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Discounting and policy options for sustainable management of the Murray-Darling River System

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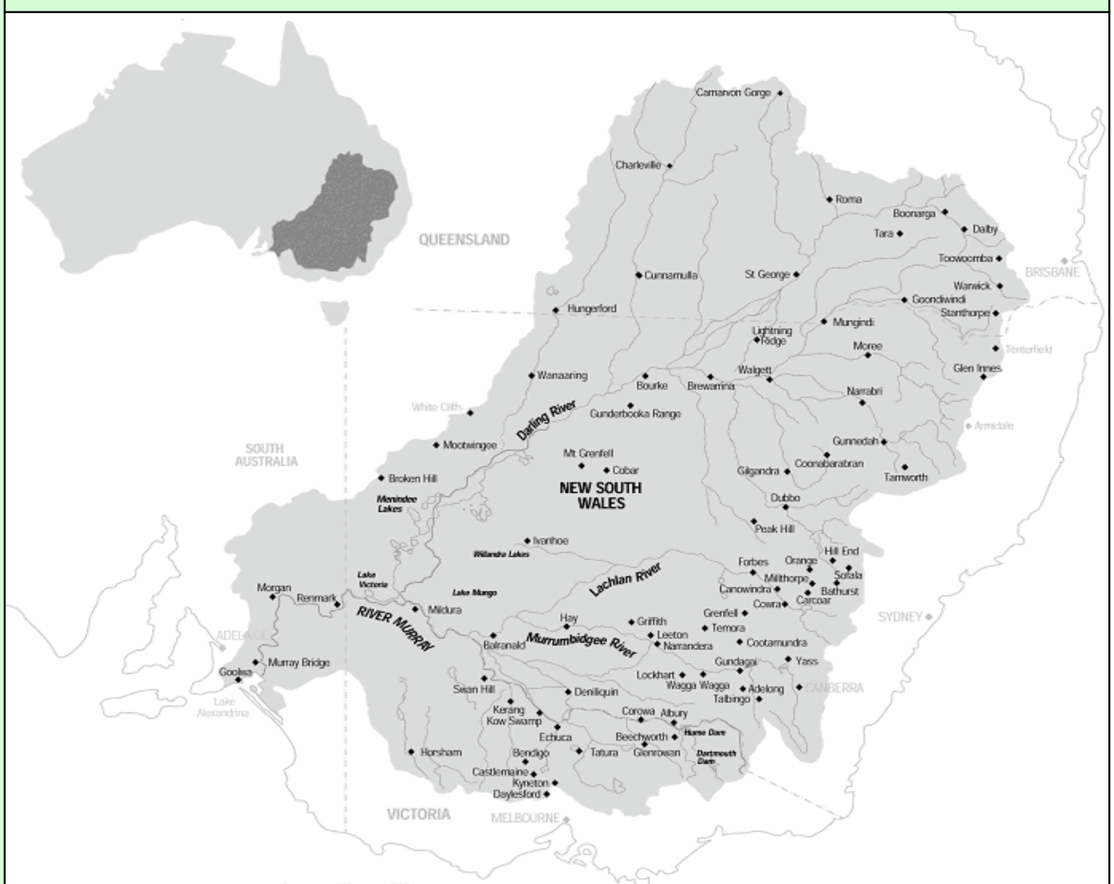

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Discounting and policy options for sustainable management of the Murray-Darling River System
Risk and Sustainable Management Group Murray-Darling Program Working Paper 1/M04

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Abstract

In many resource management problems, the starting point is one involving a large number of users with imprecisely defined rights, and an aggregate rate of resource use that is environmentally unsustainable. One possible policy response is to make formal or informal contracts with users, under which users receive current benefits in return for a commitment to forgo usage rights in future. If users have high discount rates, this response may permit a substantial reduction in resource use over time at relatively low cost. In this paper, this issue is explored with specific reference to the Murray-Darling River System.

In many resource management problems, the starting point is one involving a large number of users with imprecisely defined rights, and an aggregate rate of resource use that is environmentally unsustainable. The situation of the Murray–Darling Basin in the late 1980s fitted this description closely. Existing water allocations accounted for close to 100 per cent of average annual flows, and prevailing policies gave existing and potential users an expectation of increased usage rights in the future. Because of the variability of annual flows in the Murray–Darling, which is greater than for any other major river system in the world, it is possible to allocate more than 100 per cent of the average annual flow, and in some catchments this has been done.

In a standard property rights analysis, the response to a problem of this kind is straightforward. After the socially optimal level of use has been determined, issue tradeable resource use rights equal, in aggregate, to the optimal level, should be created and allocated (issues such as the distribution of rights and the required payment if any, are seen as purely distributional). If new knowledge implies a need for a reduction in the aggregate level of resource use rights, these can be purchased from users.

In reality, there are numerous problems with this approach. The initial determination of an optimal level of rights is difficult and, in many cases, there is pressure to preserve the rights of existing users. Moreover, in the absence of precise definitions of rights, the actual level of use associated with a given issue of rights may be higher than expected. Finally, in the absence of lump-sum sources of revenue, the option of repurchasing excess rights may involve social costs. All of these problems have emerged in the case of the Murray–Darling Basin, as will be discussed below.

One possible policy response, taking account of these characteristics of the problem is to make formal or informal contracts with users, under which users receive current benefits in return for a commitment to forgo usage rights in future. If users have high discount rates, this response may permit a substantial reduction in use over time at relatively low cost.

The current situation in the Murray–Darling Basin provides an opportunity for the adoption of such an approach. Most current licenses have been issued for a fixed term, normally ten years in the case of New South Wales. There is an expectation of renewal, but there remains the possibility of changes in conditions, or even of withdrawal of rights, at the end of the term. It seems likely that at least some users would be willing to forgo the prospect of renewal of their rights in return for a current payment, on terms that would yield improvements in sustainability at lower cost than the alternative of acquiring current rights at market prices.

The object of the present paper is to consider the desirability and practicality of the repurchase of renewal rights.

1 Background

Quiggin (2001) presented a summary of developments in policy for management of the Murray–Darling Basin from Federation to the late 1990s. This period can be divided into two phases, adopting the classification proposed by Randall (1981). In the expansionary phase, from the beginning of irrigated agriculture until the late 1980s, the main focus was on exploiting the resources of the system to promote the development of intensive agriculture. Governments were willing to support irrigation investments even when rates of return were low or negative.

Environmental problems and competition for water use became evident during the 1970s and acute during the 1980s, signalling the arrival of the mature phase in which the marginal social cost of water use is high and increasing over time. As Randall notes, when the expansionary phase reaches its inevitable end, and a mature water economy emerges, the problem of managing the resource is complicated by the persistence of policies inherited from the expansionary phase.

The most serious problems have arisen with attempts to create a market in water rights, following the imposition of a limit on aggregate extractions, referred to as the Cap, in 1995. The Cap was the first step in the development of a comprehensive policy response, referred to as the Living Murray Initiative (Murray–Darling Basin Commission 2003).

Under the Cap, it was agreed thatthe total allocation of water from the Murray–Darling Basin would not increase above the level prevailing in 1994. In future, any new allocation to one user would have to be matched by a reduction for some other user.The need for water allocations to be transferred between users naturally raised the issue of trade. The argument for trade in water rights is simple and appealing. The market would ensure that the aggregate allocation of water could be capped, and ultimately reduced, without imposing high costs on existing water users. Those who placed a high value on water could buy rights from those whose valuation was lower.

The central idea of creating a market for trade in water rights is that rights would be reallocated from low-value uses such as pasture to high-value uses such as fruit and vegetables. Although this reallocation would not, in itself, do anything for the environment, it would reduce the cost and the social and economic dislocation associated with reductions in the aggregate allocation of water.

It rapidly became apparent that this appealing idea was an oversimplification of a complex problem. Water is not a homogeneous commodity. Water in one place, and at one time is not a good substitute for water in another place or at another time. Because it is heavy and bulky, moving water from one place to another or storing it over time is complex and extensive — this is why irrigation is expensive.

Water is a complex commodity. But the structure of rights created by a century of water management is even more so. At the time of the 1994 meeting of the Council of Australian Governments (COAG), few or no water users possessed property rights comparable to titles to land. The closest approximation was a license to take water, typically attached to a particular piece of land. On the other hand, a great many existing and potential users had expectations that water would be available to them.

As a result, the first problem with water trading was to determine who had water rights. A major problem was the emergence of 'sleepers'. These were landholders who had water licenses attached to their land, but had never used them. As soon as water became a tradeable commodity, the licenses held by such sleepers became a tradeable commodity. Since extractions from the Murray–Darling Basin were already at or near 100 per cent of natural flows in 1994, it was not possible to allow both the allocation of water to 'sleepers' and the continuation of existing allocations to users who did not possess guaranteed rights. With some exceptions, the outcome was that users who had been receiving water under various provisions, but who had no specific entitlement, did not receive tradeable rights, while sleepers' rights were upheld.

Policies for the management of the Murray–Darling were developed further at the 2003 COAG meeting, which produced an announcement (but not a detailed specification) of a set of policy proposals referred to as the National Water Initative (Council of Australian Governments 2003).

Two major principles were announced. The first was that, in future, water allocations should be stated as shares of available water, rather than as specific volumes. This approach deals with fluctuations in water availability by sharing the total amount available among users in proportion to their share. It raises the question of whether it will continue to be possible, as at present, to distinguish between high-security and low-security rights. This problem will no doubt be addressed in future.

The second principle concerned an approach to the sharing of risk arisign from changes in the aggregate availability of water.Under this principle, the risk of changes in water availability due to new knowledge about the hydrological capacity of the system will be borne by users. The risk of reductions in water availability arising from changes in public policy, such as changes in environmental policy, will be borne by the public, and water users will receive compensation for such reductions. However, the details of this distinction were not spell out and are likely to prove problematic.

1.1 The Scientific Review Panel

A recent scientific survey undertaken as part of the Living Murray Initiative (Jones et al 2002) looked at options for restoring environmental flows. Average annual flows into the system are around 10 000 gigalitres (GL), and under current policies, almost all of this flow is allocated to extractive uses, primarily irrigation. (For comparison, Sydney uses around 650 GL each year.) Three options were considered, involving flows of 350, 750 and 1500 GL. The scientific panel concluded that an environmental flow of 1500 GL was needed to achieve even moderate ecological improvements.

This is not a surprising outcome. Past experience, such as that surrounding the Snowy Flows agreement (restoring water flow to the Snowy River) suggests that somewhere between 15 and 30 per cent of natural flows is needed if a river system is to maintain its environmental health. Having been offered a range of choices from 3 to 15 per cent, the scientific panel naturally chose the figure at the top of the range.

But future reviews are likely to conclude that 1500 GL is not enough. To achieve a genuinely satisfactory environmental outcome, a natural flow of 3000 GL is probably needed. Looked at another way, 3000 GL per year is the amount by which the demands of existing users and the needs of the environment exceed the sustainable volume of water supplied by the Murray–Darling river system.

Considered in this light, the policy principles announced in the Living Murray Initiative raise as many questions as they resolve. Existing public policy calls for environmentally sustainable use, so it could be argued that the environmental flow of 1500 GL called for by the scientific review panel does not involve a change of policy. This does not seem likely to be an argument that will commend itself to irrigators. Even more acute difficulties are likely to arise if reductions in aggregate water use of more than 1500 GL are sought in the future.

It is unclear what COAG intends in the short term. A sum of $300 million has been identified for compensation and adjustment assistance. This would to $400/Ml for 750 GL which is reasonably close to the market price, or to $200/ML for 1500 GL, which is about half the current market price. Additional funds would be required for mitigation works and other initiatives.

2 Repurchase of renewal rights

As noted above, one possible policy response arises from the fact that most current licenses are for a fixed term with an expectation of renewal, but with the possibility of changes in conditions, or even of withdrawal of rights, at the end of the term.

Examination of market prices suggests that some water users would be willing to sell their renewal rights relatively cheaply. Permanent water trades recorded by Murray Irrigation Limited have typically taken place at prices close to $400/ML, while temporary trades, which take effect only for a single year, have taken place at prices between $60/ML and $80/ML. This implies some combination of high discount rates and a low value for the renewal option associated with 'permanent' rights. For any such combination, the implied present value of the renewal right is small.

This point is illustrated in Table 1, where, for illustrative convenience, it is assumed that the price of 'permanent' right is $400/ML and the value of an annual allocation is $80/ML. Thus, if renewal is treated as automatic, so that a permanent right is treated as equivalent to a perpetual flow valued at $80/ML, the implied annual discount rate is 20 per cent.[1] Since renewal is assumed automatic, the future value of the right at the renewal date 10 years in the future is $400/ML. Discounting over 10 years at a rate of 20 per cent yields a present value of $69. Even lower present values arise if

[1]Because the payments are annual, the implied internal rate of return is slightly less than 20 per cent.

the future value of the renewal option is lower than the present value of a permanent right.

If the values estimated in Table 1 are accurate, a small investment in repurchase of renewal rights could significant increase the flexibility of policy options in 10 years' time. Assuming that the values of future natural flows can be converted to equivalent current natural flows by discounting at the real bond rate, such a proposal would yield an apparent Pareto-improvement relative to the immediate purchase of permanent rights. The present social value of a future reduction in water use would exceed the private present value of the associated renewal right. However, it has frequently been the case that apparent Pareto-improvements are illusory on closer inspection. It is therefore desirable to consider this issue more closely.

2.1 Discounting and welfare

The idea that high individual discount rates may lead to excessive rates of environmental degradation has been discussed extensively for many years going back at least as far as Marglin (1963). Similarly, the view that pollution problems may be addressed by paying polluters to forgo explicit or implicit rights to pollute may be traced back to Coase (1960).

Now consider a policy interaction between these two ideas. More specifically, consider the option of making a present payment to a polluter with a high discount rate in return for a commitment to cede pollution rights at some future date. The benefit–cost analysis for such a proposal is simple, and, at first sight, compelling.

Consider a simple example. Suppose that the social rate of discount is 4 per cent and a polluter with a discount rate of 10 per cent has a right to pollute. Exercise of the right will produce private benefits and social costs, both equal to \$100, and can take place in 10 years time. Then the present value of the pollution right to the polluter is about \$37, while the present value of the social cost is about \$75. Hence a policy which pays the polluter his private valuation now in return for ceding the pollution right has a benefit–cost ratio of 2.

There are, however, obvious difficulties. In terms of the arithmetic, it is apparent that the example would work equally well if the private benefits were \$120, implying that the cessation of the pollution right would reduce future welfare. This appears to imply some form of policy inconsistency. In terms of the standard market failure framework it is not clear what market failure is being corrected. Finally, the simplicity of the example raises the possibility that some form of 'money pump' is being proposed.

2.2 Welfare analysis

In considering the validity of a proposition yielding an apparent Pareto-improvement, a number of checks are appropriate. The first is suggested by the First Fundamental Theorem of Welfare Economics. Since a competitive market equilibrium is Pareto-optimal under the conditions of the theorem, any feasible Pareto-improvement must reduce the welfare loss caused by one or more missing markets. Hence, it is necessary to identify the missing market in question.

Second, it is necessary to consider whether an alternative policy could yield a superior outcome. In particular, it is necessary to examine whether it is feasible to create the missing markets, the absence of which justifies the policy.

Finally, it is useful to consider whether there exists a *reductio ad absurdam* critique. One critique of this kind arises if the conditions required for the policy in question to yield a Pareto-improvement also imply that other policies would be welfare-improving when there are strong grounds to suppose that such policies would actually reduce welfare. A second form of *reductio ad absurdam* critique arises if the policy gives rise to unbounded (or large) arbitrage opportunities.

On the first point, as has already been noted, the capacity of the policy to generate a welfare improvement depends on the absence of a market for renewal rights. The difficulties of specifying rights precisely appear to preclude the creation of such a market. However, they do not appear to prevent governments from offering to purchase renewal rights from the holders of such rights.

However, this market failure is necessary but not sufficient for a welfare-improvement. In addition, it is necessary that there should exist one or more capital market failures leading to the existence of a difference between the discount rate facing farmers and that facing governments.

To formalise these claims, consider the case where there exists a market for renewal rights. In this case, any welfare benefits achieved through the policy under consideration could equally be achieved by making loans to farmers at a rate lying between the public and private discount rates. Since such a policy would normally be welfare-reducing in the absence of a solution to the capital market failures that generated the difference in interest rates, a *reductio ad absurdam* critique applies.

Now consider the case where there is no difference in discount rates. In this case, there is no benefit associated with repurchasing rights now rather than immediately prior to the resolution of uncertainty regarding renewal. If, as seems likely, advance purchase involves additional transactions costs, it would reduce welfare relative to the alternative of deferred purchase.

3 Model

In the simplest version of the model, there are two goods, a Hicksian composite, denoted y, representing income, and a public good or bad, denoted p. There are two classes of actors, each modelled by a representative agent. The agents are a producer and potential polluter, P, and (other members of) Society, S, There are two time-periods, 0 and 1. P undertakes production of the Hicksian composite in each period, yielding pollution as a by-product. The producer's net output of the Hicksian composite in period t is denoted z_t^P, for $t = 0, 1$. The associated pollution is

$$p_t = p\left(z_t^P\right),$$

and we may equivalently write

$$z_t^P = z\left(p_t\right).$$

The objective function for P is

$$W^P = u\left(y_0^P\right) + \beta^p u\left(y_1^P\right),$$

where u, with $u' > 0$, is a utility function, $\beta^p < 1$ is a discount factor, and

$$y_t^P = z_t^P + \omega_t,$$

where ω_t is the value of transfers from society to P in period t.

Society is assumed to display linear utility for the Hicksian composite, with social discount rate β^p, and to attach disutility to p, so that

$$W^S = y_0^S - m\left(p_0\right) + \beta\left(y_1^S - m\left(p_1\right)\right)$$

where m is a convex function.

Suppose P has unattenuated rights to choose p_0 and p_1, and can freely borrow and lend at the social discount rate β . Then we can define the indirect utility function

$$W^P(\boldsymbol{\omega}, \mathbf{p}) = \arg\max_{\mathbf{y}} \left\{ u\left(y_0^P\right) + \beta^p u\left(y_1^P\right) : y_0^P + \beta y_1^P \leq z(p_0) + \omega_0 + \beta\left(z(p_1) + \omega_1\right) \right\}$$

and observe that optimisation by P requires

$$\beta u'\left(y_0^P\right) = \beta^p u'\left(y_1^P\right). \tag{1}$$

Moreover, by the envelope theorem:

$$\begin{aligned}
\frac{\partial W^P}{\partial \omega_0} &= u'\left(y_0^P\right); \\
\frac{\partial W^P}{\partial \omega_1} &= \beta^p u'\left(y_1^P\right); \\
\frac{\partial W^P}{\partial p_0} &= u'\left(y_0^P\right) z'(p_0); \text{and} \\
\frac{\partial W^P}{\partial p_1} &= \beta^p u'\left(y_1^P\right) z'(p_1).
\end{aligned}$$

Define the reservation utility for P by

$$\begin{aligned}
\bar{W} &= \max_{\mathbf{p}} W^P(\mathbf{0}, \mathbf{p}) \\
&= u\left(\bar{z}_0^P\right) + \beta^p u\left(\bar{z}_1^P\right)
\end{aligned}$$

where

$$\bar{z}_t^P = \max_{p_t} z(p_t).$$

This is the maximum welfare P can obtain in the absence of transfers from society or constraints on the choice of the pollution vector $\mathbf{p}$.

Begin by considering the social choice problem of maximising social utility W^S, subject to the constraint that P must receive the reservation utility associated with a free choice of $\mathbf{p} = (p_0, p_1)$. Setting up the Lagrangean,

$$L = W^S(\omega_0, \omega_1, p_0, p_1) + \lambda\left(W^P(\boldsymbol{\omega}, \mathbf{p}, \beta) - \bar{W}\right),$$

we obtain the first-order conditions

$$\begin{aligned}1-\lambda u'\left(y_0^P\right) &= 0;\\ \beta-\lambda\beta^p u'\left(y_1^P\right) &= 0;\\ m'\left(p_0\right)-\lambda u'\left(y_0^P\right)z'\left(p_0\right) &= 0;\text{ and}\\ \beta m'\left(p_1\right)-\lambda\beta^p u'\left(y_1^P\right)z'\left(p_1\right) &= 0.\end{aligned}$$

Combining these conditions with 1 yields

$$\begin{aligned}m'\left(p_0\right) &= z'\left(p_0\right)\\ m'\left(p_1\right) &= z'\left(p_1\right),\end{aligned}$$

the familiar requirement that marginal damage from pollution should equal the marginal benefit from additional production associated with pollution in each period. The optimal values of ω_0 and ω_1 are indeterminate, since only the present value of the aggregate transfer, $\omega_0+\beta\omega_1$, is relevant to welfare. Denote the socially optimal solution for $\mathbf{p}$ by $\mathbf{p}^{FB}$.

Now consider the problem in which the reservation utility constraint is replaced by the requirement that policy must be implemented through purchases of pollution rights from P. The initial allocation of rights to P is assumed to be given by the privately optimal levels $\overline{\mathbf{p}}$**.** We assume that the price of rights is determined competitively so that the market price π_t in each period must satisfy

$$\pi_t=z'\left(p_t\right).$$

It is straightforward to show that the solution has the same optimal values of p_0^{FB} and p_1^{FB} as before, but that P is at least weakly better off (since only welfare improving trades will be undertaken). The transfers are given by

$$\omega_t=\pi_t\left(\bar{p}_t-p_t^{FB}\right).$$

Now suppose that P is constrained in credit markets and cannot commit to contracts that require monetary repayments in period 1. Then we obtain the restricted indirect utility function

$$\tilde{W}^P\left(\boldsymbol{\omega},\mathbf{p}\right)=\arg\max_{\mathbf{y}}\left\{\begin{array}{c}u\left(y_0^P\right)+\beta^p u\left(y_1^P\right)\\ :y_0^P+\beta y_1^P=z\left(p_0\right)+\omega_0+\beta\left(z\left(p_1\right)+\omega_1\right),y_0^P\leq z\left(p_0\right)+\omega_0\end{array}\right\}$$

where we will focus on the case of a binding constraint

$$\begin{aligned} y_0^P &= z(p_0) + \omega_0 \\ \beta u'\left(y_0^P\right) &> \beta^p u'\left(y_1^P\right). \end{aligned}$$

Now society has three possible instruments available: purchases of period 0 pollution rights with payment in period 0; purchases of period 1 pollution rights with payment in period 1; and purchases of period 0 pollution rights with payment in period 1. We will denote the competitively determined prices by $\pi_0^0, \pi_1^1, \pi_1^0$ and observe that:

$$\begin{aligned} \pi_0^0 &= z'(p_0); \\ \pi_1^1 &= z'(p_1); \text{ and} \\ \pi_1^0 &= \frac{\beta^p u'(z_1 + \omega_1)}{u'(z_0 + \omega_0)} z'(p_1). \end{aligned}$$

Since P can save at the rate β, the purchase of period 1 pollution rights with payment in period 1 is redundant; an equally good outcome can always be achieved by the purchase of period 1 pollution rights with payment in period 0.

The social problem may therefore be written as

$$\max_{\mathbf{p}} W^S(\omega_0, \omega_1, p_0, p_1) + \lambda\left(\omega_0 - \pi_0^0(\bar{p}_0 - p_0) - \pi_0^1\left(\bar{p}_0 - p_0^{FB}\right)\right)$$

with first-order conditions

$$\begin{aligned} m'(p_0) - \lambda z'(p_0) &= 0 \\ \beta m'(p_1) - \lambda \frac{\beta^p u'(z_1 + \omega_1)}{u'(z_0 + \omega_0)} z'(p_1) &= 0. \end{aligned}$$

The credit constraint is binding, at the first-best equilibrium, if

$$\beta u'\left(z\left(p_0^{FB}\right) + \pi_0^0\left(\bar{p}_0 - p_0^{FB}\right) + \pi_0^1\left(\bar{p}_0 - p_0^{FB}\right)\right) > \beta^p u'\left(z\left(p_1^{FB}\right)\right)$$

which implies

$$\frac{m'(p_0)}{z'(p_0)} > \frac{m'(p_1)}{z'(p_1)}.$$

That is, if credit constraints mean that the discount rate for resource users is higher than that of society as a whole, then the second-best optimal time-path for pollution is downward-sloping relative to the first-best. By taking action now to secure future reductions in pollution, society can achieve greater benefits than with a myopic policy equating marginal social costs to marginal social benefits in each period.

The analysis may be extended to the case when future pollution damage is uncertain. It is straightforward to show that the optimal solution is to purchase, in period 0, a quantity of renewal rights consistent with the highest possible value of $m'(p_1)$ and to sell any excess rights back to users in period 1.

4 Implementation issues

Since renewal rights are not exactly specified at present, the question of how they might legally be relinquished is problematic. One possibility would be to create a new class of 'terminating' rights, and offer payments to users who are willing to convert their existing rights to terminating rights. In formal terms, there is not much distinction between terminating rights with a duration of ten years and the one-year temporary licenses that are currently traded.

Next there is the question of credible commitment. Having accepted a cash payment in return for the relinquishment of renewal rights, some or all water users might seek to repudiate or renegotiate the agreement when their licenses expired. The risk of such an outcome depends on a variety of factors, such as the capacity of water users to exert political pressure on governments. The fact that the proposal rests on individual agreements, entered voluntarily, tends to increase the credibility of users' commitments to relinquish rights.

Another possible point at which users might seek renegotiation arises when the details of renewal rights are specified. Users might argue that they were not properly informed about the rights they were relinquishing. The risk of dispute would increase if crucial details were not specified until close to, or even after, the renewal date. Thus, it would be preferable to specify the details of renewal rights well before the expiry of current rights.

5 Concluding comments

The problems of the Murray–Darling Basin have developed over more than 100 years, and will not be resolved rapidly. In most cases, the adverse consequences of excessive water use have developed slowly over time and will continue to do so. By contrast, the costs of adjustment to lower levels of extractive water use are acute and immediate.

In these circumstances, there is a strong case for policies that take account of the difference between the discount rates applicable to mitigation policies and those faced by water users. The option of purchasing renewal rights is one such policy.

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