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Irrigator preferences for water recovery budget expenditure in the Murray-Darling Basin, Australia

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ABSTRACT

This study presents results from a survey of southern Murray-Darling Basin irrigators about the percentage of funds they would allocate towards a variety of current and hypothetical trade-off choices for recovering environmental water. The findings, allowing for state-based differentials, suggest irrigators marginally prefer infrastructure expenditure above the sum of a set of market-based options (namely water entitlement purchasing, temporary water market products and exit-based packages). However, their infrastructure preference weighting is less than current budget expenditure, and use of market-based options has higher support from irrigators than current policy recognises. Further, analysis of past and current infrastructure and market-based water recovery expenditures reveals large price-per-megalitre disparities, which may be explained by diminishing marginal returns. Targeting expenditure in line with preferences of irrigators may result in increases in economic efficiency.

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Introduction

Water scarcity problems are increasing around the world, with 3.9 billion people predicted to live in river basins affected by severe water stress by 2050 (OECD, 2012). Given that there are a number of options by which governments can deal with water scarcity problems, increasing attention needs to be paid to the trade-offs involved with policy choices. The Murray-Darling Basin (MDB) in Australia provides a key example of the need to address issues of over-allocation and environmental degradation, and the costs involved in choosing different policy options. Policy initiatives since the 1980s have sought to enhance economic efficiency and sustainable allocation in water through policies including a 1997 cap on further water extraction, a 2004 National Water Initiative (NWI) that changed access rights to consumptive shares, and environmental water recovery programmes such as *The Living Murray* initiative (Musgrave, 2008). During record low river flows the Australian Government passed the *Water Act* (2007), making provision for the Murray-Darling Basin Authority (MDBA) and a ten-year *National Plan for Water Security* (NPWS) (Howard, 2007). The NPWS gained additional programme funding in 2008, and was renamed *Water for the Future* (WFF). These reforms were aimed at identifying sustainable levels of water extraction. Table 1 summarises the major differences in programme funding: WFF initially allocated $3.1 billion for water entitlement purchases (*Restoring the Balance — RtB*) and $5.8 billion for infrastructure investments (*Sustainable Rural Water Use — SRWU*). Water entitlements are otherwise known as permanent water, and involve perpetual access to a share of water from a specified consumptive pool.

In 2010 the MDBA completed its' sustainable extraction assessment and produced a Guide to a proposed Basin Plan. The Guide suggested that 3000–4000 gigalitres (GL) were needed to sustain key environmental sites (MDBA, 2010), which created negative reaction in Basin communities (Australian Parliament, 2011). This reaction led to criticism of WFF's budget emphasis on market purchases to recover environmental water. A parliamentary inquiry was established to consider the Guide's impact and report on future programme arrangements (Australian Parliament, 2011). Inquiry submissions from peak-bodies claimed WFF budget expenditure did not reflect irrigator preference for infrastructure investments over water entitlement purchases and exit/adjustment packages (Australian Parliament, 2012). A key recommendation was that strategic buyback should be the focus of future acquisitions, limiting the use of market tenders. However, it is a fact that up to 17% of MDB irrigators sold water entitlements between 2008 and the end of 2011 (Wheeler and Cheesman, 2013), and many more irrigators are considering selling water in the future (Wheeler et al., 2012).

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Table 1
Water recovery policy summary—*NPWS* and *WFF*[a]

Policy	Water purchases (RtB)	Urban water or desalination	Improved water information	Exit packages	Township water security	Grey and rainwater initiative	Infrastructure efficiency investment (SRWU)
NPWS	$3.0b	$600 m	$480 m				$3.13b off-farm $1.64b on-farm $620 m metering $500 m operations
WFF	$3.1b	$1.5b	$450 m	Total: $10.05b $57.1 m[b] Total: $12.9b	$250 m	$250 m	$5.8b across areas similar to above

Sources: Howard (2007), Wong (2009), Treasury (2009).

[a] Figures do not add exactly due to incomplete funding information, and do not include additional funding in 2010/11 of up to $310 million per annum from 2014/15 to bridge any remaining gap between WFF and the final MDB Plan.

[b] In 2009, exit package funding increased to $107.1 million.

Potential disparities between irrigators' preferences for water buyback and the position put forth by irrigation industry peak bodies motivates our assessment of water recovery expenditure allocation and programme cost-effectiveness. We view the problem as one of government seeking to optimise its objective function consisting of regional support and cost effectiveness of water recovery. In this political economy framework regional support is measured by rural community programme preferences, while cost-effectiveness is measured by megalitres (MLs) of water recovered per dollar invested. Solutions are thus possible along a production frontier between regional support and cost-effectiveness. Given media reports and submissions from federal parliamentary inquiries, regional support is assumed to increase from less buyback and more rural water infrastructure investment, representing an optimal efficiency/distribution trade-off solution. Although Basin communities benefit directly from buyback and infrastructure investment, following Tullock (1989), rent-seeking is likely to be frequent in large investments benefiting specific groups. If regional support arises from infrastructure investment, regardless of cost-effectiveness, then it may represent an optimal political solution. But, this also creates inefficiencies from expenditure on less cost-effective programmes including larger transaction costs (Marshall, 2013), path dependency (for irrigators and infrastructure operators) from higher fixed capital works and higher opportunity costs for future market recovery. While budgets for agri-environmental reforms have increased in recent years information about varying local demand for policy interventions remains scarce (Schläpfer, 2007). Further, the success of agri-environmental programmes depends largely on their acceptance by all major stakeholders, where farmers are often the largest group (Prager and Nagel, 2008). In this paper we seek to provide indirect evidence of whether there is rent-seeking in the prevalent views towards water allocation expenditure. We do so by presenting representative survey data of actual irrigator preferences for water recovery expenditure in the southern MDB (sMDB) and providing a detailed analysis of $/recovered ML data to measure cost-effectiveness of the two programmes. The value of our paper is that our results contribute to assessing distributional aspects of support/efficiency trade-offs across policy options. It illustrates the difference between information sets that governments rely on to choose policy options and actual stakeholder preference reality, which is relevant for many environmental policy management issues around the world (Hurlimann et al., 2009).

Current water recovery programmes in the MDB

Previous investigations of policies to reallocate water to environmental use focused on market-mechanisms and water use efficiency capital investments (e.g. Qureshi et al., 2010a). Here we first review the four existing programmes that have been used (e.g. water entitlement purchases, off and on-farm infrastructure investments and standard irrigator exit packages). This paper also discusses two hypothetical water recovery programmes that were included in our examination of irrigator expenditure preferences; namely temporary water market purchases and a revegetation farm exit package. The inclusion of these two additional options resulted from the authors' considerable ongoing consultation with irrigators over a number of years. These six options can be broken down into two broad policy choices: i) market-based purchases (includes water entitlements, temporary products and both exit packages, as exit packages involve the sale of water entitlements); and ii) irrigation infrastructure upgrades (on-farm and off-farm).

Water entitlement purchasing

Water entitlement purchasing (buyback) is a major policy option for recovering environmental water in the MDB. Water purchasing (both temporary and permanent) has been used in at least 12 western US states since the late 1980s (Wheeler et al., 2013). In Australia buyback gained national significance in the early 2000s. As of 31 December 2012, RtB had recovered an average annual water yield of 1117 GL across the MDB (DSEWPC, 2013). The costs of buyback have generally averaged less than $1500/ML (Wittwer, 2011).

Opponents of buyback cite negative social and environmental consequences from the policy. For example, untargeted purchasing may link poorly with environmental water requirements, particularly where ecological needs are not well established or are uncertain. Further, untargeted purchases may produce stranded asset or 'Swiss-cheese' effects from ad-hoc infrastructure removal and the spreading of operational costs across a reduced irrigator membership (Australian Parliament, 2011). However, Wheeler and Cheesman (2013) surveyed up to one fifth of all sellers to the RtB and found that 60% of water entitlement owners in irrigation areas kept their delivery rights after selling water, contradicting the view that stranded assets are being created. However, farm exit may also lead to rural depopulation and an increased community-expectation burden on remaining farmers (Williams et al., 2009). Associated reductions in food and fibre production have also been predicted, although studies of the economic impacts of water purchases find that sellers often benefit from reducing debt and investing proceeds of sales back into the farm (NWC, 2012).[1]

[1] A range of assessments into Basin Plan impacts on rural communities have been undertaken. These studies find GDP would decline between 0.2% (Wittwer and Griffith, 2011) and 0.7% (DAFF, 2011) under 3000GL recovery; but trade and dryland farming would mitigate most losses. Irrigation-dependent areas may experience larger impacts, but most regions could expect short-term negative impacts where: 1) adjustment was enhanced by unrestricted intra-regional trade; 2) cap barriers to water entitlement selling were removed; and 3) targeted buyback within

Specifically, Wheeler and Cheesman (2013) found that 70% of RtB sellers continued farming with only 50% of them reporting post-water sale reductions in farm production due to many initially having surplus water entitlements, or adapting to farming with less water.

Off-farm infrastructure

The aim of off-farm infrastructure improvement is to reduce evaporation and seepage losses from water delivery-system storage, conveyance and drainage components. Where irrigation losses contribute minimal return-flows, efficiency improvements can be cost-effective (Qureshi et al., 2010a). Community advantages from improvement projects include labour or capital injections, improved property values, and enhanced secondary/tertiary sector viability and adjustment capacity (MDBA, 2012). For these reasons governments often focus on this approach to water recovery.

Opponents question the water savings generated by infrastructure investment. They also signal potential higher farm variable costs (driven from increased electricity costs), as well as higher infrastructure access, operating, maintenance and refurbishment charges (Australian Parliament, 2011, 2012). Further, viable projects are difficult to identify. Many fail benefit-cost tests or contradict NWI agreement objectives (Crase and O'Keefe, 2009) and previous irrigator or infrastructure operator investments mean there may be limited additional gains (WMI, 2009). Finally, water recovery from infrastructure investment may be constrained by questionable seepage/evaporation loss reductions (Quiggin, 2006).

On-farm infrastructure

On-farm irrigation investments involve technological improvements in soil-moisture monitoring, irrigation timing, application techniques (e.g. drip-irrigation) and system reconfiguration (e.g. water-reuse). Advantages include greater irrigation flexibility/viability, reduced labour inputs and nutrient runoff, and production stability from more efficient water supplies. In Australia, public subsidies have often been provided to irrigators to motivate investment (Qureshi et al., 2011). Full-cost water pricing should drive irrigator efficiency investment, but peak-bodies predict under-investment where supply reliability remains uncertain (NIC, 2010). Producer surpluses occur when public subsidies increase the value of water entitlements and supply reliability (Cox and Warner, 2009). Current on-farm efficiency investment differs by state and is a result of divergent commodity, farm-type and water entitlement ownership conditions. For example, during the 1970s South Australia (SA) addressed negative over-allocation impacts by ceasing further water entitlement approvals and promoting system-efficiency upgrades (NWC, 2011). Water entitlement limits drove alternative off-farm supply arrangements (e.g. piped systems), resulting in lower irrigation investment demand.

Standard irrigator exit packages

Exit packages received relatively minor WFF funding and have only been available for a short period (see Appendix 1 for more details). The programme included purchasing all water entitlements, employment advice, new skills/training and the removal of any permanent plantings and associated irrigation infrastructure (Wong, 2009). Land acquisition was not part of the programme. Exit packages are usually attractive to irrigators near the end of their working life, who have invested or worked off-farm, or whose farming operations are economically marginal (Qureshi et al., 2010b). Exit package critics argue that land purchase inclusion generates environmental benefits, while unutilised land disadvantages regional economies (WMI, 2009). Advocates suggest budget expenditure on water purchasing is misplaced, and that money should be spent on capital improvements (Australian Parliament, 2011). But, previous research indicates that there is demand for strategic buyback and exit packages (Qureshi et al., 2010b; Loch et al., 2012). Therefore, estimating irrigator preferences for a variety of water recovery options may provide valuable insight for recovery policies.

Survey design and methodology

Given evidence that irrigators are actively selling in different water markets (e.g. Wheeler et al., 2013), and questions regarding the representativeness of the position of irrigation peak-bodies, we designed a survey to ask how individual irrigators would like to see the WFF budget allocated. Based on the authors' previous experiences (e.g. Tao et al., 2011; Morrison and Hatton MacDonald, 2011), and as a result of focus group testing, directly asking these questions avoids difficulties with complex stated preference budget reallocation tasks. For example, we originally trialled obtaining budget preferences using a best-worst scale format in focus groups. However, irrigator feedback indicated that directly eliciting responses was the most appropriate approach.

Carson and Groves (2007) suggest questions with consequential outcomes in stated preference surveys provide agents the incentive to reveal their true preferences. Truthful preferences are also probable where impacts on public policy issues are perceived as likely (Vossler and Evans, 2009). Our survey provided an opportunity to potentially influence water policy, or at least a chance for individual voices to be heard. Many irrigators commented to the authors that they were glad to be able to express their views. Further, the survey offered no opportunity to increase the funds on offer, so the incentive to over-state preferences for funding was reduced. We also conducted checks to assess the effort irrigators put into their responses. However, although we have checked and controlled for strategic behaviour as much as possible, we cannot rule it out in irrigator responses. 'Socially desirable' responses may also be possible, for example, where irrigators answer mainly to align with social norms rather than as privately motivated individuals. But we feel that strategic behaviour is less likely in this context.

Data for the empirical analysis were collected via a mail-out survey to irrigators in 2011, which was augmented through links to existing datasets reported in Wheeler et al. (2012). The survey consisted of 26 questions gathering views on water trading, budget preferences, farm production and general issues in the MDB. The design was informed by focus groups with irrigators in SA and Victoria and from in-depth pre-test interviews with individual irrigators across the MDB. Final mail-out response rate was 66%. The following section outlines the two hypothetical policy scenarios for recovering water.

Hypothetical water recovery policy scenarios

Our first hypothetical policy scenario involves utilising temporary water market trade products for environmental recovery. This includes water allocations, water entitlement leases and option contracts. Water allocation trade has been widely adopted across the sMDB (NWC, 2012). In the US, short-term water leasing has accelerated recovery progress for environmental water and provided long-term solutions, wherein permanent water sales often follow. Supporters argue water leasing provides risk and

strategic irrigation districts was undertaken. These models used hydro-economic and/or hydro-ecological data; they did not examine stakeholder opinions.

Option	% of Budget
Permanent Water Entitlements	
Temporary Water[1]: Water Allocations/Entitlement leases/option contracts	
Upgrading on-farm irrigation infrastructure	
Upgrading off-farm irrigation infrastructure	
Standard Exit Packages	
Exit Packages and revegetation payments	
TOTAL	**100%**

Note: Please make sure your percentages add to 100%

Note: 1. Complete descriptions of each term were provided in the survey.

Fig. 1. Questionnaire example of current *WFF* budget expenditure.

uncertainty management options within the environmental water context and provides a way for farmers to supplement farm income, without incurring potentially negative externalities associated with water entitlement sales (Wheeler et al., 2013). Combined market approaches are currently being debated in Australia (CEWH, 2011). Wheeler et al. (2013) suggested many sMDB irrigators will participate in selling water for the environment if such trade is available, and that water allocation trade may more effectively match seasonal environmental water requirements. Combined approaches are also sometimes advocated by community and irrigation peak-bodies (e.g. NSW Business Chamber, 2009; NIC, 2010). Our survey therefore included this hypothetical scenario to estimate how much of the budget irrigators believe should be allocated to such strategies.

The second hypothetical option involves irrigator exit packages with revegetation payments. This option was based on an existing programme, the *River Murray Forest Project*. The hypothetical exit package combined standard exit package conditions with annual revegetation payments (e.g. \$300 ha^{-1} for planting native vegetation and controlling pests on previously irrigated areas). Participants would receive annual payments for ten years (see Appendix 1 for more details). A motivation to include this option evolved from recognition that ecosystem service provision remains an objective of the *Water Act* (2007). The development of this scenario was also a result of research that suggested many irrigators prefer a variety of alternative policy options, specifically focused on structural adjustment issues (Wheeler et al., 2013).

Survey questions

Within the survey, irrigators were provided with information about current WFF expenditure, namely:

> The Federal government released the *Water for the Future* program in 2008. The major aim of this program was to return water to the environment, with expenditures incurred over ten years. \$3.1 billion was allocated to buy permanent water entitlements from irrigators (*RtB*) and \$5.8 billion was allocated for expenditure on off-farm and on-farm irrigation infrastructure (*SRWU*). \$107.1 million was spent on the *Small Block Irrigators' Exit Grant Package* in 2009, with no other expenditure planned on exit packages at this stage.

Irrigators were then provided with detailed information about the six policy options, and were asked: "How do you think the Water for the Future budget for obtaining environmental flows should be spent? Please indicate the percentage of funds that you believe should be directed towards each option for recovering environmental water", and were instructed to make sure their responses summed to 100% (Fig. 1).[2] Additional survey questions gauged irrigators' awareness of current WFF recovery budget scope, and their views on the appropriateness of such expenditure.

Preference methodology

We used a range of mean percentage calculations by state, a weighted sMDB sample, an absolute coding of irrigator preferences, ANOVA F-test and post hoc tests, and coded qualitative comments to explore irrigators' budget allocation pReferences

Results

Survey quantitative analysis

There are distinct differences across responses by state in a descriptive analysis of the survey data. For example, in 2010/11 New South Wales (NSW) irrigators owned higher (lower) relative volumes of general (high) security water entitlements; used more water; and had higher levels of carry-over, debt and farm income. Further, differences in state water entitlement and allocation trade behaviour were observed with SA irrigators most likely to enter the market, followed by Victorian and then NSW irrigators. In total trade frequency terms, around a third of all sMDB irrigators traded water in 2010/11. These descriptive results are similar to other national survey results (e.g. NWC, 2012).

Table 2 summarises irrigator responses to the budget expenditure questions. Weighted average totals represent overall composition of sMDB irrigation farms, using irrigation farm data from the ABS (2011). Hence, more weight was given to NSW/Victorian answers in the overall figures. Overall, 12% of irrigators did not answer this question, with non-responses highest in NSW (14%) and lowest in SA (10%) – albeit state non-response differences were not statistically significant. Regression analysis of item non-responses to the expenditure question suggested education was the main explanatory variable. That is, irrigators with lower education levels were less likely to answer the expenditure question. Written feedback from non-respondents often stated a dislike for completing questions on finance and apologised for not completing that particular question. Other analysis of the responses suggested irrigators did not minimise survey effort (which occurs if respondents match questionnaire examples or allocate money all to one category). For example, less than 3% of respondents matched the questionnaire example, and only 7% allocated all money (i.e. 100% of funds) to one budget category. This suggests irrigators invested time and effort in answering the questions, and also signals a lack of strategic bias in the results.

Generally, Table 2 shows that sMDB irrigators prefer less expenditure on water entitlement purchases, with a weighted average across policy options of 21%. This is significantly less than the current one-third WFF expenditure on water entitlements, and somewhat proportionally matches with 2011 parliamentary inquiry strategic water purchasing recommendations. But, infrastructure expenditure preference (56%) is also less than in the current WFF budget (≈65%). Irrigators prefer that 10% of expenditure is spent on water allocations, and that exit package funding be increased (12%, with higher preference for revegetation exit packages). However, since exit packages involve permanent sales, irrigator responses overall suggest basically no reduction in the amount of money allocated to entitlement purchasing (e.g. 33% was preferred). But, it does suggest a desire by irrigators for water purchasing to be more strategic and targeted; something addressed by

[2] Where some preferences did not sum (5% of respondents), preferences were uniformly scaled up or down to sum to 100%.

Table 2
Budget expenditure preferences by state in 2011/12.

Water policy options	Mean percentage[a]				One-way ANOVA *F*-test[b]
	NSW (n = 176)	SA (n = 205)	Victoria (n = 154)	Weighted southern MDB average	
Upgrading on-farm infrastructure	32[c]	21	34	31	17.44***
Upgrading off-farm infrastructure	28	23	25	26	2.09
Water entitlement purchases	18	34	19	21	21.71***
Water allocations/entitlement leases/option contracts	12	6	11	10	3.95**
Exit packages and revegetation payments	6	11	7	7	4.69**
Standard exit packages	5	5	5	5	0.42

Notes:
[a] Calculations do not include 'no answer' responses.
[b] Represents the robust test of equality of means (Welch) due to heterogeneous variances.
[c] An underlined state mean percentage indicates they are not significantly different from another underlined state/s percentage(s) at $p < 0.05$ using Bonferroni post hoc comparisons.
* p-Value < .1.
** p-Value < .05.
*** p-Value < .01.

the Australian government in 2012 with more 'targeted' buyback strategies (Burke, 2012).

There are also distinct budget expenditure preference differences across states (as a percentage of money available) for water recovery alternatives included in the survey. SA irrigators are significantly different in their preferences to NSW/Victorian irrigators in most water recovery options (with the exception of off-farm irrigation infrastructure and standard exit packages). For example, SA irrigators prefer higher spending on water entitlements and exit packages with revegetation payments compared with NSW or Victorian irrigators, and less spending towards on-farm infrastructure.

This finding conforms to past SA moratoriums on water entitlements and off-farm irrigation infrastructure investments, making further SA infrastructure expenditure less attractive. As expected, irrigators overall prefer more on-farm infrastructure expenditure (where highest private benefits are derived). But, they do not increase expenditure towards infrastructure; with mean expenditure preferences of 31% for on-farm and 26% for off-farm expenditure. Overall, irrigator preferences were 56% for infrastructure and 44% for all types of water market purchases. This difference was highly statistically significant.

We also analysed budget expenditure preferences by categorising respondents. If a budget share was 50% or above it was coded as a one, and this indicated the individual prioritised expenditure towards the relevant category. This method of calculation found a slight increase towards irrigation infrastructure (57%) over market trade alternatives (43%).

Survey qualitative analysis

Irrigators were also asked to provide the main motivation for their budget preferences. Qualitative answers were coded and analysed, and categorised into two major expenditure groups (Table 3).

Just over 20% of irrigators did not provide any reason/s for their budget preferences. The most commonly articulated irrigator motivation was the need to improve irrigation efficiency (49%), particularly where irrigators benefited directly. For example, one such comment included:

> Government buying pushes the price of water up for others. The government comes into the market subsidized. Exit packages are insufficient and leave agricultural land dormant. Irrigation infrastructure is very out-dated and needs improving.

15% of irrigators allocating the majority of expenditure on trade and exit packages were driven by a range of policy options, or the belief that policy needed to be more flexible in some cases and targeted in others. For example:

> On-farm infrastructure money can be difficult to use in some circumstances, because of government restrictions.

Similarly, irrigators preferring expenditure in water markets were more likely to express a desire for retirement options:

> Exit packages have to give people exiting irrigating industry a future, not just enough to clear current debt.

Food security and production reasons were named by less than 10% of irrigators who preferred a majority of expenditure on irrigation infrastructure. For example:

> Without agricultural production and best practices our production of food is under threat. Therefore money is needed at grass roots level for farm survival and to feed our nation.

Irrigators preferring expenditures in water markets were also likely to name environmental water needs as a reason. Many

Table 3
Budget expenditure reasons.

Reason	Infrastructure investment	Market-based purchases
Direct private benefits, improve irrigation efficiency	49%	14%
No reason provided	18%	28%
Balanced policy options needed, flexibility, targeted	7%	15%
Other	5%	13%
Retirement options needed	3%	9%
Food security/production reasons	9%	2%
Environmental needs for water	2%	7%
Cost of irrigation infrastructure upgrades	2%	6%
Prior farm irrigation infrastructure investment	1%	4%
Reduce irrigation externalities, stop loss of permanent water	3%	3%
	100%	100%

Table 4
Recovery programme funding and outcomes—2004–30 June 2009 and 1 July 2009–30 June 2012 (in 2011 constant dollars).

2004–2009							
Market programme	(2011 $M)	(GL)	Mean $/ML	Efficiency-based programme	(2011 $M)	(GL)	Mean $/ML
Narran Lakes	$11.3	2.0 (WA)	$562	TLM efficiency tender	$2.9	0.2 (LS)	$1460
TLM Pilot	$23.4	13.2 (GS/HS)	$1770	TLM NSW Package B	$64.5	56.0 (GS)	$1152
NSW Rivers restoration	$115.0	80.7 (GS)	$1425	TLM Rice Growers On-farm A1	$3.5	1.2 (GS)	$2923
NSW Wetlands	$13.4	9.3 (GS)	$1440	WFR Hay S&D pipeline	$14.9	1.0 (Convey.)	$1499
TLM NSW	$171.3	91.8 (GS/HS)	$1865	WFR Barren Box Swamp	$33.1	19.3 (Convey.)	$1714
TLM MIL	$21.4	17.8 (Supp.)	$1200	WFR Coleambally Irrigators	$5.6	3.4 (Convey.)	$1660
TLM Tandou	$14.5	9.3 (Supp.)	$1554	WFR Forest Creek 1	$5.4	10.7 (HS)	$503
WFR	$59.8	38.6 (GS)	$1547	WFR Forest Creek 2	$18.2	22.2 (LS)	$819
TLM SA Stage 1	$11.8	5.0 (HS)	$2360	WFR On-farm reconfiguration	$26.2	13.7 (GS)	$1911
TLM SA	$46.3	17 (GS/HS)	$2720	Northern Mallee Pipeline	$62.6	34.7 (HS)	$1806
TLM Goulburn-Murray	$46.5	120 (LS)	$387	WFR Goulburn metering	$6.8	2.0 (HS)	$3402
WFR Broken River	$1.4	1.0 (HS)	$1386	WFR Normanville metering	$14.8	16.4 (HS)	$905
WFR	$19.8	26.7 (LS/HS)	$740	WFR Normanville S&D pipeline	$4.8	3.9 (HS)	$1229
RtB(2008)	$51.0	22.0 (GS/HS)	$2320	WFR Woorinen S&D pipeline	$2.3	1.5 (HS)	$1556
				WFR Wimmera/Mallee pipeline	$282.7	40.6 (HS)	$6963
		Weighted 2004–2009 mean:	$1316			Weighted 2004–2009 mean:	$2340
				2009–2012			
RtB(2009/10)	$677.8	415 (GS/HS)	$1633	NVIRP Stage 1	$1033.0	75.0 (HS)	$13,774
RtB(2010/11)	$313.6	189 (GS/HS)	$1659	TLM Goulburn-Murray recovery	$43.0	120.0 (HS)	$3583
RtB(2011/12)	$161.9	117 (GS/HS)	$1385	Shepparton modernisation project	$55.7	22.0 (HS)	$2532
				Warren-Nyngan Pipeline	$12.0	4.0 (HS)	$3000
				WFR Central Goulburn	$42.7	18.0 (HS)	$2372
				NVIRP Stage 2	$1103.0	100.0 (HS)	$11,030
				PIIOP–NSW	$642.0	112.0 (HS)	$5732
				PIIOP–SA	$14.4	3.9 (HS)	$3692
				Menindee Lakes project	$400.0	200.0 (GS)	$2000
				NSW Major Rural infrastructure	$469.0	80.0 (GS)	$5863
				WIA/SA DEWNR irrigator efficiencies	$240.0	40.0 (HS)	$6000
		Weighted 2009–2012 mean:	$1599			Weighted 2009–2012 mean:	$5109
		2004–2012 weighted mean:	$1527			2004–2012 weighted mean:	$3302

WA = water allocation LS = low security (Victoria) entitlement GS = General security (NSW) entitlement HS = High security (NSW, Victoria, SA) entitlement Supp.=Supplementary entitlement Convey.=Conveyance entitlement

believed water would only be returned via buyback and that infrastructure upgrade costs would be high:

> Buying water entitlements is cheap. Infrastructure improvements have had to quantify water savings, and they may cost three or four times the market price of the water. Also our on- and off- farm infrastructure in SA (especially mine) is already efficient, so we are unlikely to benefit from upgrades

The next section outlines the results from the comparison of recovery programmes between 2004 and 2012.[3] This analysis is useful for cost-efficiency comparisons between major programmes.

An analysis of recovery package costs

Our analysis incorporated recovery programme information from *The Living Murray* (*TLM*), NSW *Water for Rivers* (*WFR*), the *Northern Victoria Infrastructure Renewal Project* (*NVIRP*), state-based private irrigation infrastructure operator programmes (*PIIOP*) and RtB (Table 4). Where available, we report actual infrastructure project costs (e.g. MDBA, 2009) but in a few cases only predicted project costs are available. Evidence suggests that predicted infrastructure project costs are often understated (ACIL Tasman, 2008, Fletcher and Fennell, 2012). On that basis we argue that the figures reported here are conservative estimates of $/ML costs for infrastructure projects.

Water purchasing programmes represented $2.74 billion across the period and recovered approximately 1,070GL of long-term cap equivalent (LTCE) from water entitlements. Infrastructure investments across the period represented $4.27 billion, estimated to recover approximately 962GL. Of interest is the comparison of the average $/ML of water recovered between the two programmes. The average market purchase price, accounting for reliability differences as shown, has remained relatively consistent at approximately $1450/ML. In contrast, the average $/ML associated with infrastructure investment across programmes has more than doubled; from $2340/ML to $5109/ML. This finding suggests some stability in MDB water markets that, even during a period of extreme supply constraint, provided reasonably consistent costs; at least at lower differentials than infrastructure project costs. Thus, while market recovery costs usually reflect actual expenditure, predictions for infrastructure projects may result in somewhat higher final $/ML costs than those reported here. Finally, the relative increase in $/ML for investment projects suggests diminishing marginal returns to projects, leading to significant price differentials between major programmes.

Discussion

Governments re-evaluating budget priorities in the MDB may wish to take into account this study's results on irrigators' expenditure preferences. Current expenditure allocation on RtB programme infrastructure investment and strategic buyback expenditure does not reflect the irrigator preferences presented herein. While expenditure preferences differ across sMDB states, on the whole (in terms of mean percentage of funds allocated) irrigators do prefer infrastructure investment (56%) to market programmes (44%), but the result is not what is suggested by irrigation peak-bodies who demand that more money should be allocated to infrastructure. These results suggest that an element of rent-seeking may exist in regards to infrastructure investment expenditure, and provides arguments for a different balance of expenditure across water recovery programmes.

In general, water trading and revegetation exit package alternatives reduce infrastructure investment preferences among NSW and Victorian irrigators. Further, SA irrigators' retain clear preferences for water entitlement selling over on-farm infrastructure investment. Apart from SA's past irrigation infrastructure investments, recent dry periods have seen large increases in water trade behaviour in SA. Familiarity with water trade in SA may also partially drive preferences for market recovery options. Overall, our expanded list of irrigator preferences indicates choices that could assist policy-makers to achieve water recovery targets. Alternatively, emphasis on water trade and exit packages to generate environmental water may provide environmental water managers with increased flexibility. For example, utilising different market approaches could have a significant and immediate impact on the effectiveness of recovery, and could reduce current uncertainties about water recovery outcomes (Wheeler et al., 2013).

While evaluations of government expenditure on water recovery should be driven by assessments of policy option benefits and costs—which is not the focus here—this paper substantiates that, on balance, irrigators would accept some expenditure reallocation from infrastructure investment towards alternative recovery programmes. For example, should the CEWH incorporate water allocation trade into its portfolio of recovery options, there is strong evidence of irrigator preferences for participation and a reallocation of WFF budget expenditure. In addition, if governments identify scope for rural community ecosystem service provision then irrigator interest in revegetation payments—potentially via exit packages—may achieve such outcomes. Since ecosystem service provision remains an objective of the *Water Act* (2007), this finding may provide future programme structuring relevance for policy-makers. Such programmes may evolve over time into viable ecosystem credit trade systems involving irrigators, land-holders and government. Nevertheless, its development and implementation need more careful consideration.

In this situation, it could be argued that the socially desirable response is to increase the budget allocated to infrastructure expenditure. If this is the case, then the results for market-based recovery options are stronger than presented in this study. This would again support our claims that irrigators would prefer a broad reallocation of budget expenditure across all categories to achieve environmental flows. A future concern involves positive signals of diminishing number of suitable infrastructure projects, as evidenced by their increasing marginal costs over time. The long timeframes to generate water savings, significant uncertainty about the magnitude of those savings, and likely substantial and continuing irrigator/social costs from infrastructure investment expenditure provide additional concerns. Such outcomes are probable where mean infrastructure costs persist around $3300/ML. Further, there are many prior Australian examples where public support for long-term environmental water projects has later stopped, resulting in the decline, failure and ultimate abandonment of infrastructure works (Skurray et al., 2012). This situation may not manifest entirely in the case of irrigation works established under WFF. However, once established, the ongoing cost requirements for these projects will likely not decline, as well as introducing significant transaction costs into the future (Marshall, 2013).

Conclusions

The current WFF budget prioritises irrigation infrastructure spending over water entitlement buyback, and irrigation peak-bodies have argued that public money should be increasingly reallocated from market purchases to infrastructure projects. We

[3] Much of this data was sourced from MDBA (2009). Additional sources included WFF websites (e.g. AWRC 1986), Victorian Ombudsman (2011) and state priority project sites (e.g. Bryan and Marvanek 2004).

find that, although there are differences among sMDB states, irrigator preference for infrastructure expenditure over market-based expenditure (56% versus 44%, respectively) is less than what current budget allocations or stakeholder views recognise, suggesting the presence of rent-seeking in current arguments made by irrigation groups. We also find that irrigators report strong preferences for expansion of water recovery options towards extended market arrangements (e.g. water allocation trade, entitlement leasing and option contracts). Importantly, irrigators do not support reallocation of funds away from market purchases. Instead, they prefer a targeted approach where up to one-third of budget expenditure is applied towards directed buyback (which includes revamped exit packages). On the other hand, irrigators do express preferences to reallocate money away from expenditure on irrigation infrastructure towards greater use of temporary trade alternatives. The potential for strategically biased answers towards more socially desirable responses for infrastructure expenditure suggests there may be even greater support for market-based options. Analysis of infrastructure investment across two major water recovery programmes in the sMDB also suggests that increasing $/ML of infrastructure projects may be explained by diminishing marginal returns. Market recovery, on the other hand, provides flexibility for environmental managers, relatively immediate (and less uncertain) sources of water for the environment, and opportunities for lower cost water recovery.

Such results suggest that decision makers need to be careful when they make environmental management decisions based on what is perceived to be the most popular and desirable choice. A greater scrutiny of the benefits and costs of alternative options is needed, including an expansion of the preference findings herein to a coverage of additional budget issues such as national spending on health, education defense etc. However, in the case of relatively smaller-scale budget preferences in the MDB, a reallocation of budget expenditure toward market-based programmes may increase social welfare and reduce policy inefficiency.

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Appendix 1.

Information: Murray-Darling Basin Irrigators Exit Grant Package

Up until 30 June 2009, an exit grant of up to $150,000 was a one-off, taxable and time limited payment to farmers who wished to leave irrigation was available. In addition, two complementary grants were included in the package:

- up to $20,000 for removing permanent plantings and other production-related infrastructure; and
- up to $10,000 for advice and training, including skills development, direction setting plans, succession planning and business advice.

The net asset limit was $350,000 for access to a full grant of $150,000. However, net assets exclude the value of up to 40 ha of land and the principal home (if any) on the same land title. If the value of other total net assets was above $350,000, irrigators were eligible for a reduced grant. For every $3 in assets above the threshold, the exit grant reduces by $2. This means that an irrigator cannot receive a grant of any amount if their net assets (excluding the house and land as outlined above) are more than $575,000.

Source: http://www.environment.gov.au/water/programs/entitlement-purchasing/small-block-irrigators.html

Eligibility requirements for a Revised Programme:

Based on past programme, an irrigator might have been eligible for the exit grant and the two complementary grants, if they:

- owned farm land and at least 10ML of permanent entitlements to extract water from a watercourse in the Murray-Darling Basin;
- were prepared to sell all of their permanent entitlements;
- were willing to remove all permanent plantings and on-farm irrigation infrastructure; and
- were willing to give an undertaking that neither they nor their farm land would be involved in irrigated farming for at least five years.

The net asset limit would stay the same except all the land being taken out of irrigation would be excluded from the asset calculation. In addition, in a revised programme the property size limit would be removed from this exit package.

Providing Exit Packages and Revegetation Payments.

The government spends the budget in providing exit packages to irrigators selling all their water but with an additional revegetation annual payment. This payment would be $300 ha^{-1} for planting native vegetation and controlling pests on the area you have irrigated in the past. Participants would get the $300 ha^{-1} payment each year for ten years. The Government will provide the tube stock, other materials, and some water in the first few years to help establish the vegetation.

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