Efficient use of water

Role of secure property rights

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Governments can influence the security of irrigators' water entitlements through their specification of the coverage and flexibility of property rights arrangements.

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When considering the efficient level of coverage, decision makers will need to consider both the costs and benefits of extending water rights to additional users.

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The decision on flexibility will involve trading off the cost of providing more security to irrigators when governments purchase water for environmental purposes in the market against the costs of sovereign risk, rent seeking and negotiation when governments choose to administratively reallocate water without compensation.

Water resource management

The goal of water resource management is to maximise the net benefits from water use. In the light of increasing demands for water, the Council of Australian Governments (COAG) agreed in 1994 that markets were the most appropriate mechanism for allocating water between irrigators. For markets to allocate water efficiently, however, they need to be underpinned by well defined and secure property rights.

The efficacy of water property rights arrangements was a focus of the National Competition Council's (NCC) third tranche assessment of the state and territories' implementation of COAG water reforms. Specifically, the NCC was looking for property rights that promoted efficient trade and investment while providing protection for the environment (NCC 2001).

Water property rights

The focus in this article is the security of property rights to use water. In particular, the efficiency implications of alternative policies and how those policies affect the risks attached to irrigators' water entitlements are examined. States and territories can influence the risks associated with volumetric entitlements through their selection of which water users are covered by the rights and by the flexibility of the property rights arrangements.

One of the more important security issues that the states and territories have had to deal with recently has been the level of risk to impose on irrigators when reallocating water away from irrigation to the environment. Since markets often fail to adequately account for environmental values, governments have opted to intervene to ensure that

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these values are taken into account. In doing so, they hope to improve the overall efficiency with which water is allocated between private and public uses.

The options available to governments to vary allocations between alternative uses of water include administrative and market based mechanisms. The key difference between these options is their impact on the distribution of wealth. Where water is administratively reallocated away from irrigation to the environment without compensation, irrigators pay for this transfer in terms of forgone future revenue. Conversely, if governments purchase entitlements from irrigators, the public pays for the additional water for the environment.

Notwithstanding these distributional impacts, there remain some efficiency issues relating to these options. The key efficiency issue is which option (or mix of options) will allow water to be reallocated between irrigation and the environment at minimum cost. That is, are the costs imposed on irrigators from the government varying allocations of water (mainly sovereign risk) less than the cost to government of raising revenue to purchase water in the market?

'Sovereign risk' is where a government changes the rules that affect plans or investments that are already in place

Irrespective of which option is chosen, it is important that governments clearly specify the allocation rules, thereby reducing uncertainty and allowing irrigators to manage their risk as effectively as possible.

The objective in this article is to raise some issues that the states need to consider when selecting the coverage and flexibility of a system of water property rights.

What are property rights?

A property right is said to exist when the community supports and protects the exclusive use and enjoyment of that entitlement (NCC 2001). When these rights are tradable, they can lead to an efficient allocation of resources.

For water to be allocated to generate the greatest economic return within a market, water property rights will need to be:

- well specified in the long term sense (that is, a clearly defined right to make use of a volume of water for a specified period);
- transferable and divisible; and
- enforced.

In this article, the security of property rights (where security refers to the risks associated with the full or partial withdrawal of a property right) is examined first, followed by a discussion on the economic issues that are relevant to decisions about the appropriate coverage and degree of flexibility of a system of property rights.

Factors affecting security

Security is primarily affected by the specification and enforcement of property rights. If a right is well specified and enforced, the holder of that right will have a reasonable expectation of what the right will deliver over time. These expectations do not have to be 'perfect' for the right to be secure. For example, climatic variability means that it is not possible to provide perfect or risk free quantitative information to irrigators about their water entitlements. The key issue is that water resources are managed in a way that minimises the risks that water users face when they invest in making use of that resource.

Well specified in the long term sense

Establishing an efficient market based system of tradable water rights depends crucially on the specification of property rights to water. Decisions about water use and investment in irrigated farming, particularly over the longer term, are strongly influenced by irrigators' expectations about the quantity of water that their statutory water rights or entitlements represent, and the expected market value of that quantity of water. The latter is influenced by the market price of water, which is itself determined by the interaction of the aggregate supply of and demand for irrigation water.

To say that a water right is 'well specified in the long term sense' implies that the licence holder can form a reasonable expectation about the physical quantity of water that the statutory entitlement or right will deliver over time. This expectation can relate

to both the average quantity of water that a licence will deliver each year, along with information about the likely variation around the average. Further, for the right to be well specified, the licence holder should be assured that the entitlement will not be abrogated to meet competing demands.

To simply specify that the holder of a water licence or entitlement receives a fixed percentage or 'share' of water made available for irrigation each year does not provide a well specified property right. The aggregate share of water made available for irrigation must also be specified to allow licence holders to have a reasonable expectation about the size and variability in their allocation. Under these circumstances, a fixed share in the quantity of water available for irrigation may be consistent with a well defined property right (for a discussion on 'capacity sharing', see Dudley 1992).

Having a fixed share of an unknown quantity can impose risks associated with irrigators' investments in infrastructure and perennial crops. This would be the case, for example, if governments regularly altered the quantities of water allocated to irrigation and the environment.

Where the probability of supply is affected by human intervention within an irrigator's planning horizon, and irrigators are insufficiently compensated for these changes, there is potential for irrigators to make inefficient long term investment and water use decisions (Dudley 1992).

Keeping irrigators well informed about likely changes in allocations over time, however, can reduce the extent of these inefficiencies compared with a situation where little or no information is provided. By having some information on which to base future investment decisions, the risks to irrigators of making inappropriate investments is reduced.

Enforced rights

While the existence of well specified rights is a necessary condition for security, it is not sufficient. For property rights to be secure, jurisdictions need to enforce those rights.

If the government with jurisdiction does not publicly recognise and enforce the property rights regime in question, the value of the rights will be reduced and the operation of the market in water rights will be hampered.

For example, the rights of downstream users may be attenuated if governments overallocate the upstream resource. Under these circumstances the government may be said to have failed to enforce the rights of existing water users, including the environment.

In practical terms, compared with a situation with less uncertainty, the current status of irrigators' volumetric entitlements will reduce the benefits that irrigators expect to receive from water use, which in turn will affect their production, investment and trade decisions. The price that irrigators are willing to pay for an entitlement will also include a discount to compensate for the higher risk.

'Security' of water rights

Assuming that property rights are enforced, governments can influence the security of irrigators' volumetric entitlements by specifying the coverage and flexibility of the property rights.

Coverage of rights

'Coverage' refers to the extent to which different groups of water users are included in the system of property rights. If the coverage of a system of property rights is too narrow, water users outside the property rights regime may be able to affect the availability of water for irrigation, with irrigators unable to form reasonable expectations about the reliability of their entitlements.

Flexibility of rights

The degree of 'flexibility' of a system of property rights refers to how easily rights can be altered. The more flexible the system the more easily volumetric entitlements can be altered, with irrigators facing uncertainty about future access to water.

Changing the aggregate quantity of water available to irrigators to meet changes in environmental objectives, for example, may be inconsistent with well specified water rights and efficient water markets as it lowers the expected volumes and increases the variability of their water rights. At the same time, the costs imposed by the

increased risk faced by irrigators may, from an overall societal perspective, be offset by having increased flexibility to meet environmental demands.

Irrigators in a number of regions, including those along the Murray River, currently face uncertainty about future access to water because of the delays in the initial specification of the size of environmental flows. Once this initial allocation is resolved, and a model for future reallocations is adopted, it will be important for governments to clearly specify the rules on access to water. This specification should rule out as far as possible any unpredictable events that could affect an irrigator's ability to form reasonable expectations about the size of their allocations.

For example, if a government chooses to administratively reallocate water rights, irrigators would be expected to make better investment decisions if the period of tenure within which rights could not be altered was clearly specified. If tenure was not clearly specified the risk of governments intervening to alter allocations may increase dramatically.

Another example would be the specification of rules on allocations in the event of, say, an algal bloom outbreak or a severe drought. Would the water required to flush the algal bloom be sourced from irrigators or the environment, or both?

By clearly specifying these rules the uncertainty attached to irrigators' entitlements is reduced, and risks can be better managed.

Maximising the benefits from water use

For ease of analysis, the efficiency implications of the security of property rights will be considered in two stages.

In the first stage, a static world is assumed, and the issue of what is an efficient level of coverage of a system of property rights at a particular point in time is addressed. The second stage moves beyond static analysis, and an attempt is made to identify which of the available property rights models (or mix of models) is efficient in a world where competing demands for water change.

In the first stage the role of decision makers is to identify the coverage that will facilitate the efficient allocation of water between uses. Water is efficiently allocated among uses when the net benefits from all its competing uses are maximised. In the absence of transaction costs (that is, the costs associated with extending water property rights to additional users or reallocating water between existing users), water will be efficiently allocated when the differences in the marginal net benefits between all water users are minimised.

The marginal net benefits from water use are defined as the benefits from using an extra megalitre of water *less* any costs directly associated with using that extra megalitre of water — for example, the cost of extra seed and fertiliser plus the cost of water delivery. (Note that these costs do not include transaction costs.)

The aim of *minimising* the differences reflects the presence of physical constraints on water delivery that do not allow all marginal returns to be equalised.

In the presence of transaction costs, extending the coverage of water rights to additional users may not result in a more efficient use of water. This is because the transaction costs in extending rights may outweigh any additional benefits from extending those rights.

In the second stage of the analysis it is recognised that competing demands for water change over time, and that it may be desirable to reallocate water among competing uses to reflect these changing values. Under these circumstances, the role of decision makers is to select a model for reallocating property rights that will maximise the benefits from water use over time.

In an environment of changing water demands, and in the absence of transaction costs, water will be efficiently allocated between competing uses when the differences in marginal net benefits of water use are minimised across all uses in each period.

In the absence of transaction costs, both administrative and market based models can achieve an efficient allocation of water. In the presence of transaction costs, however, the preferred model is the one that most cost effectively reallocates water between competing uses.

Economics of coverage

So what is the desired level of coverage of a system of water property rights? As mentioned in the previous section, the desired level of coverage will be that which maximises the benefits from all uses of water.

The tradeoffs that governments need to consider when deciding on the coverage of property rights — wide or narrow coverage — are presented in table 1.

A diagrammatic representation of the benefits of extending property rights to include a water user currently outside the system is presented in box 1.

In the example given in box 1, whether the extension of rights to include water use by forestry will actually lead to a more efficient allocation of water will depend on whether there are any transaction costs associated with extending those rights. Any

1 Coverage of various water uses

	Narrow coverage	Wide coverage
Differences in marginal net benefits between uses are minimised	Less likely	More likely
Monitoring and enforcement costs	Low	High
Negotiation and consultation costs	Low	High
Information costs	Low	High

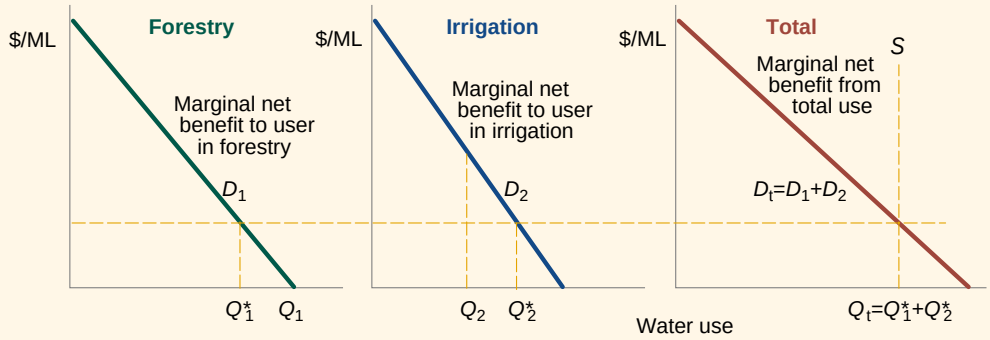
1 Forestry and irrigation demand for water

In this example it is assumed that there are two main users of water — forestry and irrigation. The benefits of extending property rights from irrigators (the current holders of property rights) to foresters (who were previously outside the system of property rights) is illustrated in the diagram below.

The three panels in the diagram represent the annual demand for water by the two users and the total annual demand and supply of water. It is assumed that forestry and irrigation make up the total demand for water. To further simplify the analysis, it is assumed that there are no environmental externalities associated with water use. It is also assumed that the marginal net benefits from irrigation are net of the long run marginal costs of irrigation infrastructure for all levels of irrigation.

Assuming no transaction costs, the efficient allocation of water between forestry and irrigation will occur at the point where the marginal net benefits from water use in each activity are equalised (that is, at Q^*_1 for forestry and Q^*_2 for irrigation).

If, however, forestry is consuming water up to Q_1, leaving Q_2 available for irrigation, the marginal net benefits from irrigation will exceed those from forestry, and there will be an efficiency gain from reallocating water away from forestry to irrigation. This analysis could be extended to multiple water users, including agents acting on behalf of the environment.



apparent efficiency gains in moving from one system to another (for example, from Q_1 and Q_2 to Q^*_1 and Q^*_2 in box 1) may be outweighed by the costs of negotiating, administering, monitoring and enforcing the extension in rights, as well as by any costs in gathering information on the level of water use and marginal net benefits from water use by forestry.

Moreover, governments will need to consider the impact of extending property rights for water on other rights such as existing rights over land. For example, expanding water property rights to include changes in land use (say from grazing to forestry) will involve attenuating property rights over land if landholders currently have the right to change land use activities.

Since the extension of water property rights will often result in the attenuation of other rights, governments will need to consider whether or not to compensate those adversely affected by change. If they do compensate for any loss in asset value following the change, governments will have to factor into their decision making the cost of raising revenue to pay for this compensation.

If governments choose not to compensate those adversely affected by an extension in property rights, they will have to choose whether they negotiate with those affected by change, or whether they simply impose change.

While governments can impose change without negotiation, most have committed to consulting widely with stakeholders before implementing change. For example, landholders and other stakeholders were widely consulted prior to the passage of the New South Wales Water Management Act in 2000 (New South Wales Department of Land and Water Conservation 1999).

The costs of negotiation include not only the direct costs of the government consulting with and negotiating a change in property rights with landholders, but also the opportunity cost of time spent by landholders in the negotiation process.

If governments bypass the negotiation process, and impose a change that is not in the interests of landholders, they will have to trade off the cost savings of bypassing the negotiation process against the increased costs of monitoring and enforcing these changes.

The cost of gathering information on water use by forestry and the marginal net benefits from water use by forestry compared with other uses may also be quite high. At the moment there is little reliable information available on water use by plantation type, design and management practice, let alone information on the marginal net benefits from water use by plantations.

Coverage – current issues

The South Australian case study (box 2) illustrates how, in the south eastern corner of the state, the expansion of forestry on land that was predominantly used for grazing has the potential to significantly reduce the availability of water for irrigation and the environment. Under these circumstances there may well be a net social gain from abrogating rights to rain that falls on-farm, and to include water use by forestry in a uniform system of property rights for all water use activities.

However, a change in land use from grazing to, say, dryland cropping may not significantly reduce the availability of water to irrigators, in which case the inclusion of cropping in the property rights regime may result in a net loss to society once the cost of extending these rights are factored in. This may also occur in some other catchments where an expansion of forestry may have only a minor impact on the availability of water to downstream users, limiting the benefits from including forestry in a water property rights regime.

When landholders change land use — say from grazing to forestry — there will often be a lag between increased forestry plantings, reduced surface flows and aquifer recharge, and reduced extractions for irrigation. Reflecting this time factor, the decision to extend or not extend water property rights to the forestry sector should be based on the comparison of the present value of the net benefits of each option.

Water harvesting on farms (box 3) is similar to land use change in that both activities reduce the volume of water entering streams or aquifers, thereby reducing the availability of water to other users.

2 South Australian forestry

The south eastern part of South Australia is experiencing an unprecedented expansion in forestry, with the area planted to forests expected to increase from 100 000 hectares in 1999 to around 135 000 hectares at the end of 2001 (South Australian Department of Water Resources 2001).

Clearly, this increase in area planted to forests on land previously used primarily for grazing will reduce the volume of rainfall that becomes either recharge to ground water or surface runoff, potentially threatening the availability and reliability of water for irrigation and the environment.

The hydrology in south eastern South Australia is such that most of the region's water reserves are underground, with almost a million megalitres of ground water available for extraction each year (Hopton, Schmidt, Stadter and Dunkley 2001).

If the trend in extensive land use change from grazing to forestry were to continue, the impact of lower recharge to the ground water system would, for unchanged extractions, result in the violation of the assessed maximum sustainable yield in fully allocated management zones.

For example, the impact of an additional 35 000 hectares of forestry in a 100 millimetre a year fully allocated ground water recharge area would require a reduction in extractive allocations equivalent to that necessary to irrigate 24 000 hectares of vines (South Australian Department of Water Resources 2001).

While the South Australian *Water Resources Act 1997* sets out the framework for managing the state's water resources, it does not cover circumstances where rainfall is intercepted before it enters a watercourse. Hence, other than by reducing allocations to irrigators, the act cannot adequately deal with the reduced availability of the ground water resource brought about by a significant change in land use. One option being considered is to require new plantations to have a water licence equivalent to the reduced recharge when rain is intercepted by the plantation. The area devoted to forestry could still expand under this model, with forest developers purchasing allocations from existing water users where water is fully allocated.

Options for extending property rights

Governments have the option of extending property rights to water harvesting, forestry or any other relevant activity through regulation or licensing. Using the water harvesting example, setting a uniform limit on the amount of water that can be harvested

3 Farm dams

The ownership of water that falls on farms has been a heavily contested issue. While the Queensland, New South Wales and Victorian governments agree that water can be taken for domestic and stock needs, they differ on who owns water in excess of these requirements that falls on a property owner's land.

Under the Queensland *Water Act 2000*, all water that falls on-farm may be captured by the property owner as long as the banks used to retain water are less than 5 metres high. As a result, over the past two years there have been instances where huge earth works have been constructed to divert water before it can enter rivers and steams. That said, however, the 'water resource planning' process provides some protection in catchments where water harvesting threatens allocations to other water users. Under these circumstances, consultative mechanisms under the planning process can lead to restrictions on water harvesting.

In contrast to the Queensland Act, the New South Wales *Water Management Act 2000* allows farmers to capture only 10 per cent of the water that falls on their property. The remaining 90 per cent must be allowed to flow off the property and on to downstream users, or if farmers wish to purchase some of this excess, to do so in the market.

Under Victoria's *Water Act*, property owners will no longer have an automatic right to water that falls on their property beyond their domestic and stock needs. The Act requires all existing dams to be registered and a licence acquired for water captured by new dams. While irrigation reuse dams will still be allowed to capture water that has been used for irrigation, any water caught in excess of the reuse limit will have to be paid for or allowed to flow off the property.

by farmers through regulation is likely to be arbitrary, and unlikely to yield an efficient allocation of water. To achieve an efficient allocation of water through regulation, governments would need to have information on the marginal net benefits from water use by all users. Acquiring this information is likely to be very expensive.

An alternative to regulation is to require farmers to have a water licence to engage in water harvesting. New licences could be issued in catchments where water had not been overallocated, whereas farmers would have to purchase a licence from an existing user in catchments that had been fully allocated.

When comparing the efficiency of licensing and regulation, the costs of monitoring and enforcing each option will need to be factored in.

The New South Wales government has chosen to extend property rights to water harvesting by requiring farmers who harvest in excess of 10 per cent of water that falls on their farms to have a licence. Similarly, under Victoria's *Water Act* farmers require a licence to capture water in new dams in excess of that necessary for stock and domestic purposes.

While these limits on harvesting tend to be arbitrary, allocative efficiency is enhanced by allowing farmers wishing to harvest water in excess of their predefined limit to purchase water from existing irrigators in catchments where water use is capped.

Choice of model

So what is the preferred model for reallocating property rights?

The preferred model will be the one that allows the net benefits from water use to be maximised through time. To achieve this, the model will need to be able to facilitate the transfer of water to higher value uses at minimal cost.

Reallocation of water between alternative uses may be desirable, for example, where the consumptive and environmental values for water change in response to fluctuating commodity prices or changing environmental awareness. This may require the reallocation of water through either or both market based or administrative means.

Three models for reallocating property rights are presented in table 2. These models differ in terms of certainty of tenure and compensation.

When choosing between these models, decision makers will have to trade off the costs of providing more security to irrigators against the costs of providing less security to irrigators. Basically, this will come down to balancing the costs of raising revenue to compensate irrigators for any loss in entitlements against the costs of sovereign risk (for both irrigators and property right holders in the broader economy), rent seeking and negotiation (see box 4).

In the following analysis of the models presented in table 2, the very strong assump-

2 Alternative models for reallocating property rights

		Administrative adjustment	
	Market adjustment	**With partial compensation**	**Without compensation**
Minimise differences in marginal net benefits between uses	Likely	Likely	Likely
Costs of raising revenue	Yes**	Yes*	No
Sovereign risk for irrigators and others	No	Likely*	Likely**
Rent seeking	No	Likely*	Likely**
Negotiation and consultation costs	No	Likely	Likely

* Less costly. ** More costly.

tion is made that the government has information on the marginal net benefits from water use for irrigation and the environment.

In cases where the marginal net benefits from environmental uses exceed those from irrigation, the government can equalise these benefits by either purchasing entitlements for the environment in the market or by administratively reducing entitlements for irrigation.

Market adjustment

The first model considered in table 2 involves allocating water rights to irrigators and the environment, with the government (or its nominated agency) acting on behalf of the environment. With this approach, some time after the initial distribution of rights the government reallocates water to reflect changes in environmental and consumptive values by purchasing or selling water in the market. The government does not alter irrigators' rights, but rather purchases rights.

The major cost associated with this approach is the cost of raising revenue to purchase additional water for the environment. These costs may be somewhere in the order of 20–50 per cent of revenue raised (Findlay and Jones 1982; Pope and Fayle 1990; Good 1991; Curran and Podbury 1994).

Alternatively, if the government chooses not to raise additional revenue, but rather to substitute funds from existing programs (with revenue unchanged), there will be an efficiency loss if the benefits from purchasing environmental flows are less than the forgone social benefits from the other programs. Of course, these alternative programs will still incur the cost of raising revenue in the first place.

The voluntary exchange of rights in the market, however, avoids the costs associated with negotiating a change in rights and sovereign risk. Moreover, once the initial assignment of rights has taken place there will be no incentive for rent seeking. As Randall (1983) states, stability of rights discourages self interested investment in institution-changing behaviors while unstable rights encourage it. Randall goes on to describe voluntary exchange as the unimpeachable method of conflict resolution.

4 Transaction costs

Raising revenue

If the government chooses to enter the market to purchase entitlements, or alternatively to compensate irrigators for any loss in entitlements, it will incur the cost of raising public funds. Other factors remaining unchanged, such funding will require the raising of additional revenue.

On some estimates, the cost of raising the additional revenue falls in the range of 20–50 per cent of the revenue raised (Findlay and Jones 1982; Pope and Fayle 1990; Good 1991; Curran and Podbury 1994).

It should be clearly stated at this point that the actual funds paid to irrigators to compensate for any loss in entitlements, or to purchase entitlements in the market, represent a financial transfer from the public to irrigators. While this transfer will affect the relative wealth of these two groups, it does not represent a net economic loss. However, the cost of raising the additional revenue represents a deadweight loss to society.

Forgone social benefits

The alternative to raising additional revenue to purchase entitlements from irrigators is to draw funds away from existing programs, leaving total revenue unchanged. This substitution of funds, however, will incur an efficiency loss if the forgone social benefits from these existing programs exceed the benefits from purchasing water for environmental purposes.

Sovereign risk

In the water sector

Where irrigators face the prospect that governments may change property rights at some time in the future, they are subject to what is termed 'sovereign risk'. By maintaining a position whereby the rules under which irrigators operate can be changed, the government adds to the difficulty for irrigators to make good investment decisions.

The presence of sovereign risk makes suboptimal investment a real possibility because the added risk leads to a lower

Continued

4 Transaction costs cont'd

present value of expected net benefits from any investment option. This lower net benefit can be the result of a shorter 'expected' time period to realise returns from that investment, or lower expected net benefits from the infrastructure each year (Chang and Thompson 1989).

Sovereign risk has the potential to affect not only the level of investment by irrigators, but also the type of investment.

In the broader economy

When governments alter property rights in one sector, they introduce an element of uncertainty for property right holders in other sectors that their rights may also be altered. Hence, property right holders outside of the sector directly affected by a change in rights also face increased sovereign risk.

Rent seeking

Rent seeking is another potential cost associated with altering rights; in the case of water it refers to the activities that irrigators, environmentalists and other interest groups engage in to receive preferential treatment by governments.

While this preferential treatment usually refers to interventions that improve the financial position of the interest group, the concept can be extended to nonfinancial benefits such as improved environmental benefits.

Similar to those seeking to improve their position, there will be others seeking to avoid any government decisions that adversely affect their position, financial or otherwise. Both of these groups will be prepared to invest in lobbying activities up to the point where the last dollar so invested equals the expected benefits of achieving their preferred position. These activities represent a net loss to society to the extent that these resources could have been used more productively elsewhere in the economy.

This market approach would allow governments to react quickly to any changes in the demand for water for environmental or consumptive purposes.

Administrative reduction in rights without compensation

This model allows governments to alter property rights to reflect changing circumstances through direct intervention. It is assumed in this model that the government increases allocations of water to the environment by reducing the quantity of water available for irrigation, and that irrigators are not compensated for any loss in entitlements.

While the model allows governments to equalise the net benefits from irrigation and environmental uses, the potential for governments to intervene to reallocate water to the environment (that is, sovereign risk) reduces the security of irrigators' future water entitlements. This increased uncertainty will be reflected in a lowering of the returns that irrigators expect to receive from water use over time, and may adversely affect their long run production and investment decisions.

This increase in uncertainty faced by irrigators may also be transferred to other sectors of the economy to some extent, as property right holders in these sectors come to view their rights as being less secure. This increase in sovereign risk will lead to efficiency losses in the broader economy.

Another potential cost associated with this model is the incentive it creates for interest groups to engage in rent seeking behavior. For example, if the government regularly adjusts the split between consumptive and environmental uses, it is highly likely that irrigators and environmentalists will engage in lobbying activities in order to gain an advantage in any future reallocations.

Moreover, while governments do not have to negotiate with irrigators over any loss in entitlements under this model, most governments have committed to consulting widely with those affected before altering property rights. The costs of negotiation may be quite substantial if a large change is being sought. For example, a 20 per cent reduction in irrigation entitlements to meet environmental needs would meet with a significantly higher level of resistance by irrigators and communities that are dependent on irrigation than would a 5 per cent reduction.

Administrative reduction in rights with partial compensation

Governments are not limited to the two extreme reallocation models presented above. They could, for example, choose the middle ground, which would involve a combination of administratively reducing irrigators' rights while partially compensating them for any financial loss.

Since the government does offer some compensation under this model, it will incur a cost in raising revenue to fund this compensation. However, this cost will be lower than where governments enter the market to purchase entitlements, as the level of compensation required will be less. The additional cost of raising revenue under a system of partial compensation (compared with no compensation) will need to be balanced against the lower costs of sovereign risk and rent seeking.

The provision of some compensation will reduce the level of financial risk faced by irrigators in their production and investment decisions, while reducing the incentive for rent seeking. It is not possible to say whether the costs of negotiation will be lower with partial compensation than with no compensation. While partially compensating irrigators is likely to reduce their resistance to a reduction in rights, irrigators will also have an incentive to intensify negotiations to maximise the level of compensation offered for any reduction in rights.

New South Wales model

The water licensing arrangement set out in the New South Wales *Water Management Act 2000* (see box 5) contains elements of administrative and market based models. Under the new act, general water licences are issued for a period of fifteen years, but are subject to the conditions of the ten year 'water management plans' that operate in each catchment.

If the government wishes to increase allocations to the environment, it can do so by changing the terms of the water management plans. This change in the plans will in turn be reflected in reduced allocations attached to each irrigator's licence. While

5 New South Wales Water Management Act 2000

The New South Wales *Water Management Act 2000* came into operation on 1 January 2001. The act created an entirely new water licensing system and requires catchments to develop 'water management plans'. While these plans are being progressively developed, the original goal of completing these plans before the end of 2001 was not be met. Each plan will contain a 'bulk access regime' that contains the water sharing rules for each catchment. The regime sets out how much water is available for extraction by licensed users and how much water will be allocated for environmental purposes. Although the government will set initial bulk access regimes, they will be the combined result of community consultation and scientific research.

Each water management plan will be set in legislation and will operate for a period of ten years. During this ten year period the bulk access regime can be altered, with any loss suffered as a result of reduced water allocations compensated. If the changes to the bulk access regime are made in the transition period between water management plans, however, no compensation is required.

Under the new act, all licences will be renewed in accordance with the plans established in each catchment. These new licences have been split into two components. The first component requires operators to acquire a water use approval. An approval is needed for each specific land based activity that may affect the quality or quantity of the water resource. The second component is the water access permit. This permit, which allows a specified volume of water to be extracted and used, is the only part of the licence that can be traded. Access permits are issued for a period of fifteen years for private enterprises, such as irrigators, or twenty years for larger water utilities, such as local councils.

the government can alter a water management plan at any time, any changes that occur within the ten year planning period will need to be compensated at market value. If a water management plan is changed in the transition period between plans (at the end of ten years), however, no compensation is required.

Trade implications

Just like in a single region, the different levels of risk attached to water rights where interregional trade is possible can distort resource use. More water would be expected to be traded into the region offering more certainty to irrigators. The issue for decision makers will remain the same, however. That is, are the benefits of maintaining flexibility to alter allocations without compensation greater than the efficiency losses experienced by irrigators operating in a less certain investment environment?

Wealth effects

Economic efficiency aside, the three models presented above will have different impacts on the wealth of irrigators and the wider community. From the discussion so far, the question is, 'Who bears the cost of increasing environmental allocations?' Where the government purchases allocations from irrigators in the market to increase environmental allocations, the cost will be borne by the wider community. In contrast, irrigators will bear this cost where governments increase environmental allocations by administratively reducing irrigation entitlements without full compensation. Where irrigators are partially compensated for any loss in entitlements, the cost is borne by both irrigators and the wider community.

The aim of reallocating water between uses is to increase the efficiency of water use. If the reallocation of water is based on this premise, it will be theoretically possible for the beneficiaries of a reallocation (for example, the wider community in the case of a reallocation in favor of the environment) to compensate those adversely affected by the change (in this case, irrigators), and for the beneficiaries to still be better off.

However, there may be many practical difficulties with this process. For instance, it will be necessary to identify the winners and losers of any change and to quantify the gains and losses of these individuals. There will also be transaction costs in organising any financial transfer.

Conclusion

Governments can influence the security of irrigators' volumetric entitlements through their specification of the coverage and flexibility of property rights arrangements. If coverage is too narrow, irrigators' entitlements may be affected by the actions of third parties, while if property rights arrangements are ill defined, irrigators may face uncertainty about future access to water.

When considering the efficient level of coverage of a system of property rights, decision makers need to consider both the costs and benefits of extending water rights to additional users. What is more, the method by which rights are extended to other users has the potential to affect the efficiency of water use. For example, the extension of rights through blanket regulation of activities such as forestry is unlikely to achieve an efficient allocation of water. The alternative of requiring forest developers to obtain a water licence to establish forests may lead to a more efficient allocation of water, with foresters having to compete for water in the market in order to obtain a licence in regions where water is fully allocated. Whether it is cost effective to monitor and enforce licensing arrangements, however, will need to be considered.

The issue of which of the available property rights models (or mix of models) is preferable in a changing world will also confront decision makers. This will involve trading off the cost of providing more security to irrigators when governments purchase environmental water in the market against the costs of sovereign risk, rent seeking and negotiation when governments choose to administratively reallocate water without compensation. The preferred model will be one that allows water to be reallocated between alternative uses to reflect changes in demand at minimal cost.

Irrespective of which model is chosen, however, it is important that governments clearly specify the allocation rules, thereby reducing uncertainty and allowing irrigators

to manage their risk as effectively as possible.

Finally, the operation of an effective water market has the potential to reduce the opportunity cost of transferring water between uses. For example, if water is administratively transferred to the environment, a market will allow the remaining water available for irrigation to be transferred to activities that offer the highest returns.

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