the environmental manager's decisions. We will take as exogenous that the environmental manager's objective is to maximise basin-wide environmental benefits and the environmental manager does not suffer from any

internal incentive problems. Our discussion is framed using the *common agency* framework; that is, where an agent has multiple principals (Dixit 1996, 1999). We will assume that the principals have already decided on how much they will pay the agent (ie, the environmental manager) but have not decided on what they want the environmental manager to do. We will also incorporate the advocacy framework of Dewatripont and Tirole (1999) and the project selection choice model of Aghion and Tirole (1997) to analyse the incentives implicit and explicit in the design of the environmental manager's interactions with its principals.

The principals are State governments and the Australian Government and as such have different incentives than the agent. Specifically, each principal maximises its constituencies' level of environmental benefits rather than basin-wide environmental benefits (ie, the sum of States and Commonwealth environmental benefits) or some other objective function. Given these parochial incentives, each principal will prefer if the agent made decisions beneficial to their respective constituency.

The role of the agent is to present the principals with a portfolio of project options. The agent will select these projects according to its preferences; because we have assumed the agent is benevolent, the projects will maximise environmental benefits from a basin-wide perspective.

We will use the Aghion and Tirole (1997) framework of project choice in a principal-agent framework to analyse the interactions between the agent and principal. The Aghion-Tirole framework allows us to analyse project selection by delegation of *formal authority* within an organisation as opposed to delegation of *real authority*<sup>12</sup>. If an agent has formal authority, we can say it is *independent*. If it has real authority, we can say it is *supervised*. Otherwise, the agent has no authority to act without its principals' permission. The broad predictions of the Aghion-Tirole framework is that the delegation of formal authority to the agent provides incentives to the agent to acquire relevant information about projects. The delegation of real authority may harm communication between the agent and the principal if the principal cannot commit to overruling the agent.

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<sup>12</sup> *Formal authority* is the explicit or implicit *right* to make decisions whereas *real authority* is the *effective control* over decisions (Aghion and Tirole 1997).

We will consider three cases for the purposes of organisational design. The ‘Independent Agent’ (IA) is where the environmental manager is independent of the principals and is free to choose the projects as it sees fit. In this case, the agent also has total discretion over the funds allocated by the principals. Using the Aghion-Tirole terminology, the agent has both real and formal authority. The ‘Supervised Agent’ (SA) is where both the agent and principals propose projects but the principals have the final say on which projects will receive funding. In this case, the agent has real authority but the principals have formal authority. The ‘Passive Agent’ (PA) is where the agent is passive and the principals decide among themselves which projects will receive funding. Here, the principals have both real and formal authority.

In the second and third case the principals can decide amongst themselves which projects will get approved. We will assume that the principals choose projects based on a unanimous voting rule. Such a voting rule runs the risk of dead lock because there may be no core equilibrium<sup>13</sup>. This is especially problematic in a committee situation where side deals are possible; one principal may be able to improve on a unanimous coalition by offering another principal a bilateral side-deal that improves on the unanimous coalition. The consequence of not prohibiting side-deals (or not effectively enforcing prohibition of side-deals between the principals) may result in the principals never agreeing on a unanimous choice of projects. However, the unanimous voting rule may be required to ensure participation by all the principals; unanimity represents a credible commitment by the majority principals to not exploit minority principals. For example, if there were majority voting, some principals could form a simple majority and use their position to allocate all projects to the majority and leave nothing for the minority (ie, the majority *exploits* the minority); we can think of this exploitation by the majority as a negative externality on the minority (Cullis and Jones 1992). As a result, unanimous voting is a rational response to ensure the widest possible participation given the opportunity cost of the gains of project selection.

An alternative way of viewing the principals’ interactions is by using the advocates framework of Dewatripont and Tirole (1999). In this framework, advocates (ie,

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<sup>13</sup> A core equilibrium is where individuals can form mutually beneficial coalitions and where no alternative coalition can improve on it (Myerson 1991).

agents) collect information about projects and give this information to an arbitrator (ie, principal). The principal uses this information to make a decision that maximises its objective function. The advocates collection of information is random so it is possible that not all relevant information is collected. Furthermore, advocates can tamper with negative information to their cause. Nevertheless, this adversarial process gives each advocate an incentive to collect as much useful information to win the contest. Dewatripont and Tirole (1999) contrasts an adversarial process with an inquisitorial process and finds competing advocates have greater incentives to collect information whereas an individual inquisitor suffers from pursuing multiple objectives. Furthermore, assuming asymmetric information, these authors show under what conditions whether inertia<sup>14</sup> or extremism<sup>15</sup> is optimal if the advocates were unsuccessful in collecting information. When the costs of inertia are less than the costs of extremism than the status quo is favoured. Conversely, if the costs of inertia are less than the costs of extremism than any decision except the status quo is preferable.

We can adapt this advocacy framework to the situation we are considering by first noting that the advocacy situation exists at the level of the principals rather than at the agent's level. However, the agent is delegated the role of information collection and the principals may or may not engage in investigation; this last point is dependent on the case we are examining. The advocacy view reveals important insights for institutional design that an analysis of the voting rule might miss. The agent in our situation has multiple objectives and so *a priori* has little incentive to collect all available information; this is because the costs of multiple information collection activities could be substantial. Conversely, the principals have strong incentives to collect information advantageous to their argument; a principal will gain if a decision is made that favours their preferences. This suggests that if the internal incentives of the environmental manager do not promote basin-wide environmental benefits, this organisational structure may not maximise basin-wide environmental benefits.

We will now analyse each case by the following criteria:

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<sup>14</sup> *Inertia* is when no decisions are made (Dewatripont and Tirole 1999).

<sup>15</sup> *Extremism* (or *misguided activism*) is when, in the absence of information, is when a decision is made to favour a cause/project/group/etc. (Dewatripont and Tirole 1999).

1. *Individual rationality* of the principals: does participation in the institution make the principal worse off? If so, we say it is not individually rational for the principal to participate. If the principal was at least not worse off, then is it individually rational for the principal to participate in the institution.
2. *Incentive compatibility* of the principals: do the principals have an incentive to maximise basin-wide environmental benefits? If they do, then the institution is incentive compatible because they will act in the interests of the basin rather than for their parochial interests.

This differs from individual rationality because incentive compatibility is about the behaviour of the principal within the institution, not the decision to participate.

3. *Credible commitment* of principals: is there an incentive for the principal to abide by the rules of the institution? If not, then the principal cannot make a credible commitment to abide by the rules.

This differs from incentive compatibility because credible commitment is about the principal restricting its degree of freedom by credibly committing to behave within the rules.

Also, credible commitment is not about participation, although a principal may participate in an institution even if it cannot make a credible commitment; this situation may arise if there is no monitoring or enforcement regime.

4. *Positive basin-wide impact*: would the final choice of projects maximise basin-wide environmental benefits? This is qualitative rather than quantitative and there may be different degrees of impact.

In the Independent Agent institution, the agent is delegated with the formal and real authority to choose and implement projects according to its objective to maximise basin-wide environmental benefits. This implies that the principals cannot overrule the agent even if they are made worse off by the agent's selection. For this institution to work, the principals must be able to credibly commit to refrain from interfering with the agent's choice of projects. However, principals have little incentive to maintain credible commitment because they may be worse off from delegating formal authority to the agent. This may lead to lower participation; the risk or uncertainty of being worse off may deter the principals from participating in the institution. Incentive compatibility may also be unattainable because there are no incentives to commit to the rules of this institution. In other words, the principals are better off by

reneging on any commitments to delegate formal and real authority to the environmental manager because they are better off by influencing the agent's choice of projects. Given this discussion, the impact on basin-wide environmental benefits is ambiguous at best because there is likely to be some pressure exerted by the principals to skew the choice of projects towards their respective preferences. *A priori*, we cannot say if basin-wide environmental benefits will improve, worsen or stay the same. However, there may be some countervailing forces within the principals and dead lock from failure to secure unanimity is probably the most common outcome. In summary, the Independent Agent institution does not satisfy individual rationality because of the risk of being worse off for the principals; does not satisfy incentive compatibility because the principals are better off by reneging on commitments; there are no incentives for credible commitment; and it is ambiguous what the basin-wide environmental benefits impact of this institution design is.

In Supervised Agent institution, the principals have formal authority but the agent has real authority. This means the principals can use their formal authority to overrule the agent's choice of projects. There are two broad versions of this institution: the first is where no formal authority is delegated to the agent; the second version is where there is 'contingent delegation' of formal authority to the agent (ie, the agent can behave as in the Independent Agent unless overruled by the principals).

In the first version, let us call this the 'Supervised Agent with Micro-management' (SA-MM) institution, the principals monitor the agent's activities. This can be thought of as 'micro-managing'; the principals may choose to collect information on project choices to ensure the agent is expending enough costly effort or to collect information to further their respective causes. According to Aghion and Tirole (1997), micro-management results in the agent expending less effort and so the agent collects less information. However, the principals collect more information. Whether or not better informed principals will lead to a socially efficient outcome is ambiguous because of the unanimity voting rule and the parochial incentives of the principals. On the one hand, better informed principals are more aware of the trade offs between different projects but the lack of (assumed) congruence between the principals may not guarantee that a decision is made much less a basin-wide environmental benefits maximising one. While basin-wide environmental benefits change and incentive compatibility is ambiguous, this institution is likely to be

individually rational because participation by any principals will not make them worse off. Also, there are no incentives to not abide by the rules since each principal can choose to micro-manage the agent; therefore, this institution provides incentives for credible commitment. To summarise, individual rationality and credible commitment is achievable under the SA-MM institution but it is ambiguous if incentive compatibility and improving basin-wide environmental benefits change is.

Let us refer to the second version of Supervised Agent as the ‘Supervised Agent with Contingent Delegation’ (SA-CD) institution. In this design, the principals can delegate formal authority to the agent but can choose to overrule any of the agent’s decision *ex post*. In other words, delegation is *contingent* on the agent’s choice of projects; if any of the agent’s decisions are detrimental or another project portfolio exists that makes a given principal better off, then the principals may choose to overrule the agent. Let us assume that the decision to overrule by the principals is resolved by unanimous voting. From our previous discussion of unanimity, it is clear that this is a costly way of making decisions. Thus, the principals will only overrule if *all* principals are better off by doing so; ie, all are harmed by the agent’s decision or there exists a portfolio that will make them better off. Nevertheless, under this institution, some principals may be worse off from *contingent delegation* because it may not be possible to secure unanimity to overrule. This may make participation difficult to secure since it could mean one principal is consistently exploited by the majority. The converse of this is that incentive compatibility is partially secured because of the costly nature of unanimous decision making. The possibility of majority exploitation may make credible commitment difficult to secure because there is a strong incentive to influence the agent or to cease participation in the institution. As for basin-wide environmental benefits, if credible commitment and participation could be secured, this institution may improve basin-wide environmental benefits. Credible commitment and participation could be secured by imposing a restriction on the agent’s project choice such as to ensure that none of the principals are made worse off or to incorporate an appeals process to deter such decisions (Dewatripont and Tirole 1999). If credible commitment and participation cannot be secured, then environmental benefits are unlikely to be improved because of the lack of cooperative action. To summarise our discussion, individual rationality and credible commitment may be difficult to secure unless an appeals process or administrative rule is imposed

that prevents exploitation of minority principals; but incentive compatibility may be partially secured depending on the decision rule; and basin-wide environmental benefits may be enhanced if individual rationality and credible commitment is possible.

The Passive Agent institution is where the principals have real and formal authority over the choice of projects. The agent is redundant in its role as project selector for the principals. Given this, the agent will have little or no incentive to expend effort to collect relevant information. The principals on the other hand, will have strong incentives to collect information since they stand to benefit from any positive information they can collect. In this case there are strong incentives to participate since each principal can be made better off by engaging with the other principals. When the principals participate, the only checks on their decisions are other principals but the possibility of side-deals makes decision making easier. However, incentive compatibility to act in the interests of the basin are weak since the principals will be able to pursue their parochial objectives. However, the principals may act as countervailing forces to each other which may move the principals' choice of projects towards maximising basin-wide environmental benefits. Credible commitment to operate within this framework is strong since the principals can act with little or no restrictions except from other principals. Finally, basin-wide efficiency will probably not be achieved unless the principals' preferences are congruent with maximising basin-wide environmental benefits. However, it is possible for the countervailing incentives of the principals to result in a neutral environmental benefits impact since if the principals are sufficiently divergent, no decisions are likely to be made; in this case the status quo is preserved. Given this, *a priori*, the environmental benefits impact of the Passive Agent institution is ambiguous. To summarise, participation and credible commitment are secured, the basin-wide impact is ambiguous and incentive compatibility is not achieved.

**Table 1 Summary of proposed institutional structures**

	<i>Independent Agent (IA)</i>	<i>Supervised Agent with Micro-management (SA-MM)</i>	<i>Supervised Agent with Contingent Delegation *</i> (SA-CD)	<i>Passive Agent (PA)</i>
<b>Individual Rationality (Participation)</b>	No, risk of being worse off	Yes, can micro-manage	Yes, can overrule and no minority exploitation	Yes, little restrictions on project selection
<b>Incentive Compatibility</b>	No, better off renegeing	Ambiguous, depends on principal's incentives	Partially, can overrule but is costly	No, pursue parochial objectives
<b>Credible Commitment</b>	No, better off influencing agent	Yes, can micro-manage/influence agent	Yes, can overrule and no minority exploitation	Yes, have little restrictions on project selection
<b>Positive Basin-wide Impact</b>	Ambiguous, depends on project selection	Ambiguous, depends on project selection	Probably, costly to overrule agent	Ambiguous, countervailing incentives

NB: ‘\*’ assumes there is an appeals process or administrative rule that prevents any principal from being worse off by the agent’s decision.

The principals do not have an incentive to participate in the Independent Agent institution so we can neglect this for discussion. This leaves the other institutions to consider. These remaining institutions all secure individual rationality and credible commitment. PA is not incentive compatible, the SA-MM is ambiguous and SA-CD is partially incentive compatible. SA-MM and PA are ambiguous in terms of basin-wide environmental benefits whereas SA-CD will probably improve it. Given this, SA-CD appears to be the optimal choice. This is dependent on the incorporation of an appeals process or administrative rule to prevent exploitation of the minority. If checks against minority exploitation cannot be implemented then SA-CD is no longer individually rational for the principals to participate in, therefore the choice becomes either institutions SA-MM and PA. SA-MM appears to be preferable because there may be some chance of the principals acting in the interests of the basin whereas under PA is not incentive compatible for the principals to act in such a way.

### **3.3 Incentives and the Environmental Manager**

Up to now, we have not discussed how leadership affects the behaviour of the agency. Leadership is important in choosing the mission, making it credible and acceptable to the environmental manager’s employees. How a leader for the environmental

manager is chosen is important but is very difficult to implement. The attributes of a good leader for the environmental manager will depend on the objective of the environmental manager and the type of people employed. For example, if the focus of the environmental manager is to maximise the basin's wealth from the sustainable use of riverine resources, an ecologist or environmental economist may be the most suitable leader. However, the skill sets of the leader are just one important factor of the leader; other, non-economic factors such as personality type, management style and other psychological factors may or are probably more important. How much economics can contribute to the selection of an environmental manager's leader is a subject of future research.

An important thing to note from this discussion is the futility of using environmental outcomes as a performance measure of the environmental manager. The links between actions and environmental outcomes are not well known; to make outcomes a performance measure will introduce perverse incentives for the environmental manager. Because environmental outcomes are non-verifiable, the environmental manager's employees will have less incentive to expend effort; this is a typical moral hazard problem. Instead, focus on process may be an important way of eliminating moral hazard. Also, career concerns, the mission and professionalism are important for encouraging higher effort.

A longer term concern is to research what is the best institutional structure given the parochial incentives of the environmental manager's principals. Our analysis was restricted to considering institutional structures within the framework of the Murray Darling Basin Agreement. However, this may not be the optimal structure, even considering the transaction costs of reform.

#### **4 Public Good Contribution Mechanisms**

In the last section, we argued that a Supervised Agent with Contingent Delegation was optimal given the institutional choices. We will assume for this section that this is the institutional background we are faced with. Effectively, we are assuming that the environmental manager will choose a portfolio of projects according to its benevolent preferences. What would this mean for the Commission?

Rather than being a silver bullet, this would cause, or bring to the fore, tension in the Commission. At its root, the MDB Agreement brings together States that have

divergent aims. Hence, the principals (Council and Commissioners) may not be very satisfied with a group of projects that focused exclusively on basin-wide environmental outcomes. Given that the principals have to approve implementation of projects (often via unanimous vote) this could cause a problem: many of the project suggestions by the environmental manager's may be rejected.

To date, this tension has been relieved via jockeying about projects. So, for example, a block of funding is allocated to a broad area such as "to improve the riverine environment" and then representatives of the States play an important part in contributing technical and other advice to project construction and selection. In this way, State representatives argue for projects that they deem beneficial. Having already committed some fixed cost share up front, the aim of each State representative is—at least in part—to further the State's interest. The selected portfolio of projects reflects this negotiation.

However, a successful environmental manager would circumvent this, almost by definition: it would be set up to focus on "one river - one environment". A successful environmental manager would try to present to Commission and Council only those projects that were most cost effective.

How do we resolve this tension?

One approach is to view the co-funding of projects as contributions to a public good. The theory of public goods relates to the case where there is one project that benefits several players (e.g. a basin-wide biodiversity project). The problem for public goods contributions is that each player has a private value for the good, but if asked to contribute her private valuation she would have an incentive to understate her benefit, and 'free ride' on the contributions of others.

The environmental manager may articulate the worth of projects using an appropriate environmental metric but State representatives would view projects from a wider perspective: the benefits in terms of jobs in a State, or whether it fits with the State's approach in the past, etc. This additional aspect of the State representative's objective function is private information.

The literature on public goods analyses mechanisms that may get different players to truthfully reveal the degree to which they value projects, in this case, the cost share they are willing to contribute.

#### **4.1 Some Mechanisms**

Public good contribution (or demand revelation) mechanisms try to get participants in a public good experiment to tell the truth about their valuation of the public good, even though their natural incentive would be to free ride.

The way that demand revelation mechanisms usually operate is as follows. Participants (ie. the principals in our case) are told to deliver some 'message' (a contribution<sup>16</sup>) — either a quantity of public good, or cost share, or both — and then the rules of the mechanism determine whether or how much of the public good is provided, and if it is provided and what each participant's contribution will be. Participants are then told about the result. In some cases a mechanism operates using an iterative procedure.

A demand revelation mechanism is 'incentive compatible' in a theoretical sense when truthful revelation is a dominant strategy: each player maximises her utility by telling the truth, regardless of the messages sent by the other players.

As will be discussed below, getting truthful revelation has proven problematic. There are systems that have been developed that can get truthful revelation (such as the Clarke-Groves mechanism) however the contributions involved with these mechanisms do not necessarily sum to the total cost of the public good. In economics parlance, these truth-revealing mechanisms do not 'balance the budget'.

Mechanisms have subsequently been developed that balance the budget (so that total contributions equal the cost of the public good) however in general these mechanisms do not have truth telling as a dominant strategy.

Incentive compatible mechanisms have generally been examined using experimental economics. Using this approach economists have been able to characterise the circumstances under which incentive compatible mechanisms work, and their degree of efficiency.

We consider three mechanisms below: Clarke-Groves, Groves-Ledyard, and the Smith Auction. We do this to give the reader a feel for the types of mechanisms that have been advocated in the literature. The application of any mechanism in a policy

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<sup>16</sup> Often referred to as a bid.

setting would require further research to ensure that it were applicable to the specific context.

#### 4.1.1 Clarke-Groves

Following Varian (1992) we consider the Clarke-Groves mechanism for a discrete public good, which has the following characteristics:

- There is a public good, such as a basin-wide project, that can be supplied in aggregate quantity,  $X$ ,
- The total cost of providing  $X$  is  $TC(X)$ ;
- Each individual  $i = (1, \dots, I)$  receives a value from the public good equal to  $v_i$  (where  $I$  is the total number of individuals)
- Each individual can contribute a bid to towards the supply of  $X$ , call this  $b_i$

Each individual's payoff function is:

$$\text{payoff to } i = \begin{cases} v_i + \sum_{j \neq i} b_j & \text{if } b_i + \sum_{j \neq i} b_j \geq TC \\ 0 & \text{if } b_i + \sum_{j \neq i} b_j < TC \end{cases}$$

If the public good is funded each individual gets paid the bids by other participants, as well as receiving her own valuation. If the public good is not funded, each individual gets zero.

This mechanism can be shown to be incentive compatible in that truth telling is a dominant strategy (Varian 1992). However, it is not 'budget balanced': total payments ( $\sum_i b_i$ ) do not necessarily equal the total cost,  $TC$ .

The mechanism can be adapted to one that balances budget, but this generally involves the loss of the property that truth telling is a dominant strategy. One such adaptation is the Clarke Tax or pivotal mechanism. Varian 1992 provides more detail on this mechanism. The pivotal mechanism adds another term to the payoff schedule that corrects for budget imbalance, and this term is not dependent on the individual's bid. Chen (2002) states that the pivotal mechanism has had some problems in terms of achieving efficiency in the laboratory. For example, early experiments found the pivotal mechanism to be no more efficient than majority rule voting when the choice

was whether or not to proceed with a public good of fixed cost<sup>17</sup>. However, subsequent experiments found that providing more information to subjects about payoffs from different courses of action could substantially improve efficiency. In these experiments, the pivotal mechanism managed to achieve 90 per cent efficiency.

#### 4.1.2 Groves-Ledyard.

The Groves-Ledyard mechanism has been examined by Chen and Plott (1996). In Groves-Ledyard each player pays a cost equal to:

$$C_i(x_i | \mu_i, \sigma_i) = \frac{X}{I} \cdot q + \frac{\gamma}{2} \left\{ \frac{I-1}{I} (x_i - \mu_i)^2 - \sigma_i^2 \right\}$$

Where:

- $\gamma > 0$  is the ‘punishment parameter’<sup>18</sup>
- $x_i$  is individual  $i$ ’s proposed incremental quantity of the public good ( $\sum_i x_i = X$ )
- $\mu_i = S_i/I$  is the mean of others’ messages ( $\sum_{j \neq i} x_j = S_i$ )
- $\sigma_i^2 = \sum_{j \neq i} (x_j - \mu_i)^2 / (I - 2)$  is the squared standard error of the mean of others’ messages
- $q$  is the unit cost of the public good

Chen and Plott find the Groves-Ledyard (G-L) mechanism is very efficient: it provides between 85 per cent and 98 per cent of the efficient public good quantity when the punishment parameter is unity; and between 96 per cent and 99 per cent of the efficient quantity when the punishment parameter is 100<sup>19</sup>.

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<sup>17</sup> An efficient choice in this context is when a group decides to proceed with a public good project that has positive net benefits.

<sup>18</sup> The term ‘punishment parameter’ comes from the fact that a higher value increases subject  $i$ ’s payment as he deviates further from the mean of others’ messages.

<sup>19</sup> An efficient quantity of public good is where the (vertical) summation of marginal benefit across all subjects equals the marginal cost.

Although the G-L mechanism, as implemented by Chen and Plott 1996, provides very high levels of efficiency, it presents a challenge for implementation in our context. This is for at least two reasons:

- 1) Subjects provide messages about the quantity of the public good and are then told their cost share, but they cannot calculate their cost share with certainty beforehand; each subject's cost share depends on others' messages. It would be difficult to get a State representative to nominate a quantity of public good without knowing the cost.
- 2) Subjects deliver just one message and this is binding so that when taken in conjunction with other messages it determines the quantity of public good and each subject's cost share. In the Chen and Plott experiments subjects learn over time how to 'play the game'. In an experimental context dealing with small amounts of money this may not be a problem. However, in a policy setting this would be problematic because it would force the principal to commit to a once-off message that may have large funding implications. This may induce 'learning' through time, but such learning would come at a large cost.

These issues would require further research prior to the G-L mechanism being a feasible option in a policy setting.

#### 4.1.3 Smith Auction

The Smith Auction—so called because of the work of Vernon Smith (1979, 1980) — has been one of the most examined demand revelation mechanisms. A discrete version of the Smith auction could be described as follows.

- Each agent places a bid,  $b_i$  towards the supply of a public good quantity  $X$
- The authority calculates the sum of bids,  $\sum b_i$ .
- If  $\sum b_i < TC$ , then the auction goes to another auction round. Agents are asked if they would like to alter their contribution. If after a large number of rounds,  $T$ , we still have  $\sum b_i < TC$  then the auction ends and the public good is not provided

- If during rounds 1 to  $T$  the authority calculates a  $\sum b_i > TC$ , then any surplus funds are returned to bidders using some pre-defined rules<sup>20</sup>. Each agent is told their allocated contribution, and the auction goes to a vote
- Recall that the institutional context is a Supervised Agent with Contingent Delegation; ie, the principals can overrule the agency only *if* all agents vote yes to the overrule motion. A voting round could be included here where the agents (ie, the Council members) can choose to overrule the environmental manager using a unanimous voting rule. If all agents vote yes, then the project is rejected. If at least one agents vote no, then the project is accepted.

The theoretical properties of the Smith Auction are not fully understood (Chen 2002). However, because it takes the form a bidding process it is easy for participants to understand. The unanimity requirement may appeal to principals because it may be seen to provide an additional safeguard. However, Banks *et al.* 1988 and Chen and Plott (1996) have argued that unanimity is inefficient, so this safeguard may come at a cost.

## **4.2 Implementation Issues**

### **4.2.1 Cost Shares: Fixed versus Varying**

We stated in the background that the Commission currently allocates certain budgets with fixed cost shares to broad areas of work. Yet a public good contribution mechanism would mean that any one project, or group of projects, could have varying cost shares. There is no reason why the cost shares agreed to by State representatives should align with the cost shares determined in an up-front agreement.

However, this approach could still be implemented because each state has allocated a fixed 'amount' to projects in the basin. Each State could 'draw down' on this amount over time. This system may mean that (say) one State draws down it's total contribution prior to others. This is not really a problem and it could even provide an appropriate incentive: a State that drew down its allocation early could then decide whether it wanted to contribute more than its pre-allocated amount. This could be

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<sup>20</sup> For details see Smith (1979)

appropriate because there is no reason why the initial amount, selected with very little information, was efficient. After having seen many project proposals State representatives will have a lot more information about what can be achieved, and the cost of obtaining these achievements. If the relevant State decides not to contribute any more funding, then it will place zero bids thereafter, and the projects selected will be those where the remaining States receive sufficient benefit.

#### 4.2.2 Information Demanded by the System

In a public good contribution mechanism each State representative would have to contribute funding to project areas. In order to do this, each State representative may demand information about the projects she is contributing to. This would place discipline on the environmental manager to estimate the effects of projects up-front. The revelation of this information, if used in conjunction with other processes, could improve dynamic efficiency: there would be learning by the players about the goods being procured, and about their cost, and this should help the players be more aware of the trade-offs involved. This should improve future decision making.

Within a public good contribution mechanism, States could independently undertake any research that they require about State-specific benefits (e.g. the links of a project to State tourism). This would be information that each State would be concerned with, and it would be private information.

This system, unlike the current one of negotiations, would be more transparent for two reasons. First, the environmental manager would be required to provide metrics. Second, each State's contribution to a project would be public information. This would allow concerned individuals to question the principal's decisions, ie. the principals can be made accountable.

## 5 Conclusion

This paper considers the issue of establishing an environmental manager within the constraints of the MDB agreement. The environmental manager's role is to select a suite of projects that maximise basin-wide environmental benefits for funding by the 'contracting' governments to the MDB agreement. The problem is to design an internal and external institutional structure of the environmental manager to maximise basin-wide environmental benefits. The optimal design of the environmental manager may not result in a first best outcome in the theoretical sense; that is, there are institutional constraints in the MDB agreement that prevent us from ever reaching the best possible outcome.

The key institutional constraint is the (assumed) non-benevolence of the States and the Australian Governments. Each of these principals of the environmental manager have different objectives when it comes to environmental policy of the Murray Darling Basin. To some extent, if the principals have countervailing incentives to each other, they partially (but not completely) reduce the impact of their non-benevolence. However, it is unlikely that this is enough to ensure basin-wide environmental benefits are maximised. We showed that the design of external incentives for the environmental manager can have a significant impact on environmental policy in the Murray Darling Basin. In particular, individual rationality, incentive compatibility and credible commitment of the principals should be considered when designing external incentives of the environmental manager. Our paper briefly canvassed the obvious institutional forms. However, more intensive research may produce a more appropriate structure.

Restricting the 'jockeying' of the States' and Australian governments may seem desirable. However, our research suggests that the governments may partially cancel each other out. Research on how to use these countervailing incentives to ensure environmental benefits are maximised may yield more appropriate institutions for environmental management of the Murray Darling Basin.

We did not discuss how to enforce the agreement. How the agreement is enforced has incentive effects on the principals behaviour and may affect institutional design. Further research is needed to determine these effects.

The internal design of the environmental manager is important to ensure it fulfils its role. While the agent may not be able to deliver a first best outcome given the non-benevolent nature of its principals, it can be the difference between second best and inefficient environmental policy. The first step in designing internal incentives is to recognise that the mandate given to the environmental manager will be vague partly because of diverging principal objectives and also because of the nature of environmental outcomes. This makes the use of high powered incentives difficult because tying the environmental manager's remuneration to environmental outcomes cannot be done meaningfully. Lower powered incentives such as missions, professionalism and career concerns may be more appropriate for inducing high effort by staff.

Leadership of the environmental manager is an important topic, but one which requires more research. The questions we need to answer is how do we pick a leader? If we have a bad leader, what internal incentives could minimise this risk? Economics is largely silent on this and it may turn out economists cannot contribute much. Nevertheless, how leadership affects institutional performance has obvious economic implications.

Another side of the problem is the efficiency of resource allocation by a group of governments with different preferences. We use public good theory to show that there are incentive mechanisms that can be used to elicit truthful revelation of each principals' marginal benefit for a given project. Three mechanisms were considered: Clarke-Groves, Groves-Ledyard and the Smith Auction. In the Clarke-Groves, each government has an incentive to contribute funds because they are better off from starting the project. However, even if all governments contribute, the project's budget may not balance but information is revealed, albeit at high social cost. In the Groves-Ledyard mechanism, governments are 'punished' for not contributing the same amount; ie, free riding is punished. There is evidence that this mechanism is efficient. However, governments need to learn how to 'game' this mechanism quickly because the costs of free riding are considerable. Finally, the Smith Auction determines cost-sharing rules through sequential auctions. The final outcome is determined by a

unanimous voting. This mechanism provides governments with an incentive to reveal their marginal benefit from a project by allowing them to update their bids sequentially. Unanimity may impose inefficiencies but this voting rule is already part of the current institution. We have examined these revelation mechanisms in terms of their efficiency properties but not in terms of their incentive properties; ie, is it sensible for a government to sign up to an agreement that allocates funds using one of these mechanisms, vis a vis other mechanisms. A topic for future research may be to analyse how different mechanisms affect participation and incentive compatibility given the institutional structure.

The application of any mechanism in a policy setting would require further research to ensure that it was appropriate to a specific context.

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## **7 Appendix I**

### **7.1 *The Living Murray Initiative***

In March 2001, the Murray-Darling Basin Ministerial Council (the Ministerial Council) agreed to a vision and a set of objectives for the River Murray. The vision is to create ‘*a healthy River Murray System, sustaining communities and preserving unique values*’. In pursuing this vision, the Ministerial Council has embarked upon a significant program of community consultation and studies into the costs and benefits to the environment and the community of enhancing environmental flows in the River Murray.

To aid discussion on the amount of water for recovery, the Ministerial Council nominated three environmental flow reference points (EFRPs). These included the return of 350GL, 750GL and 1,500GL to the Murray each year. *The Living Murray* program included the consideration of economic impacts associated with each of these reference points.

In April 2002 Council directed the Commission to more clearly identify local as well as system wide problems and benefits with particular reference to the Murray Mouth, Coorong, Chowilla, Gunbower, Barmah-Millewa and Murray Cod populations. These *icon sites* have had an implementation plan developed costing around \$150m over seven years. Activities include floodplain management and restoration, structural and operational changes, sand dredging and fish-ways.

There are many issues surrounding the Living Murray initiative that are yet to be resolved. Key issues include the level of water for recovery, options for recovery, how any reduction in water availability may be distributed across jurisdictions and features of the institutional arrangements governing water entitlements, trade and the delivery of environmental outcomes.

The TLM has focused on water flows and the solution to the environmental problem. In doing so, the initiative has generated considerable amounts of information about the relationship between flows and environmental outcomes. This work is essential for the future management of the riverine environment. However, there is still considerable work that needs to be done to address the ongoing needs for information

and the institutional arrangements that would be required to support the delivery of alternatives to flows for riverine improvement.

### **7.2 *Blue Print for a National Water Plan, Wentworth Group***

This report recognises the fundamental need for water by all. It goes on to point out 3 broad areas for national water reform that should be considered by COAG. These are:

- 1) Protect river health and the rights of all Australians to clean and useable water.
- 2) Establish nationally a consistent water trading and entitlement system that provides security for both water users and environment.
- 3) Engage local communities and ensure a fair transition.

In order to achieve the broad objective the report suggests the following steps should be taken.

Increased recognition of the environment by providing the rivers will have first call on water in storage, a river classification system and the establishment of an environmental water trust for stressed rivers. It highlights the need to better account for water by establishing water accounts and linking them to more clearly defined water entitlements, improving trading arrangements and recovering water to solve the over allocation problem. Finally, the report discusses the need for increased community engagement to reduce water consumption.

The Wentworth report focuses on high level desired outcomes but does not address the question of implementation. It successfully iterates the desires of many but contributes little to a solution. Instead, it recommends that COAG commit funds to addressing the issues it raises.

### **7.3 *Council of Australian Governments Communiqué***

The role of the COAG to initiate, develop and monitor the implementation of policy reforms which are of national significance and which require cooperative action by Australian governments. COAG met on the 29<sup>th</sup> august 2003 and agreed to develop a National Water Initiative (NWI) to:

- a) improve the security of water entitlements
- b) ensure ecosystem health

- c) ensure there are clear water trading rules, robust water accounting and pricing based on full cost recovery
- d) encourage water conservation in our cities

There was a commitment of \$500m over 5 years<sup>21</sup>. Four specialist teams have been formed to assist senior officials in alignment of the above objectives, with an additional Murray Darling Basin Task Team. The additional team will assist in the drafting of an inter-governmental agreement (IGA) for the \$500m. The objectives of the IGA include:

- seeking to address water over allocation in the Basin.; and
- helping to achieve the environmental objectives agreed by the Murray Darling Basin Ministerial Council in its First Step Decision under the Living Murray Initiative.

Of particular interest, is the need for the team to address institutional arrangements ensuring the \$500m is spent cost effectively to address over allocation and environmental outcomes including:

- creation of an environmental management function and detailed guidance on the approach to environmental management;
- water recovery functions and detailed guidance on the approach to water recovery, including structural adjustment;
- governance reform for the Murray Darling Basin Commission, in particular for the purpose of delivering the LMI; and
- relationship of arrangements with the Snowy water recovery arrangements.

The COAG communique is important because it aligns closely with the Wentworth reports recommendations for areas of change and brings in the work done by TLM. It also recognises and formalises the concerns expressed by many for the environment by may a financial commitment to the issue.

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<sup>21</sup> Australian Government 200, NSW and Victoria 115, SA 65 and ACT 5

#### **7.4 The Green Paper – Securing Our Water Future**

The Green paper (GP) provides a very comprehensive coverage of the issues associated with providing a water management system that sustainably manages water for both environmental and consumptive use. The paper provides a discussion of issues but goes further than the other reports by suggesting possible solutions. .

Key areas discussed in the paper include water resources and their allocation, more efficient water use in both urban and rural areas, restoring and managing river health and water pricing.

The GP suggests a number of changes to water property rights combined with the formal establishment of environmental managers. There would be formal recognition of the environment as a consumer of water with issues of delivery priority with respect to irrigators considered.

The paper suggests institutional arrangements be examined to determine whether CMAs could assume responsibility for water delivery for environmental benefit. In order to do this CMAs would manage the environmental flow regime - have the water released at specific times and locations to produce an environmental benefit. This may involve changes to the Victoria water act 1989 to enable the CMAs to hold bulk water entitlements.

The GP paper focuses on solutions at the state level, and proposed initiatives will consider any implications of the national water reform agenda which includes the National Water Initiative, the Living Murray Initiative and commitments under CoAG. This will need to include alignment between ideas of a state based environmental manager as opposed to a basin level manager, given the fundamental linkages between actions and outcomes.