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Selling the Farm Silver? Understanding Water Sales to the Australian Government

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Abstract In 2007–2008 the Australian federal government committed $3.1 billion over 10 years to purchase water from irrigators in the Murray-Darling Basin and to deliver this water to key environmental assets. Given that water entitlements often represent one of the most valuable assets owned by irrigators, this study investigates irrigators' willingness to sell water, and their actual water sales, to the government. It uses 1,570 surveys from 2008–2009 and 2010–2011 in the southern Murray-Darling Basin. Water sales can be classified as either last resort or strategic. Overall, the results suggest that farmers who do not hold strong traditional farming attitudes, and have higher debt, lower farm income, larger high security water entitlements, lower water allocations over the past 5 years, and those who have been net sellers of water allocations are more likely to have sold water or are thinking of selling water to the government. A dynamic comparison of how water sale preferences change, and an estimate of the total amount of water entitlements irrigators are willing to sell, indicates that it is probable that there will be enough water offered to the program in the future, at least to meet initial minimum environmental water targets. However, other concerns indicate that a potential restructure of the program may be required.

Keywords Water entitlements · Environmental water sales · Murray-Darling Basin · Irrigators

Abbreviations

MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
GMID	Goulburn-Murray Irrigation District

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RtB Restoring the Balance
SA South Australia
NSW New South Wales
VIC Victoria

1 Introduction

In response to an increasing recognition of the environmental harm caused by the over-allocation of water entitlements, in 2007–2008 the Australian Government committed $3.1 billion to buy back existing permanent water entitlements from willing sellers over 10 years in the Murray-Darling Basin (MDB). Known as *Restoring the Balance* (RtB), this Government initiative was the latest in a series of policies aimed at achieving a more sustainable balance of water use in the MDB (Crase and O'Keefe 2009; Grafton 2011).

RtB is the Australian government's primary market-based mechanism for recovering environmental water required to meet the environmental watering targets defined in the *Guide to the proposed Basin Plan* (the Guide). Released by the MDBA in October 2010, the Guide is a first step towards a Basin-wide framework to manage the water resources of the MDB. The Guide called for environmental water holdings to be increased by 3,000–4,000 GL annually, which represents an average reduction in current watercourse diversions of 27–37% (MDBA 2010). By 30 June 2011, RtB had dispensed approximately $1.25 billion to purchase water entitlements from willing irrigators, yielding an average annual volume of 752 GL (DSEWPC 2011).

To date, most of the policy focus on water recovery has concentrated on volumes of water entitlements as the sole environmental metric. However, such a focus on entitlement volume ignores the nuances involved with environmental water management and the non-linearity between volume and environmental outcomes (Crase et al. 2011). In addition, there has been a call for increased use of alternative derivative water products to be used in buy-back to increase the flexibility and cost-effectiveness of the program (Productivity Commission 2010; Wheeler et al. 2011).

Like most market-oriented policies, the buy-back of water depends on the voluntary participation of irrigators. There is still a significant gap to close between water entitlement holdings and minimum targets, and the RtB program will continue to be the primary market mechanism for recovering water. There have been increasing calls for the government to be efficient and targeted in its purchasing of water entitlements. The planning and design of cost effective recovery of significant volumes of environmental water necessitates an understanding of who sells water and who does not. Water is often one of the most valuable assets owned by irrigators; hence they can be hesitant to sell and low participation might lead to insufficient water recovery to meet environmental objectives. Understanding participation in the Australian buy-back program will allow future programs to be designed to address the concerns of those not participating. In addition, identifying those who are selling large proportions of their water and hence potentially exiting the industry may help in the design of structural adjustment policies for farming.

Another policy question is whether there will be enough willing sellers in each region to meet the environmental water recovery targets of RtB. The federal government is targeting their water purchases by area, with a very high priority for some areas. Purchases from the southern MDB are classified as very high priority. Much of the current stock of water entitlement purchases have been made in a period of drought, when irrigators have been experiencing stress and higher than normal debt levels. Some critics suggested (e.g.

Thampapillai 2009a) that the government may struggle to purchase enough water after the drought broke and the corresponding financial stress reduced. However, purchases by the government in 2011 have been made in a period of drought recovery with full seasonal water allocations, some low permanent crop commodity prices and flooding. Although the government received fewer bids than previous rounds, they still fully allocated their tender budgets (DSEWPC 2011).

This study uses a wide array of information from 1,570 irrigator surveys from two recent years across the southern MDB to: (1) explain why irrigators sold water to the government; (2) identify future willingness to sell water to the government; and (3) predict a dynamic estimate of the total volume of water in the southern MDB that irrigators are willing to sell to the program.

2 Water Markets and Buy-Back Literature Review

2.1 Water Markets in Australia

The southern MDB comprises a number of irrigation regions in New South Wales (NSW), Victoria (VIC) and South Australia (SA). Unlike other areas in Australia, the southern MDB is hydrologically linked which allows water trade to occur, with water markets in existence since the 1980s (NWC 2011). In the MDB water entitlements are also known as the permanent right to receive seasonal allocations of water. Allocation water is also called temporary water and is defined as a percentage of irrigators' water entitlements, which is announced throughout the water season. Allocations vary across the MDB depending on the class of right (high, general or low security), and geographic location. Table 1 provides a historical overview of seasonal allocations in the southern MDB, from the early 2000s to 2010–2011. It highlights the water shortage that irrigators experienced in the recent drought, especially from 2006–2007 onwards.

Although there has been increasing participation by irrigators in the water market, institutional policies can play a large role in influencing water trade within regions in the southern MDB. Caps have traditionally been placed on the amount of water that is allowed to trade out of a region to prevent concerns about sudden, widespread removal of water and industry out of regions. Under the National Water Initiative, the cap was eased from 2 to 4% in Victoria in 2006 and due to the 2009 bilateral agreement between Victoria and the Commonwealth there is to be a move to full and open trade by 2014. To date the limit has constrained water from being traded out of many Victorian districts (NWC 2011). One of the aims of this paper is to investigate how institutional constraints influence the willingness of irrigators to sell water to the government.

2.2 Water Buy-Back Literature Review

As a tool for acquiring environmental flows, water buy-backs are relatively new to the water sector. There are not many examples of water buy-back programs in existence and even fewer studies on buy-back participation. There have been more studies of fishery buy-backs and participation in water markets, as discussed later in this section.

Australia's water buy-back programme is not unprecedented internationally, as the western USA has had environmental recovery buy-backs from the late 1980s, although USA buy-backs are not on the scale that is proposed in the MDB. Ise and Sunding (1998) studied the purchase of agricultural water rights for wetland restoration in the Lahontan Valley of

Table 1 Final water allocations in the southern Murray-Darling Basin (%)

	High reliability entitlements					Lower reliability entitlements			
Year	Vic Goulburn	Vic Murray	NSW Murray	NSW Murrumbidgee	SA Murray	Vic Goulburn (low)	Vic Murray (low)	NSW Murray (general)	NSW Murrumbidgee (general)
1998–1999	100	100	100	100	100	0	100	93	85
1999–2000	100	100	100	100	100	0	90	35	78
2000–2001	100	100	100	100	100	0	100	95	90
2001–2002	100	100	100	100	100	0	100	105	72
2002–2003	57	100	100	100	100	0	29	10	38
2003–2004	100	100	100	95	95	0	0	55	41
2004–2005	100	100	97	95	95	0	0	49	40
2005–2006	100	100	97	95	100	0	0	63	54
2006–2007	29	95	69	90	60	0	0	0	10
2007–2008	57	43	50	90	32	0	0	0	13
2008–2009	33	35	95	95	18	0	0	9	21
2009–2010	71	100	97	95	62	0	0	27	27
2010–2011	100	100	100	100	67	0	0	100	100

Source: NWC (2011; 5)

Nevada and found that financial distress, land quality, farm productivity, distance from the city centre and off-farm income were the primary factors influencing participation in the program. Several farmers in Nevada suggested that leasing water in dry years would be preferable to permanent purchases of water rights.

Within Australia, there have been a number of buy-back programs in the lead up to (and in conjunction with) the introduction of the RtB program. As part of the *Living Murray Initiative*, the Murray-Darling Basin Commission aimed to acquire 500 GL of water to secure water to protect icon environmental sites through infrastructure-based projects and the purchase of water entitlements (Walpole et al. 2010). The NSW Market Purchase Measure was the largest buy-back program under the *Living Murray* program. Walpole et al. (2010) found that the majority of landholders who participated in the program had larger than average farms, significant water holdings, higher education levels and often had substantial off-farm incomes. The study also found that financial planning was the most common reason for selling water followed by succession and retirement planning/considerations.

The first round of the Government's current RtB buy-back tender ran from February to June, 2008 and it purchased 24 GL of high, general and low security water at a cost of $34 million. DEWHA (2008) interviewed 20 successful sellers, 20 unsuccessful sellers and 14 brokers to explore how sellers intended to use the proceeds from the sale and found that: (1) over half intended to retire debt; (2) a third to re-invest in the farm; (3) a quarter to invest elsewhere, perhaps in an effort to diversify and generate off-farm income; and (4) 15% intended to stop farming, though some planned to resume at a later date. In terms of how much water irrigators sold, 35% sold their total entitlement, 30% sold 30–100%, and the remainder sold less than a third (DEWHA 2008).

Thampapillai (2009b) interviewed 41 irrigators in the MDB in 2008 to assess their willingness to sell water to the Federal government and found that potential sellers were more likely to be facing financial hardship, close to retirement, in possession of a reasonable off-farm income and had no family succession in place. Thampapillai (2009a) suggested that endowment effects (e.g. Kahneman et al. 1990) may inhibit water trading, where irrigators wish to hoard water or are reluctant to yield control of their water entitlements.

Unlike research into influences on participation in water buy-backs, a substantial body of research has analysed participation in Australian water markets. This research provides relevant insights for this study. Examining characteristics of early water traders in the Goulburn Murray Irrigation District (GMID) in 1998–1999, Wheeler et al. (2009) found that the early adopters of allocation trading were similar to the traditional profile of early agricultural adopters. By 2006, this profile had significantly changed, with far less differences between traders and non-traders. Substantial differences were also found between traders in the allocation market and traders in the entitlement market (Wheeler et al. 2010). From interviews with irrigators, Fenton (2006) found that motivations for selling permanent water entitlements in northern Victoria were primarily related to individual farm financial decisions, such as reducing debt, preparing to exit the industry, or providing financial security for retirement. These findings are consistent with Bjornlund (2004). Others have suggested broader social and community pressures, including social norms, as primary inhibitors to selling water entitlements in earlier times (Fenton 2006; Edwards et al. 2008). There are many other non-economic factors which can influence irrigators' decisions, particularly those relating to buying and selling water (Maybery et al. 2005; Kuehne et al. 2010).

Lessons from fishery buy-back programs may transfer to water buy-backs. The key lessons from this body of literature are that the amount of the financial offer, attitudes towards fishers' livelihood and resource management, and the certainty of existing regulations are likely to influence decisions to participate (Kitts et al. 2001; Chen 2009).

Irrigator reactions to the *Guide*, and the existing literature on fisheries and water buy-backs and water markets suggests that debt is one of the main reasons why farmers sell water. It also suggests that non-economic factors, including views and attitudes toward family, land, water and the environment are likely to play a significant role. This paper seeks to examine the influences on current and future irrigator participation in the RtB program. We are interested in the role that human, social, farm, financial, regional and institutional capital play in the decision to sell water to government. Is farm debt the main reason irrigators sell their water, and have water sales been predominantly a strategy of last resort? Do attitudes of irrigators towards farming in general and their lifestyle goals determine their water sale decisions? How do regional differences (such as drought, different allocations and securities of rights and institutional restrictions on trade) impact on the decision to sell water? The other pressing policy question that we seek to answer in the final section of this study is whether there will be enough willing sellers to at least meet the minimum environmental water recovery targets introduced in the Guide.

3 Methods

To address our questions of what influences irrigators' water sale decisions to the government and whether there will be enough water willingly offered over the program duration, we used a combination of ordered and binary probit regression, factor analysis and OLS regression.

3.1 Data Description

Irrigator surveys across the southern MDB were collected by telephone over 2 years: 2008–2009 (n = 624) and 2010–2011 (n = 946).[1] Two study areas were included in the 2008–2009 survey, the Riverland in SA (where mostly wine grapes, citrus, fruit and nuts are grown) and the Goulburn-Murray Irrigation District (GMID) in Victoria (mainly dairy, broadacre, cropping and livestock operations). The 2010–2011 (August to early October 2010) survey also included Murrumbidgee and Murray regions in NSW, plus other irrigators along the Murray River in SA. These three areas are important because they have interconnected water trade. In addition, the GMID is the largest irrigation district in the MDB, SA has predominantly permanent plantings with high security water entitlements; and NSW is a mixture of annual and permanent crops and has mainly general security water entitlements, and is the state which has sold most water to the RtB program.

3.2 Ordered and Binary Probit Regression Analysis

A series of questions were asked regarding irrigators' participation in selling water for the environment. The first asked about their willingness to sell water entitlements to the government, and if they were thinking about selling water or had already done so, the second question collected information on the volume of water irrigators were thinking about selling (had sold).

[1] The 2008–2009 telephone surveys had a response rate of 55% (or 70% including those who agreed to be interviewed but were not called back due to sample size being met). The 2010–2011 survey had a response rate of 30% (or 37% if including irrigators who agreed to be surveyed but were not called back). The surveys used computer assisted telephone interviewing methodology, randomly surveying from irrigation organisation and commercial farming lists. Given missing answers for some variables, we conducted sensitivity analysis on our results by using multiple imputation methods to account for the missing observations and found that our results did not significantly change.

Given the nature of our dependent variables (willingness to sell water entitlements and actual sales of water), ordered and binary probit models were considered appropriate. The ordered probit is presented as follows: Define y^* as a latent dependent variable measuring the exact but unobserved willingness to sell water to the government; we express $y^* = x\beta + \varepsilon$, in which x is a vector of independent explanatory variables that potentially influence the dependent variable y, and ε is an error term. We observe:

$$\begin{aligned} y &= 1 \quad \text{if } -\infty \leq y^* < \mu_1 \\ y &= 2 \quad \text{if } \mu_1 \leq y^* < \mu_2 \\ y &= 3 \quad \text{if } \mu_2 \leq y^* < +\infty \end{aligned}$$

and y is a rough categorization of y^*. Our dependent variable y is the willingness to sell water to the government (where 1 = not at all, 2 = slightly considered and 3 = seriously considered). β, μ_1 and μ_2 are unknown parameters to be estimated by the maximum likelihood method using the log-likelihood function (see Greene 2008).

To model the actual decision to sell water to the government, the dependent variable of the binary probit is: 1 = if an irrigator has sold water to the government, and 0 otherwise. The definitions of the dependent and independent variables are provided in Table 2, and Appendix B provides the summary statistics.

Although we also conducted our regression analysis by each state, given the large range of results this paper only presents the total southern MDB regressions. Table 3 provides an overall snapshot of some of the differences between regions in irrigators' willingness to sell water to the government by state and year. In 2008–2009, many more irrigators indicated no interest in selling water to the government in the GMID than in the Riverland. In 2008–2009 Riverland irrigators who were willing to sell water to the government had, on average, smaller water entitlement holdings (and are willing to sell more of their water entitlement). There was no such clear pattern for GMID irrigators. 19% of Riverland irrigators said they would sell all of their water in 2008–2009, while only three percent of GMID irrigators would. Such a situation is understandable considering that Riverland permanent crop irrigators were under greater distress than GMID irrigators in the recent drought. The 2010–2011 data indicate the difference that non-drought years make, where SA irrigators were now less willing to sell water than in 2008–2009, and there is no significant difference between states as to the proportion of their water entitlement they are willing to sell.

3.3 Independent Variables

Independent variables are classified into four groupings: (1) human and social capital (age, education, years spent farming, risk attitudes, succession plans, children, value constructs, whole farm plan, health, trading behaviour, information sources, membership); (2) farm capital (water entitlements, farm type, farm size, farm diversification, irrigation technology, organic); (3) financial capital (farm operating surplus, debt, equity, productivity, off-farm income); and (4) regional capital (CAP presence, location, drought, mean end allocation in past 5 years.[2]) The 2010–2011 regressions have additional variables to the 2008–2009 regressions.

The surveys included questions on irrigators' trade behaviour, farmer socio-economic and farm characteristics, and 56 value and attitude statements developed from previous attitudinal research (Morrison et al. 2011). Respondents were asked to rate their level of agreement with

[2] This was the mean of the end water allocation received in the irrigator's region over the past 5 years, weighted by the particular type of entitlement security owned.

Table 2 Variable definitions

Variables	Definitions
EnvWaterWill	Willingness to sell water entitlements to government for environmental flows: 1 = not at all; 2 = slightly considered; 3 = seriously considered.
EnvWaterSale	1 = if have sold water entitlements to government for environmental purposes; 0 = otherwise
Human and social capital	
Age	Farmer's age
Gender	1 = male; 0 = otherwise
Farmyears	Number of years spent farming
Lowedu	1 = if highest education is Year 10 or below; 0 = otherwise
Successor	1 = if expect a family member to take over the farm; 0 = otherwise
Tradition	Factor score of tradition
Succession	Factor score of succession (2008–2009 only)
Commerce	Factor score of commerce
Environment	Factor score of environment
Technology	Factor score of technology
Risktype	Likert scale: from 1 = totally unwilling to take risks to 5 = completely willing to take risks
Health	Likert scale: 1 = poor, 2 = fair, 3 = good, 4 = very good and 5 = excellent
Child	Number of children
Info_gov	1 = if information source is government agencies; 0 = otherwise
Physical capital	
Alloctrade	1 = if sold allocation water in the last 5 years; 0 = otherwise, for 2008–2009; models 1 = if a net seller of allocation water over the years; 0 = otherwise, for 2010–2011 models
Entitlementsale	1 = sold water entitlements in the market in the last 5 years (excluding sale to the government); 0 = otherwise
Carryover	Carryover water saved from the 2008–2009 season
Farm plan	1 = if have a whole farm plan; 0 = otherwise
FTE	Number of full time equivalent employees working on a farm
Farmsize	Farm size (ha), in 1,000s (in natural logarithm)
Irrig	Irrigation area size (ha), in 1,000s (in natural logarithm)
HSwater	Total high security surface water entitlement (ML) before sale to the government, in 1,000s (in natural logarithm)
LGwater	Total low or general security water entitlement (ML), before sale to the government in 1,000s (in natural logarithm) for SA and VIC only
HS/Gwater	Total general and high security water entitlement (ML), before sale to the government in 1,000s for NSW only
Reuse	Percentage of area connected with a reuse system
Annualcrop	Percentage of area in annual crops
Hort	Percentage of area in horticulture
Grazing	Percentage of area in grazing
Diverse	Index of how many farming activities the farm earns income from
Organic	1 = Certified organic produce grower; 0 = otherwise
Financial capital	
Osurplus	Farm operating surplus, (in natural logarithm), for 2007–2008 and 2009–2010
Off_farm	Percentage of household income from off-farm work (semi-continuous variable: 0, 12.5, 37.5, 63, 88 and 100%)

Table 2 continued

Variables	Definitions
Debt	Farm debt, in $1,000s, at time of survey in 2008–2009, and debt to equity ratio for the farm, at time of survey in 2010–2011
Productivity	Likert scale of productivity change in the last 5 years: 1 = strongly decreasing to 5 = strongly increasing
Regional capital	
Netevap	Regional net evaporation (rainfall take evaporation) of the respective season from the closest weather stations (in mm), for 2007–2008 and 2009–2010
Cap	1 = cap has prevented entitlement trade in the past; 0 = otherwise
Endalloc	Mean season end allocation level of the previous 5 years, respectively weighted by individual ownership of high and low/general water entitlements
State	VIC = 1 if a Victorian irrigator, 0 otherwise; and SA = 1 if a South Australian irrigator; 0 otherwise

each attitudinal statement using a five-point Likert scale. This study uses key irrigator attitudinal constructs that were identified through factor analysis in each year. Five important attitudinal constructs were identified in the 2008–2009 data: *Succession, Tradition, Commerce, Environment and Technology*, while in the 2010–2011 data identified: *Tradition, Commerce, Environment and Technology*. The higher the factor score, the more the farmers associate

Table 3 Willingness to sell water entitlements to the Government (%)

	2008–2009		2010–2011		
	Riverland[a]	GMID	SA[b]	VIC	NSW
Potential responses to government water purchase scheme					
Have not at all considered selling water	44	62	61	59	57
Have slightly considered selling water	24	15	8	13	17
Have seriously considered selling water	26	14	16	16	19
Have sold water	6	8	14	12	7
Total	100	100	100	100	100
How large a percentage of your water would you consider selling or have you sold?[c]					
0%	44	72	69	72	83
Between 1 and 25%	7	9	11	11	3
Between 26 and 50%	10	8	9	6	1
Between 51 and 75%	5	4	4	2	1.5
Between 76 and 100%	14	4	2	2	1.5
100%	19	3	6	6	10
Total	100	100	100	100	100

[a] Chi-squared test statistics indicate that irrigators in Riverland and GMID had significantly different willingness levels to sell water ($p = 0.00$)

[b] Chi-squared test statistics indicate SA, VIC and NSW irrigators had significantly different willingness levels to sell water ($p = 0.01$). It also needs to be noted that SA includes other SA Murray irrigators separate to the Riverland region

[c] Two-group mean comparison test indicates the percentage of water entitlement Riverland and GMID irrigators would offer for sale differed significantly in 2008–2009 ($p = 0.00$) and multi-group mean F-stat comparison test indicates the percentage of water entitlement SA, VIC and NSW irrigators would offer for sale did not differ significantly in 2010–2011 ($p = 0.55$)

themselves with the values embedded in that construct. For example, an irrigator with a high score on the *Environment* construct is more environmentally-oriented than an irrigator with a lower score. All of the five constructs were used as attitudinal explanatory variables in our regression analysis in each state. Appendix A describes the methodology further.

4 Results

The restricted model results for the southern MDB willingness to sell and actual sales are presented in Table 4 (based on a BIC comparison that provides strong support for restricted model following Raftery (1996) guidelines). It should be noted that 2008–2009 represents surveys from the Riverland and the GMID only, and 2010–2011 represents surveys from all three southern interconnected MDB states. The models have reasonable fit, have no serious multicollinearity issues (as tested with VIFs and correlation analysis) and are estimated with robust standard errors.

4.1 Willingness to Sell Water

In our willingness to sell water models in 2008–2009 and 2010–2011, there was significant evidence that human and social capital had an influence on those thinking of selling water to the government. In particular, it is clear that values and attitudes of irrigators do play an important role when thinking about selling water or not. Irrigators are less willing to sell water to the government if they were more succession (*Succession*) and tradition (*Tradition*) orientated, indicating the importance of needing water for the family and the business to continue farming. It is possible that these value constructs are associated with the endowment effect (e.g. Kahneman et al. 1990) of irrigators, and it is these irrigators who are more likely to refuse to sell. On the other hand, there was evidence in the 2008–2009 models that farmers are more willing to sell water if they are more commercially oriented (*Commerce*), and those who were more environmentally orientated (*Environment*) were more likely to be willing to sell water in 2010–2011. Irrigators who cannot imagine doing anything else but farming are highly unlikely to want to sell their water entitlements, while irrigators who have a very commercial outlook and are highly financially motivated are much more likely to consider it.

Male irrigators were slightly more willing to sell water in 2008–2009, while those who have worked fewer years on a farm are more willing to sell water. Irrigators who used government agencies (*info_gov*) as their main source of information were more likely to be thinking about selling water in 2008–2009.

As hypothesised, farm and financial capital played one of the most significant roles in influencing willingness to sell water. Farm income (*osurplus*) is inversely related to the willingness to sell water across both years. Similarly, the more full-time employees on the farm (*FTE*) in 2010–2011, the less likely the irrigator is thinking about selling water. Although debt (*debt*) was found to be positively related to the willingness to sell water in some state models, no such evidence was found in the restricted southern MDB models. The larger the high security water entitlements (*HSwater*) owned by irrigators, the more likely they were willing to sell water across both years. Given the difference in water entitlements across the states, Fig. 1 explores this relationship between water sale preferences and size of water entitlement across the 2 years for each state.

Each point in Fig. 1 represents a mean water entitlement size for each category of water sale behaviour; by state and water security (Victoria and SA represent the mean of 2 years,

Table 4 Ex-ante and ex-post restricted models of southern MDB water sales to the Australian Government

	Willingness 2008–2009[a]	Sale 2008–2009[b]	Willingness 2010–2011[a]	Sale 2010-2011[c]
Age	–	–	–	−0.01(0.01)**
Gender	0.28(0.15)*	–	–	–
Farmyears	−0.01(0.00)***	–	−0.01(0.00)***	–
Lowedu	–	–	–	0.40(0.17)**
Tradition	−0.24(0.06)***	−0.21(0.07)***	−0.19(0.06)***	−0.12(0.06)*
Succession	−0.21(0.06)***	–	–	–
Commerce	0.17(0.06)***	–	–	–
Environment	–	–	0.18(0.05)***	–
Child	–	–	–	0.09(0.04)*
Info_gov	0.33(0.12)***	–	–	−0.61(0.35)*
Alloctrade	–	0.27(0.15)*	0.39(0.11)***	0.43(0.15)***
Entitlementsale	–	–	0.44(0.14)***	–
Cap	–	–	0.84(0.13)***	–
Farm plan	–	–	–	0.39(0.16)**
FTE	–	–	−0.04(0.02)**	–
Farmsize	–	–	0.08(0.03)**	–
HSwater	0.10(0.06)*	−0.00(0.00)*	0.07(0.03)***	–
HS/Gwater	–	–	–	0.0001(0.00)**
Annualcrop	–	−0.01(0.00)**	–	−0.003(0.00)*
Hort	−0.005(0.00)*	−0.01(0.00)***	0.003(0.00)**	–
Osurplus	−0.03(0.01)***	–	−0.02(0.01)**	−0.02(0.01)*
Debt	–	0.001(0.00)***	–	–
Endalloc	−1.11(0.32)***	−0.64(0.29)**	−0.01(0.00)***	−0.01(0.00)***
VIC	–	–	–	0.54(0.17)***
SA	–	–	–	0.73(0.20)***
Cut1/constant	−85.08(24.39)***	48.20(21.82)**	0.45(0.25)*	−1.01(0.48)**
Cut2	−84.38(24.38)***	–	0.97(0.25)***	–
Obs.	524	573	655	746
χ^2	77.08***	44.58***	122.62***	52.08***
McKelvey & Zavoina's R^2	0.25	–	0.21	0.25
% correctly predicted	0.61	0.89	0.67	0.88

* $p < .1$; ** $p < .05$; *** $p < .01$. Robust SE in parentheses
[a] Ordered probit model
[b] Binary probit model with endogenous regressor (debt). Wald test of the exogeneity of debt is 7.60 ($p = 0.006$)
[c] Binary probit model

NSW represents 2010–2011 only). In general, they show that irrigators in Victoria own more water entitlements than in SA (and they mainly own high security entitlements) and NSW irrigators own more general security entitlements (on average, NSW irrigators own 3.8 general security entitlements to their every 1 high security entitlement). Overall the graphs confirm that the more water entitlements irrigators own, the more willing they are to sell water.

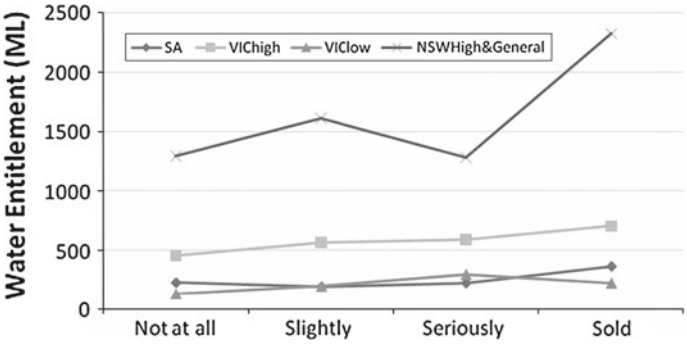

Fig. 1 Irrigator water sale preferences to the government by mean water entitlement size, by state

The results in 2010–2011 found that an increase in total farm size (*farmsize*) was positively associated with an increase in willingness to sell water. In 2008–2009, an increase in the percentage of the farm producing horticultural products (*hort*) was negatively associated with willingness to sell, while in 2010–2011 it was positively associated with those thinking about selling water. This change is interesting. The main forms of horticulture in our irrigation regions include wine grapes, citrus and other fruits and nuts. Traditionally, those with permanent crops have less flexibility with water use decisions, and have been more likely to buy water entitlements and allocations than sell water; hence the relationship identified in 2008–2009 is understandable. However, in the last few years, prices for wine grapes (and citrus) have plunged, with many unable to sell their produce. Future price predictions remain low. Hence, there has been a total change of circumstances experienced by many horticultural growers in the last couple of years, and many of them are moving towards a decision where they will have to sell water entitlements (and most likely have to sell their farm, reduce irrigated area or buy in allocation water), hence helping to explain the positive influence in the willingness to sell model in 2010–2011. However, no significant influence in actual water entitlement sales to date was discernible.

Previous water market experience does play a part in influencing water entitlement sales. In 2010–2011, net sellers of allocation water in the past were more likely to be willing to sell water entitlements. Exploring whether the past experience of selling water entitlements influences future behaviour, we found that in 2010–2011 irrigators who sold water entitlements in the past are more likely to be thinking about selling water to government. This suggests that past water market experience does have an impact on future plans, or at least on the acceptability of selling water again, while it was not found to be associated with actual sales.

Finally, regional and institutional water market characteristics played a significant role in influencing the willingness to sell water entitlements. In terms of the water shortages that irrigators have experienced in the past drought, an increase in their mean end water allocation (which was individually weighted by how many general/high security entitlements each irrigator owned) in the past 5 years was associated with less willingness to sell water, and less water sold. Therefore, irrigators who have had less water on average have been more likely to sell their water, either because they are exiting the industry and/or are more likely to believe that irrigation will be increasingly difficult in the future, or lack of allocation water has had a cumulative impact and forced irrigators to sell some water entitlements. This variable was more important than the actual climate conditions (rainfall and evaporation) that were experienced on farms. As expected, if irrigators had been unable to sell their water entitlements due to the existence of a Cap, this then increased their willingness to sell water in the future, but it had no impact on who had actually sold their water.

One other economic variable that was tested was the price at which irrigators were willing to sell. Unfortunately we only had price information for those who were thinking of selling (irrigators were asked an open-ended question about how much they would accept) and the price for those who sold their water (hence our reported models could not include price as a variable). However, sensitivity testing including price on the willingness to sell water entitlements reveals that a strong significant negative relationship exists between willingness to sell and price. That is, those who were only slightly considering selling their water wanted a much higher price than those who are seriously considering selling, had submitted a tender or had sold their water.

4.2 Actual Sales of Water to the Government

Our ex-post models found that irrigators were more likely to have sold water to the government across the 2 years (at least at the 10% level of significance), if they had: higher farm debt[3]; smaller high security water entitlements; lower farm incomes; a higher number of children; lower education; a whole farm plan; used government agencies as a source of information; a smaller percentage of the property under permanent horticulture; a smaller percentage of the property under annual crops; less-orientated towards traditional farming attitudes; lived in South Australia; were younger; had been a net seller of allocation water in the past; had better health; and a lower mean annual water allocation in the past 5 years.

Although it is clear that values and attitudes of irrigators do play an important role in the decision to sell water or not, more evidence of their influence was found in our ex-ante models rather than our ex-post models. Farm financial factors also seem to be relatively more important in our ex-post models, while regional and institutional factors, although important in our ex-post models, seem to have the most influence in the ex-ante models.

4.3 Volume and Proportion of Entitlement Offered for Sale

Figure 2 explores the relationship between proportion of the water entitlement willing to be sold and the mean size of water entitlement (by high and low/general security) across the 2 years for the three states.

It seems that the overarching story is that there is an inverse relationship between water entitlement size and the proportion of total water entitlement holdings willing to be sold. That is, the more water owned, the less likely irrigators will put all of it up for sale. From Table 3 results, we know that irrigators in SA in 2008–2009 were more likely than VIC irrigators to consider selling water to the government and were considering selling much larger proportions of their entitlements. These irrigation district results reflect the regional differences in drought severity, institutional factors, permanent crop issues, commodity price conditions, as well as historical factors.

For space reasons the results of our volume regressions are not included in this paper (but are available upon request). Overall however, the results of these regression analyses are similar to those for the willingness to sell/sold models. In particular, it was confirmed that the more high security entitlements owned, the higher the volume of water to be sold. But, if the dependent variable was measured as proportion of total water entitlement to be

[3] We found debt was endogenous in some of our actual water sale models for 2008–2009, and hence had to be instrumented. Current farm debt is likely to be endogenous with the actual water sale decision since farmers who have sold water to the Government might use the revenue to reduce their farm debt. The instrument variables we used for farm debt in 2008–2009 are two attitudinal questions: 'It is best to avoid reliance on financing from banks', and 'Bank finance is the only way to ensure business growth'. A Wald test of the exogeneity of the instrumented variable is reported in Table 4.

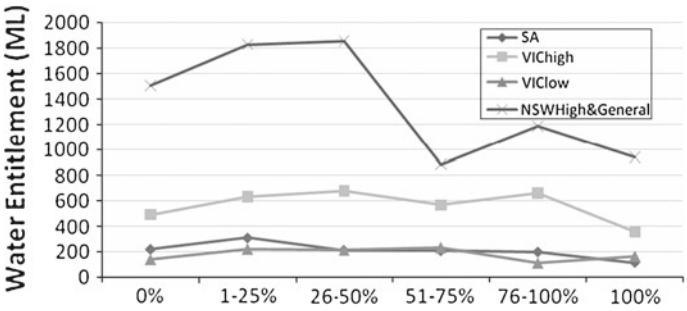

Fig. 2 Proportion of water entitlement considered for sale to the government by mean water entitlement size, by state

sold, the smaller the high (or general/low) security water entitlements owned the higher the proportion of total entitlement holding to be sold. This supports the findings from Fig. 2.

4.4 Total Water Entitlements Willing to be Sold to the RTB Program

The final pressing policy question we address is whether enough willing sellers will come forward in each region to meet environmental water recovery targets. As mentioned previously, it has been estimated that an additional 3,000–4,000 GL is needed for environmental purposes, which would translate to reductions in annual surface water diversions of 442–593 GL for the Goulburn, 442–592 GL for the Murray in Victoria, 474–635 GL for NSW Murray, 665–892 for Murrumbidgee and 173–232 GL for the Murray in SA (MDBA 2010).

We estimated how much water irrigators are willing to sell to the government for environmental purposes (W_i)[4]:

$$W_{i,t} = EP_{i,t} * ENT_{i,t} \quad (1)$$

where the relevant equation parameters and variables are expressed as:
EP_t expected proportion of water entitlement considered for sale at t; ENT_t total water entitlement owned at t[5]; i southern MDB state; t year, Feb 2009 or 2010–2011.

Table 5 illustrates the results. As at the beginning of 2009, it was estimated that in VIC and SA there was a willingness to sell 236 GL more of high security water to government,

[4] In our volume proportion models of the percentage of the water entitlement irrigators are willing to sell to the Government (volume offered for sale/total entitlement), we predicted a proportion figure for an average irrigator: $\hat{P}_{i,t} = X_{i,t}\hat{b}_{i,t}$ ($X_{i,t}$ is the vector of all independent variables for an average irrigator and $b_{i,t}$ is the respective vector of coefficient estimates). As $\hat{P}_{i,t}$ is the estimated proportion for an average irrigator who reported a proportion value in the survey, we need to take into account those irrigators who did not report a proportion value to calculate $EP_{i,t}$. Hence $EP_{i,t} = \hat{P}_{i,t} *$ preport, where preport is the percentage of irrigators who reported a proportion value in the survey. For example, from the NSW 2010-2011 volume proportion regression, the predicted proportion value for an average irrigator who reported a proportion value is 0.29; and the percentage of irrigators who reported a proportion value in NSW is 0.39. Therefore the expected proportion for an average irrigator in NSW is 0.26*0.39, which is 0.10. As the total entitlement of NSW Murray and Murrumbidgee Irrigation Area was 2,157,700ML (ACCC 2010), this gives us the volume of water Murray NSW and Murrumbidgee irrigators are willing to sell to the government as 215,770 ML (2,157,700*0.10). Note, if other sources of entitlement ownership are used that have higher entitlement numbers, then $W_{i,t}$ will be higher, which would further confirm our conclusion that enough water is available to be sold to the government.

[5] 2010–2011 data sourced from ACCC (2011), 2008–2009 data sourced from GMW (2008) and from information provided by Greg McCarron (Central Irrigation Trust) on the 25/10/10.

Table 5 Total willingness to sell water to the government in 2008–2009 and 2010–2011 in the southern MDB

	2008–2009		2010-2011		
	VIC	Riverland	VIC	SA	NSW
ML willing to sell*	196,040	39,506	125,384	20,968	215,770
Entitlements purchased** (ML)	6,297	427	253,965	49,896	272,420
Guide minimum total target (ML)	884,000	173,000	884,000	173,000	1,139,000
% Target remaining willing to sell	22.3	22.9	19.7	16.4	24.9

* Based on high security entitlements in VIC and Riverland only, and general/high in NSW
** Secured purchases by Federal government in regions (SA, VIC Murray, Goulburn-Broken, Murrumbidgee, NSW Murray) for 2007–2008 and as at 30/09/2010 (DSEWPC 2011)

Table 6 Change in the same farmer's willingness to sell water to the government between 2008–2009 and 2010–2011 in the Riverland and GMID (%)

Willingness to sell water	%				
	1: Not interested	2: Slightly considered	3: Seriously considered	4: Sold	Total
1 Not interested at all	71[a]	12	10	7	100
2 Slighted considered	41	14[b]	27	18	100
3 Seriously considered	28	8	33	33	100
4 Sold	53	12	12	24	100

[a] 71% of those not interested in selling water in 2008–2009 remained not interested in 2010–2011, while 7% had changed their mind and sold water
[b] 14% of those who were slightly considering selling water in 2008–2009 were still slightly considering selling in 2010–2011, while 18% of them had actually sold water

representing 22% of the gap left to be bought.[6] Although the total amount of water willing to be sold fell in VIC and SA (to 146 GL) in August 2010, once taking into consideration the volumes of water already sold, it still represented 19% of the gap left to be bought. NSW irrigators seemed more willing to sell more water back to government, in 2010 their willingness represented 25% of the target left to buy back (though it must be noted that NSW estimates are based on general and high security entitlements).

The above results suggest that although water sales continued in the regions, the percentage of the gap of entitlement left to sell seems to have remained fairly constant. This indicates that more irrigators had decided to move towards selling their water (or sold water) between 2008–2009 and 2010–2011. The question remains as to how constant that gap may stay over the ongoing years of the program. Taken by themselves as a static analysis, they may suggest a lack of willingness to sell water at reasonable prices in the future. Of most interest for this paper is the question about how stable water sale preferences are, and how they change over time. Our surveys were designed to try and investigate this stability. All irrigator names who participated in the 2008–2009 survey were included in the randomly sampled irrigator phone contact lists for 2010–2011, which allowed for the creation of a panel data-set with 214 irrigators in VIC and SA answering both surveys. Table 6 illustrates the change in the same irrigator's willingness to sell water to government from 2008–2009 to 2010–2011.

Overall, 46% of irrigators did not change their water sale preferences over the 2 years, while 22% became less interested in selling their water and 31% become more interested.

[6] Where the percentage of the remainder of the target (RT) is:

$$RT_{i,t} = W_{i,t}/(\text{Guide Total Minimum Target}_i - \text{Current Gov. Entitlements Purchased}_i) \quad (2)$$

Of those who in 2008–2009 stated that they were not at all interested in selling water, 71% were still not interested, 7% had sold and 22% were now thinking about it. Of those who had sold water in the past, half of them (53%) were not interested in selling again. There was considerable movement (positive and negative) in the water sale preferences of those who had been considering selling water. SA irrigators were more likely to have become less interested in selling water in 2010–2011 than VIC irrigators, indicating the importance that past low allocations played for SA irrigators.

5 Discussion

Our results support the notion that a full understanding of why farmers are selling water to government needs to consider a wide array of influences: human; farm; social; financial, institutional and regional capital. One cannot assume that irrigation regions will react similarly. Without a comprehensive understanding of farmer water sale behaviour, policies may be based upon unrealistic expectations of how farmers may react or the consequences of policy intervention.

The surveys over the 2 years revealed that there are primarily two types of water sales: (1) those of last resort primarily driven by debt, and other circumstances such as divorce and death with 44% using the proceeds to reduce farm debts; and (2) more strategic sales influenced by water prices, farm investment plans and water surpluses (which is associated with the size of high security water entitlements), with 16% investing the proceeds in on-farm investment, and 22% in off-farm investment.

In times of lower water prices (as 2010–2011), last resort sales will dominate strategic water sales. Therefore, an increase in water prices will potentially bring in more strategic sellers in the future (although those selling strategically may reduce over time as their available surplus water will fall). Our dynamic analysis of water sale preferences showed that farm decisions such as selling water entitlements do change from 1 year to the next. More farmers over time have moved towards more seriously thinking about selling their water to the government than those who became more negative towards the idea, while half of our panel sample in VIC and SA remained constant in their preferences. But, it is still unknown to what extent NSW irrigators will change their willingness to sell (or not to sell) water, nor at what price an irrigator may decide to come into the market.

In addition, the environmental economics literature on issues surrounding stated preferences suggests that some respondents may have limited information and knowledge about the issue and may be misleading in their answers (Whitehead et al. 2008). It is impossible to rule out strategic bias in our models of future water sale preferences; however, the underlying consistency suggested by the panel-data analysis supports the robustness of our results. Further research will need to provide more insights into the temporal relationship between water sale preferences and compensation demanded.

Although there are high levels of unwillingness by irrigators to sell water back to the government, and our estimates of the current total willingness to sell is less than the total amount needed for buy-back, water sale preferences will change over time. It is therefore probable that enough water entitlements will be offered for sale by irrigators over the program's decade. It does not necessarily mean however that enough entitlements will be available in every particular area in the MDB that the government is seeking to recover water from. In addition, given the high levels of anger and distrust and general unhappiness by irrigators, it seems possible that the buy-back program may need restructuring to address concerns about effectiveness, efficiency and equity.

6 Conclusion

Although there is a lack of interest shown by the majority of southern MDB irrigators in selling water entitlements to the government, an analysis of water sale preferences over 2 years suggests that it is probable that enough water will be offered to the RtB program over the next decade, at least to meet minimum water environmental targets from the Guide. However, future issues associated with the effectiveness of how environmental water holders manage environmental water flow, an increase in the minimum environmental water needs deemed necessary and a need to address significant irrigator concerns with the current program means that a restructure of the buy-back program could be required.

A key conclusion to be drawn from this study is that irrigators are not homogenous when it comes to selling water to the government in the past, and their intention to sell water to the government in the future. To develop an accurate picture of future irrigator water sale behaviour, one needs to consider a wide variety of factors, many of which are socio-demographic. However, attitudinal factors seem to influence future willingness to sell more so than actual sales. Farm and financial characteristics such as water entitlements owned and farm debt are positively associated with water sale behaviour, but they have influenced actual sales of water more so than future willingness to sell water. Increases in future water prices will encourage future water offers. The history of each irrigation region's water allocation, drought experience, institutional policy issues, regional factors and the different trends in major commodity prices (and its corresponding impact on farm income) are all additional influences on irrigators' decisions over what to do with what many consider to be their most valuable asset.

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Appendix A: Factor Analysis of 2008–2009 Irrigator Attitude Questions

Factor analysis was used in both years to identify the underlying value constructs from the 56 attitudinal questions. Given space restrictions, only the full factor analysis results for 2008–2009 are reported here (as the results for 2010–2011 found very similar value constructs, full results by request to the authors).

For the Riverland, 19 value statements (from the initial 56), were in the final factor analysis after 37 unsuitable statements were removed and for the GMID, 15 value statements were in the final factor analysis. Principal components factor analysis was used to fit the data to reduce the number of variables into a manageable number of factors and allow us to use the factor scores for each respondent as variables in subsequent regression analysis (Wilson 1976).[7] Five factors with eigenvalues above one were identified. The total variance

[7] The diagnosis indicated the appropriateness of the retained variables for factor analysis. Specifically the determinant of the correlation matrix is 0.02 and 0.06 for the Riverland and GMID, respectively (this determinant will equal 1.0 only if all correlations equal 0); Bartlett's test (null: variables are not intercorrelated) was rejected for both states and the Kaiser–Meyer–Olkin Measure of Sampling Adequacy was 0.73 and 0.72 for Riverland and VIC, respectively [unacceptable if below 0.5 (Kaiser 1974)]. For the Riverland, five factors with eigenvalues of 3.3, 2.4, 2.0, 1.4 and 1.3 were identified, which accounted for 17.3, 12.5, 10.5, 7.3 and

Table 7 Irrigator questions used

	Riverland					GMID				
Variable	Succession	Commerce	Tradition	Environment	Technology	Succession	Commerce	Tradition	Environment	Technology
q1. Family should be an integral part of the farming enterprise	0.79					0.63				
q2. I would like some or all of my family to continue farming	0.74					0.76				
q3. Farmers should encourage family members to be involved in family farm	0.76					0.75				
q4. I would like to buy or develop enough land for my family to remain or to become farmers	0.64					0.72				
q5. Financial gain is the only reason for my involvement in farming		0.74								
q6. Dollars and cents is what farming is all about		0.68					0.80			
q7. A maximum annual return from my property is my most important aim		0.67								
q8. I view my farm as first and foremost a business enterprise		0.61								
q9. My land is just something I use to generate an income		0.66					0.72			
q10. I could never imagine living anywhere other than this area			0.80					0.81		
q11. I want to continue farming for as long as I am able			0.64					0.53		
q12. Farming is the only occupation I can imagine doing			0.72					0.64		
q13. My life would be worse if I moved from this farm			0.72					0.78		
q14. I try to preserve the beauty of the countryside				0.69					0.78	
q15. Managing environ. problems on my farm is a very high priority				0.73					0.73	

Table 7 continued

Variable	Riverland					GMID				
	Succession	Commerce	Tradition	Environment	Technology	Succession	Commerce	Tradition	Environment	Technology
q16. I am willing to do something about the environmental effects of my farming practices				0.61					0.57	
q17. The wider community can reasonably expect landholders to adopt recommended practices that lead to improved environmental outcomes				0.70						
q18. Knowing about new technology that becomes available is important to me					0.85					0.89
q19. I am open to new ideas and alternatives about farming					0.81					0.85
Proportion of Variance Explained	12.5	10.5	17.3	7.3	6.6	20.2	7.1	13.7	8.3	10.1
Determinant of the correlation matrix	0.02					0.06				
Bartlett test of sphericity (χ^2; p value)	1,157.4; 0.00					822.1; 0.00				
Kaiser–Meyer–Olkin measure of sampling adequacy	0.73					0.71				

Total $n = 546$. Answers were given on a five point Likert scale (1 = strongly disagree, 5 = strongly agree)

Table 8 Summary statistics table

	2008–2009		2010–2011	
	Mean	SD	Mean	SD
EnvWaterSale	0.07	0.26	0.12	0.32
EnvWaterWill	1.67	0.82	1.54	0.79
Age	54.65	10.90	54.61	11.03
Gender	0.85	0.35	0.89	0.31
Lowedu	0.40	0.49	0.16	0.37
Tradition	0.02	1.00	−0.02	1.01
Succession	0.03	0.99	–	–
Commerce	0.002	1.00	−0.00	0.98
Environment	0.01	0.99	0.01	0.99
Child	–	–	2.80	1.37
Info_gov	0.66	0.47	0.08	0.27
Alloctrade	0.14	0.35	0.32	0.47
Entitlementsale	–	–	0.16	0.36
Cap	–	–	0.17	0.38
Farm plan	0.69	0.46	0.72	0.45
FTE	2.48	4.22	2.21	2.83
Farmsize	3.73	1.78	4.57	2.05
HSwater	5.12	1.32	4.19	2.42
HS/Gwater	–	–	834.41	1, 226.61
Annualcrop	5.48	16.80	33.54	40.92
Hort	45.59	46.79	30.67	45.30
Osurplus	6.19	5.09	6.55	5.07
Debt	262.19	661.01	0.40	0.38
Endalloc	76.78	0.40	50.94	19.35

– indicates variable is not available

accounted for by the five factors was 54% for the Riverland and 59% for the GMID and this was regarded as satisfactory (Hair et al. 1998).

Table 7 displays the relevant questions after Promax rotation was used and factor loadings below 0.30 were considered as insignificant both statistically (Stevens 2002) and practically (Hair et al. 1998) and thus dropped. The variables included in the first factor (factor loading bigger than 0.3) are all related to the dimension of family; hence we named this construct *Succession*. The variables included in the second factor relate to the profitability of the farm business; hence, it was named *Commerce*. The third was *Tradition*, the fourth *Environment* and the fifth *Technology*. Thompson's regression method (Thomson 1951) was used to predict the five factor scores for each irrigator (Table 7).

Appendix B

See Table 8.

Footnote 7 continued
6.59% of the variance, respectively. For the GMID, the five factors identified have eigenvalues of 3.0, 2.1, 1.5, 1.2 and 1.1, which accounted for 20.2, 13.7, 10.1, 8.3 and 7.1% of the variance, respectively.

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