THE UNIVERSITY OF MELBOURNE

Melbourne Institute Working Paper Series

Working Paper No. 18/05

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MELBOURNE INSTITUTE
of Applied Economic and Social Research

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Melbourne Institute Working Paper No. 18/05

ISSN 1328-4991 (Print)
ISSN 1447-5863 (Online)
ISBN 0 7340 3197 1

December 2005

*This is a revised version of a paper presented at the Industry Economics Conference, La Trobe University, September 2005, and at the Productivity Commission, September 2005. I gratefully acknowledge the many useful comments received in these presentations when revising the paper.

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Abstract

Developing the institutional details for markets which will improve the allocation of scarce water as proposed in recent government initiatives is still a work in progress, and the designers face many challenges. Differences in the relevant market time interval, the important effects of geography on costs, and differences in the forms and extent of market failures suggests a system of three property rights rather than a single property right system. Specifically, it is proposed that there be a market for water at source, for water delivery, and a water use licence to capture differences in external costs. For water at source, a dual system of water entitlements with different levels of supply security is proposed. The public good nature of most benefits provided by environmental flows requires direct government intervention informed by ecological assessments and non-market valuation of these services. Water treatment and delivery infrastructure costs should reflect at least operating costs and scarcity rents when capacity constraints are reached. The importance of natural monopoly calls for regulatory oversight over infrastructure fees. A system of water use licences based on one of regulations, taxes or tradeable permits is proposed to internalize the different regional and water use external costs of water use.

1. Introduction

Australia has begun on a path of developing secure and transparent property rights and competitive markets to allocate and to reallocate scarce water among some, but not all, of the competing uses. From the time of European occupation through to the 1970s, most water was allocated on a first-come-first-served basis at a near zero price, and with very restricted opportunities for mutually beneficial trades. At least for the consumptive uses of water (namely water used by households, industry and irrigators), the coordinating role of competitive market prices has been seen as a good way to reallocate water from low value to higher value uses, with several supportive national and state level government initiatives. However, there are still many unresolved issues in defining property rights, and there remain many restrictions on the transfer of some water rights, particularly over time and across regions. Also, there are a number of externality and natural monopoly market failures with the use of water for consumptive uses, and many of the environmental uses of water have public good properties, which in combination provide compelling cases for some forms of government intervention as part of a package of market reforms. Considerable institutional design is needed in developing an appropriate mix of markets and government intervention to improve the allocation of water and to provide appropriate investment incentives.

This paper seeks to review the path of market reforms so far, to examine some of the remaining challenges and options for completing the task, and in some cases to suggest the way forward to improve the allocation of scarce water among competing uses. Section 2 provides a brief historical description. The usefulness of competitive markets, and some market failure limitations, for allocating water and for guiding the choice of associated investment decisions are presented in section 3. Challenging issues and some of the mechanism design options for specifying water property rights, for infrastructure to treat and deliver water, and for accommodating externalities associated with the use of water for some consumptive purposes are evaluated in section 4. Section 5 considers

some of the approaches to allocate and to manage water for environmental flows to provide largely public good services. A final section 6 draws some conclusions about needed institutional changes if markets are to be more effective in allocating water in Australia in the coming decades.

2. History

Up to the middle of the twentieth century, with the exception of periodic drought years, water was considered a plentiful resource and little attention was given to its efficient allocation. As described in more detail in Davidson (1965), Harris (2005) and others, land and water rights were treated as a joint property right, these rights were allocated on a first-come-first-served basis, and water was provided at zero or at near zero prices. Except for drought periods when quantitative restrictions on use were announced, supply was unlimited, and governments funded new dams and delivery infrastructure to augment supply as required. Very little if any consideration was given to the allocation of water to provide environmental services.

From about the 1970s public perception grew that Australia was moving into a mature water economy stage where demand was exceeding supply at ruling near zero prices. Further, the adverse results from benefit cost analyses and growing concern for the environment began to place a brake on the attraction of constructing more dams.

In recent decades, further growth in demand for water for households, for industry and for irrigation, and an emerging politically vocal demand for water for environmental flows, began to show up in evidence of marked differences in the value of water in different uses. The different uses were not just between the broad uses of water for irrigation, city households and industry, but also between the irrigation of different crops, and further between different farmers in different regions and using different irrigation techniques growing the same crop. Today there is also a growing awareness that the value of water allocated to environmental flows varies widely with the different packages of environmental services provided by different flows. That is, against a background of limited water supplies and growing demands it became more generally recognized that

the historical pattern of water allocation was far from efficient, and that the magnitude of its inefficiency was growing.

From the 1990s to the present, the intent of government policy, if not its actions, has been to move to greater use of market forces for the reallocation of water from lower value to higher value uses. A Council of Australian Governments (COAG) agreement of 1994 was a landmark decision to separate water rights from land rights, to move to consumption pricing and full cost recovery of water, and to facilitate the trade of water. The National Water Initiative (NWI) of 2004 gave a strong push for the development of a more comprehensive set of water property rights and of greater trading of permanent water and of water across regions. State governments, and in particular the Victorian government Green and White papers of 2003 and 2004, have complemented the NWI and have fleshed out some of the institutional details for the development of and implementation of more effective water markets. At the same time, a number of decisions have been made to cap the withdrawal of water for consumptive uses and to maintain and in some cases to increase the allocation of water for environmental flows.

Certainly there has been much progress in the use of markets to reallocate water to higher value uses, but much remains to be done. In urban areas considerable progress has been made in shifting to cost based pricing. However, the inclusion of an opportunity cost component for water, including for environmental flows, in setting prices remains rudimentary. Also, as Edwards (2005) argues, the increased use of regulatory measures to reduce urban consumption results in efficiency losses. In the large irrigation usage of water, markets for the allocation of water within a season and within a region are reasonably well developed. However, the poor state of development of property rights over longer term entitlements to water and infrastructure, together with a large number of restrictions on inter-regional transfers, has hindered the application of markets for the transfer of permanent water entitlements and the transfer of water between regions. In Victoria in 2003 for example, the NCC (2003) estimated that 3 to 8 % of irrigation water was subject to temporary trades and less than 1 % to permanent trades. In general, irrigators now pay at least variable delivery costs. There is considerable evidence,

admittedly much of it anecdotal, that the prices paid for water by different irrigators vary widely across different users. To a large extent current government policies continue to separate or balkanize the urban and rural water markets, and the separation was made explicit in the Victorian White Paper (2004), but Adelaide is a notable exception in having purchased water on the market from up stream irrigators. Allocations of water for environmental flows are essentially ad hoc quantitative political determinations. Rather than political decision making on building new dams of the first half of the twentieth century, the new political game is to use public funds with no supporting benefit cost studies for projects to increase the effective supply of water to be allocated to environmental flows; and where market purchases from existing water users might be more cost effective.

3. Water Markets and Allocative Efficiency

From an efficiency perspective, limited water is allocated efficiently when marginal social benefits are equated across the alternative uses and users of water. Alternative water uses include irrigation, industry, housing and the environment, and ultimately these uses provide food, electricity, showers and protection of riverine flora and fauna, etc which enter peoples' utility functions. The marginal social benefit is a gross benefit less the marginal social costs of water treatment, delivery and disposal, and less any marginal external costs of water use. In the absence of any market failures, marginal private benefits equal marginal social benefits, and with private decision makers equating marginal private benefits with the market clearing price, market prices provide the coordinating role to achieve an efficient allocation of water.

Further, market prices also provide signals to the private sector on the choice of investment projects. Water investment projects could include new dams, improved delivery infrastructure, new irrigation technology, R&D into water saving technology, and so forth.

While a system of well defined water property rights and competitive markets seem a very effective institutional arrangement for the allocation of most consumptive uses of

water, the reality is that there are a number of significant areas of market failure which provide a prima facie case for government intervention in the allocation of some water resources. Most consumptive uses of water for irrigation, by households and by industry have private good properties of rival consumption and low costs of exclusion. For these uses, a market with well defined property rights supported by quality information and a binding legal system can achieve efficient allocation and investment decisions. By contrast, many of the services provided by environmental flows, including the existence and option values associated with protection of flora, fauna and biodiversity, and the passing on of heritage to future generations, have classic public good properties of non rival consumption and high costs of exclusion. While competitive market forces result in the efficient allocations of private goods, they result in free riding and the under provision of the public goods. That is, an allocation system based on market forces alone would allocate too much water to consumptive uses and too little to environmental flows.

Some uses of water may involve external costs which would be ignored in the prices generated by markets. Waste water from households and industry generates mostly point forms of pollution. Even here, the magnitude of the marginal external cost often will vary widely, depending on the water use, any treatment, and on the assimilative capacity of the environment. With some irrigation uses of water, surplus or run-off water can involve pollution to underground water, augmentation of downstream water tables and increased salinity. Typically such pollution is of a non point form, it is difficult to measure, and the time lags and geographic differences between water use and external cost can be long and diverse. To the extent that the external costs of different uses of water vary with the use, market forces will allocate too much water to the relatively high polluting uses and too little to the relatively low polluting uses.

The pricing of infrastructure to process and deliver water, and investment in delivery infrastructure, often will confront problems of market failure. First, because of the magnitude of economies of scale, relative to demand, much water delivery infrastructure has natural monopoly characteristics. Second, investment in the infrastructure usually involves large, lumpy infrequent outlays, which, once incurred, become sunk costs.

Third, in many cases both the investment outlays and the operating costs for water processing and delivery infrastructure have common property cost properties, and with large numbers of users of a particular infrastructure unit, costs of club good negotiations can be expensive. Each of these characteristics provide challenges in market design and policy intervention if efficient allocations are to be reached.

Two other properties of the market for water are relevant in considering different institutional options. First, a key characteristic of Australian water is the extreme variability from year to year in natural rainfall as it affects both water supply and water demand. Second, there are a number of important areas of imperfect knowledge which must be faced by policy intervention. The prospect of climate change means there is uncertainty about the parameters of the seasonal flow probability distribution functions for the future. Current available knowledge on the ecological effects of different environmental flows on the supply of environmental services supplied is limited, and then estimates of the marginal values members of society place on changes in environmental supplies are few and far between. These and other information limitations should be recognized in the design of a mixed market and government intervention model for the allocation of water.

4. Some Issues in Water Market Design

This section considers some of the issues and options in the design of an effective water market that would bring to fruition the ideals of the 2004 NWI. While the section primarily is concerned with the allocation of water for consumptive uses with private good properties, it also could embrace the allocation of property rights for water for environmental uses.

An initial question is the scope of a water market, or markets. The marginal social cost of each and every water use includes the opportunity cost or scarcity value of the water at the dam wall (and with most investment costs being sunk costs), treatment and delivery costs (to include seepage and evaporation), and any external costs associated with water use. As noted by Heaney et al. (2005), to just define water property rights and effectively

to ignore issues of supply variability, water delivery costs and external costs with water use likely will result in very large inefficient transfers of water use. In principle, each unit of water use could be demarcated by the combination of characteristics of water, delivery and externality. This could result in a large number of water products with different characteristics, and thin markets for each product category. Another option is to consider three sets of market property rights for water, for delivery and for conditions on use, and with each water use requiring one of each of the three categories of property rights.

A three property rights system has a number of potential advantages. In the case of water measured at source or the dam wall (rather than the current practice of at the delivery or use point), it leaves a thick market with a large number of buyers and sellers for a homogeneous product, and this market could have a market period as long as a season or year. Attention in the specific water property right specification then can focus on the variability of supply and the allocation of risks associated with supply variability. Costs for the treatment and delivery infrastructure have important geographical dimensions, not only distance and topography, but also in the case of limited capacity relative to demand the meaningful market period may be very short, perhaps a day in peak demands. Because large parts of the infrastructure system have natural monopoly properties, government ownership or regulation is likely to be required. A usage license could involve regulations, taxes or tradeable permits to recognize external costs. Because the pollution costs of water use vary with location, water use, and water use technology, the required corrective regulation, tax or tradeable permit also varies widely. An advantage of the three property rights system is that it unbundles property rights with different geographic dimensions, with different time dimensions, and with different regulatory intervention requirements.

Sometimes it is argued that water, or at least those uses required for basic human survival, is special and should not be treated as a market commodity, and that on social equity grounds all people should be allocated a basic water entitlement, and often also at a zero price. Of course, similar arguments could be made for basic food, health, education, and other “necessities” of life. In the context of the total consumptive use of

water in Australia, such basic uses represent less than 5 per cent of the total, the demand for such uses likely is highly inelastic, but also for the majority of Australian households this basic demand is an inframarginal water demand decision. Then, granting all citizens a basic entitlement of water, even at a price way below a market clearing price, would not influence the efficiency argument for applying a market system to allocate the remaining water.

4.1 Water property rights

Good water property rights provide for unambiguous ownership and uses of water, the benefits and costs of use are explicit, transparent and clear, and there is freedom to buy and sell at the going market price. Such property rights require a legal basis, an official and transparent recording system for the rights, and a system of water accounts with well understood and believable measures of water availability and use. Current property rights in general do not meet these criteria. A challenge for the NWI is to develop a consistent set of property rights for all actual and potential users of water in a catchment, and to facilitate investments to link potential trades between different catchments.

For each water catchment, as discussed by McColl and Young (2003), it is likely that water property rights will have an entitlement, a bit like a corporate share representing a long term property right, and for each market period entitlements will carry a water allocation, a bit like a dividend per share, specifying the available water per entitlement for the particular period. Trade can be temporary for allocations, or entitlements can be traded for longer term or permanent transfers of ownership. Because many of the uses of water require complementary investments in long life capital items, including household appliances and gardens for households, plant and equipment for industry, and irrigation systems and perennial crops for irrigators, it is necessary for the development of effective Australian water markets to establish a system of longer term water property rights or entitlements.

At least two ideas have been suggested in defining water property rights that recognize the natural variation in the available supply of water from year to year. The simplest

option would have entitlements expressed as a share of the available supply, with the allocation being a share of the available water each season. Another option would have two types of entitlement, namely a high priority volume entitlement with a high reliability of supply or allocation each season, and a lower priority entitlement for the residual available supply. In a world of zero transaction costs, a Coasian theory result is that both systems give an efficient allocation. However, given the reality of significant transaction costs, and given that there are different sets of water users with different valuations on the reliability of supply (eg drinking water versus gardens, annual crops versus perennial crops, and different degrees of risk aversion), the system with two types of entitlements with different levels of security has advantages by economizing on transaction costs (Freebairn and Quiggin, 2005). For either system, the market price per water allocation each season will rise and fall with the availability of water, and with demand variations, and the entitlement prices will reflect the discounted stream of expected prices of future water allocations.

The initial allocation of water entitlements raises a number of options. From the perspective of efficiency, as pointed out by Coase (1960), with good property rights in a world of perfect knowledge and zero transaction costs the initial allocation is not a barrier to an efficient market. Current government policy to allocate entitlements on a "grandfathering" arrangement (ie to allocate the property rights to current water users) has the virtue of perceived distributional equity, given that some have purchased entitlements at market prices in recent years and others believe that they are the owners even though the legal basis for that perception is weak at best. Ideally, the initial allocation of water property rights would be made to current up-stream water users as well as to current down-stream water users so that the water market efficiently allocates limited supplies between all actual and potential water users.

4.2 Treatment and delivery infrastructure

Services for the treatment and delivery of water to different users need to be priced appropriately to achieve allocative efficiency and to signal desirable investment opportunities. So far, both the discussion of and policy towards the use of markets for the

pricing of and investment in water processing and delivery infrastructure are in an early stage.

Marginal costs of water delivery should include a charge for variable costs of operating and maintaining the infrastructure, an annuity value for any new investment and major refurbishment expenses, and where and when capacity constraints are reached a scarcity rent to ration the capacity. Historical capital costs are sunk costs, and they would not be included in usage charges. For business financial sustainability reasons, and perhaps for equity reasons, it sometimes is argued that these sunk costs should be recouped in some form of access charge (which apart from decisions to enter or leave does not affect marginal costs). Differences in water losses associated with evaporation and seepage incurred in delivering water to different locations could be included in marginal water delivery costs. Alternatively, another option proposed by Beare et al. (2005) and others for recognizing differences in water losses in distribution by destination is to use a set of administered exchange rates for effective water delivered relative to the source in the market for water entitlements[1].

A challenging issue in the pricing of water treatment and delivery infrastructure is that many of the costs have common property characteristics. That is, for the different users of a particular piece of non-congested infrastructure, eg a canal, the operating and investment costs are essentially the same whether one, several, or all of the potential users take water. In effect, from one user to full capacity use of the infrastructure, the marginal cost of additional water delivery is zero, and for efficiency the appropriate infrastructure use charge is zero. In order to meet a financial viability outcome, the Victorian White Paper (2004) proposed that water delivery rights be tied to the land (in a type of "grandfather" arrangement) and that all actual and potential users incur their share of the infrastructure delivery costs as a fixed fee, primarily on the argument that the water delivery infrastructure provides a valuable option which is capitalized in a higher property valuation. Such an arrangement should overcome many of the often stated concerns about stranded assets if some but not all users of a particular piece of infrastructure sell their water entitlements. The use charge becomes non-zero only for

either closure of the whole system or for an investment to expand capacity. Then, the closure or investment decision requires obtaining a group consensus which may involve strategic behaviour and high transaction costs.

Almost always the water delivery infrastructure will involve economies of scale and natural monopoly characteristics. To avoid monopolistic exploitation and inefficiency requires government intervention, including supporting a water catchment cooperative, direct government ownership and setting prices at marginal cost, or by regulation by price ceilings on private suppliers.

4.3 Water use licenses

Many of the uses of water involve pollution or external costs. Examples are household sewage, industrial wastes, and irrigation additions to the water table and enhanced down stream salinity. The magnitude of the external cost per unit of water use varies widely with uses and location, and there are a number of operating and investment options which users can adopt to ameliorate the magnitude of external costs.

Water use licenses provide one way to internalize the pollution costs. The license could take the form of a regulation, for example requirements to treat sewage or not to use flood irrigation, or of taxes on the externality, for example a tax per ML of sewage or per ML of irrigation of rice in region X, or the requirement to purchase pollution permits, for example per ML of sewage or per tonne of salt emission. Where the pollution is of point form, such as household and industrial sewage, measurement may be relatively easy and at low cost. However in other cases of non-point pollution, for example in most cases of irrigation, direct measurement of the pollution at source may be difficult and costly. Then, the quest for lower transaction costs may need to focus on easier to measure inputs, such as water, outputs, such as tones of rice, or production processes, such as flood irrigation, but these measures are only loosely correlated with the externality quantity. Sometimes the second best solution may be worse than allowing the externality. Considerable empirical work is required in helping to design water use licenses for different water uses and circumstances in order to incorporate the wide range of different

forms and levels of pollution costs of different water uses in an effective market allocation system.

5 Environmental Flows

Allocating water for the provision of environmental goods and services is at the forefront of the current policy debate, including the NWI. Most environmental benefits associated with the preservation of unique flora and fauna, and for heritage for future generations, have classic public good properties of non rival consumption and high costs of exclusion. As a consequence of the free-riding behaviour, a competitive market would allocate too little water for the environment and too much to uses with private good properties, and there then is a prima facie case for government intervention. Ideally, an efficient allocation of water for the environment would equate the sum of marginal benefits to different members of society of the public good environmental benefits with the market price of water in the market for private good uses of water by households, industry and irrigators.

Many challenges have to be surmounted to obtain estimates of the marginal social benefits of allocating more (or less) water to the environment. Nevertheless, the general strategy for obtaining the estimates is well known. First, the relevant base comparison point is the current allocation pattern. Past decisions represent sunk costs. Second, ecological information is required on the changes to biodiversity, heritage, recreation and other environmental products which would be provided, relative to the status quo, of changes in the water allocated to the environment. In this context, there are many difficult questions about the form and timing of environmental water flows, and about cost effective ways to achieve particular increases in the output of environmental services. Third, individual valuations of the marginal private benefits of changes in the biodiversity, heritage and other environmental services provided from the above second step of the analysis are required. Contingent valuation and choice modeling techniques, while contentious, are available for this step (see, for example, Bennett, 2005). We can expect the marginal private values of environmental services provided by water to change over time with changes in the available information to households, with increases in their

income, and with changes in tastes and attitudes. Fourth, social marginal benefits are obtained by summing the individual private benefits. Clearly, each of these steps involves imperfect knowledge. Inevitably, in reality, as is the case with government expenditure allocations to other public goods, including defence, national parks and basic research, rent seeking by lobby groups and the political system generally likely will play a pivotal role in determining the water allocated for environmental services.

Several options for government intervention and for the administration of allocations of water for the environment might be considered (see also Ladson and Finlayson, 2004). Regulatory options include caps on the water available for market allocation for consumptive uses, either as a volume or as a share of available supplies, or minimum volumes or shares to be allocated for the environment. Presumably procedures for modifying these regulations in the future also should be made as explicit and as transparent as feasible. The actual choice of regulation would then impinge on the specific definition of tradeable water property rights, both for the entitlements and allocations. Alternatively, water property rights could be allocated to an environmental trustee who has the responsibility and is monitored to meet society goals on the provision of environmental goods and services. Some of the challenges and an economic evaluation of these institutional options for an environmental manager are discussed by Eigenraam et al. (2004); suffice to say, they conclude that the task is far from easy. Should in the future government on behalf of society wish to increase the allocation of water to the environment, the trustee would be given additional public funds to buy from the market water rights from current consumptive water right owners.

6 Conclusions

Australia is only a part of the way down the path in developing effective markets to allocate water and to signal associated investments, but in many respects it is a world leader. Some of the challenges arise from the extent of market failures, including the public good characteristics of environmental services, the natural monopoly and common cost characteristics of most water treatment and delivery infrastructure, and the pollution external costs associated with many uses of water. A mixed market and government

intervention system has to be developed in the context of wide variations in water supply and in the context of imperfect and evolving information about many basic hydrological and ecological facts.

To accommodate the effects of differences in social costs associated with geography, in market time intervals, and in the extent and form of government intervention, it is proposed that the market for water be decomposed into three separate components. These are the establishment of property rights for water for all uses, including for environmental flows and for consumptive uses by irrigation, industry and households, at the dam wall; a regulated pricing system for the provision of infrastructure for water treatment and delivery; and a system of use licenses to internalize the external costs of water use pollution.

Effective water markets to encourage the more efficient allocation of water among alternative uses and users by households, industry and irrigators (and environmental trustees if the government intervention is to allocate general water rights for the provision of environmental services) requires the specification, allocation and management of far better water property rights than is currently in place. Entitlements need to have a relatively long life to facilitate the complementary investments involved in water use; the allocation of risks for supply volatility should be transparent and explicit; and the entitlements should be fully transferable. A dual property rights system with a high security volumetric right and a lower priority share of the residual supply is proposed. The system of grandfathering the initial allocation of water rights, both for up stream and for down stream water users, will in time lead to efficiency whilst according with perceptions of equity and political saleability.

Extensive government involvement in the pricing of the infrastructure for treating and delivering water seems necessary because of natural monopoly. The importance of common costs, not only investment costs but also operating costs, raises interesting design and pricing challenges. One solution is to impose a charge, effectively a fixed cost, on all actual and potential water users served by a particular unit of infrastructure

for the option value provided by the infrastructure. Where the capacity of infrastructure is fully utilized, the marginal charge would include a scarcity rent to both allocate the limited capacity and to signal the benefit of an investment expansion.

External costs of pollution associated with the use of water vary widely by use and by location. A system of user licenses which involve regulations, taxes or tradeable permits is proposed to internalize the external costs.

Through the sum of the market price of the water property right, charges for the infrastructure and the costs associated with the user license fee, different water users face the marginal social cost of their water use. Given the market price, each and every water user can compare their private information on the value of water to them in current uses to decide whether to buy or to sell, and on whether to invest.

Endnote

[1] In principle and under certainty, the two options can be specified so as to have the same effect on the total cost of water to the user by destination. Where the price of allocated water varies by year, as is likely to happen, the exchange rate need not change but the water delivery charge for seepage and evaporation would vary with the water price.

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