The Implications of Information Asymmetry for the Achievement of Australia's National Water Objectives

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ABSTRACT

On 29th April 2008, Senator Penny Wong outlined details of Water for the Future; the Rudd Government's $12.9 billion plan to secure the long term water supply of all Australians. Funding under Water for the Future will be used to support significant water reform across the country. In order to formulate strategies to achieve the objectives of the Plan, decision makers will require information related to the relative profitability of different irrigation activities, such as production costs and returns, as well as the potential irrigator response to and impacts of reductions in water availability or changes to water policy more generally. The aim of this paper is to highlight the potential for unexpected outcomes to arise from policies which are formulated in a world of information asymmetry. The heterogeneity of irrigation sectors and indeed individual irrigators within these sectors mean that actual impacts or responses will vary significantly between sectors/individuals. Hence while governments may try to predict the potential consequences/impacts of changes to water policy, the resulting outcomes may be far from what was intended.

Key Words: Crop Deaths; Irrigator Behaviour; Economic Assessment; Water Policy

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[2] All responsibility for the content of this paper remains with the authors. The views expressed in this paper are the author's and should not be taken to represent the views of the South Australian government.

1 Introduction

On 29th April 2008, Senator Penny Wong outlined details of Water for the Future, the Rudd Government's $12.9 billion plan, Water for the Future, a long-term plan to secure the long term water supply of all Australians. Funding under Water for the Future will be used to support significant water reform across the country.

Water for the Future, formerly the National Plan for Water Security, is the culmination of a number of years of water reforms in Australia. Table 1 below highlights the staged efforts of national water reform going back to CoAG negotiations of 1994.

Table 1: Recent history of national water reforms

Year	Major Australian Policy Initiative
1994	COAG Water Reform Framework within National Competition Policy
1995a	MDB Cap introduced
1995b	Water reform implementation linked to competition payments
1998	MDBC commenced Pilot Interstate Water Trading Trial
2001	National Action Plan for Salinity and Water Quality
2002	MDBMC started Living Murray process
2003	COAG agreed, in principle, to implement a NWI
2004	COAG finalised NWI
2007/08	Water for the Future (Formerly National Plan for Water Security)

Source: Young and McColl (2009)

In order to formulate effective strategies to achieve the objectives of the Plan, decision makers will require information related to the relative profitability of different irrigation activities, such as production costs and returns, as well as the potential irrigator response to and impacts of reductions in water availability or changes to water policy more generally.

Only by analysing such data can decision makers hope to predict and understand the potential consequences of changes to water policy. Even when such analysis is undertaken, results presented or the conclusions drawn from them are often based around industry averages/benchmarks and assume that each irrigator/farmer within the same sector has the same cost and return structure.

However, given the large degree of heterogeneity of irrigators within any sector, the actual impacts of changes to water policy may be significantly different to those predicted based on an analysis of industry benchmarks or averages.

As stated by Watson (2008), "Irrigation farmers and irrigation areas vary in economic efficiency and their environmental effects. The relative profitability of irrigated industries has changed radically in the past and will in the future."

For example, while it may be true that the average citrus grower is less profitable than his/her Winegrape counterpart, some citrus growers would be more profitable or generate more value added than some wine grape growers.

Hence any attempt by decision makers to formulate strategies and policies based on limited industry level data may lead to perverse outcomes as irrigators respond differently than expected.

Section 2 below tables the estimated aggregate cost of perennial tree crop death along the South Australian River Murray corridor. It then goes on to highlight an example of the heterogeneity of horticultural industries by tabling estimates of the Marginal Value Product (MVP) of water for different crop types and age profiles.

Section 3 then goes on to discuss some of the methodological and other issues associated with the analysis, while section 4 then summarises the key findings and provides some advice as to the appropriateness of policy formation based on incomplete information/analysis that treats irrigators as being homogenous.

2 Estimating the Marginal Value Product of Water

Methodology

In order to inform on the potential impacts of reduced irrigation water availability, a set of development budgets for the 5 main horticultural and viticultural crops along the SA River Murray corridor were developed. These represented Riverland Grapes (warm climate), Lakes Grapes (cool climate), Almonds, Citrus, and Stone fruit (see Appendix A for an example).

Development budgets were chosen rather than gross margin budgets as they accounted for the capital cots associated with crop establishment, an important factor in determining the longer term returns to water use. These development budgets were used to estimate the net cost of perennial tree crop death as well as to assess the difference in the short and long-run profitability (rates-of-return) given a certain assumption about crop water use in the current year (either nil, crop survival, or normal requirements for production).

For a crop that received:

- *nil* water this year, it was assumed that the crop would be removed and replanted over the next 3 years;
- *survival* requirements this year, it was assumed that there would be a yield reduction for the next 3 irrigation seasons after which the crop returned to normal[3];
- *normal* production requirements, there were no changes to the normal production levels.

Using the development budgets in this way enabled a calculation of the difference in value of each of the water application options.

This was estimated by comparing the Net Present Value (NPV) over 30 years of the future income streams for a hectare of each crop type which received either a nil, minimum or normal production water allocation this season. In order to calculate this NPV, a discount rate of 8% was utilised.

When divided by the amount of water required for each option, this provided estimates of the returns to water, the MVP of water, at differing levels of water use (survival and normal requirements) in the current irrigation season.

[3] Provided that this crop received adequate water in following years

Results

Net Cost of Perennial Tree Crop Death

The first result worth noting from the analysis is estimated net cost of perennial tree crop death along the South Australian portion of the River Murray.

Initial indications are that if all permanent horticultural crops in South Australia reliant on River Murray irrigation water were to die from lack of water, that the NPV (8%) of income foregone would be of the order of $20-$30,000/ha for vines and up to $70,000/ha for tree crops. This cost represents the difference between maintaining the current replanting schedule[4] for all trees/vines (which will depend of the remaining lifetime of the trees/vines), versus replanting over the next 3 years with associated yield losses until the trees/vines reach maturity.

If no water was made available and all current plantings were lost, this would represent a loss of future earnings, due to bringing replanting schedules forward, of about $1,350 million. This estimate assumes normal water allocations are available from the next irrigation season onwards and that all crops are replanted within the first 3 years of destruction[5] to minimise the value of lost production.

Clearly not all crops would be replanted. Some growers could not afford to replant and there would be insufficient planting material available. Any delays in replanting would increase the cost of losses. However replanting with more profitable varieties would help offset losses.

The estimate of $1,350 million does not include losses that would be experienced by the vegetable industry or from irrigated pastures reliant on River Murray irrigation water.

Returns to Water by Application Level

Another key message from this analysis is the value which irrigators place on water at differing levels of application. Irrigators who are yet to irrigate their crop place quite a relatively high value on the water because it enables them to ensure the survival of their trees and avoid the capital costs associated with replanting and yield losses until the replanted crops reach maturity. Once a crop has received sufficient water to enable survival, the MVP of water declines as the extra water use now only generates output, rather than avoiding significant future yield losses and securing capital assets. This is also supported by the findings of Bjornlund and Rossini (2007) who state that "…irrigators are likely to suffer significant long-term losses if they do not irrigate. They are therefore willing to pay prices in excess of the productive

[4] In which all crops are replanted 30 years after establishment.
[5] Insufficient planting materials will mean that not all crops can be replanted immediately. The assumption used is that 1/3 of the crop is replanted in year 1, 1/3 in year 2, and the remaining 1/3 in year 3.

value of water in order to protect their assets and stay in business for the next season”).

Table 2 below shows the estimated MVP of survival water for each crop type at varying ages. The equivalent MVP’s of water for normal production are then tabled in table 3.

Table 2: Marginal value product of survival water by Crop and age

	Remaining Life of Plantings				
	5 Years	10 Years	15 Years	20 Years	25 Years
Citrus	$6,000	$7,400	$8,400	$9,100	$8,700
Riverland Wine Grapes	$300	$4,300	$7,100	$8,900	$10,200
Lakes Wine Grapes	$100	$6,400	$10,700	$13,600	$15,600
Almonds	$3,400	$4,900	$6,000	$6,700	$7,100
Stone Fruit	$5,200	$7,500	$9,100	$10,200	$10,900

Table 3: Marginal value product of normal production water by crop and age

	Remaining Life of Plantings				
	5 Years	10 Years	15 Years	20 Years	25 Years
Citrus	$3,000	$3,000	$3,000	$3,000	$1,100
Riverland Wine Grapes	$3,600	$3,600	$3,600	$3,600	$3,600
Lakes Wine Grapes	$7,400	$7,400	$7,400	$7,400	$7,400
Almonds	$3,700	$3,700	$3,700	$3,700	$3,700
Stone Fruit	$3,400	$3,400	$3,400	$3,400	$3,300

Table 2 above shows that the crops with the longest expected lifetime remaining yield a relatively higher MVP of survival water. These are the crops for which replanting/capital expenditure is not expected in the near future, and hence by providing these crops with survival water the irrigator is avoiding bringing forward capital expenditure that has only more recently been made. The only exception is Citrus, which drops from 20-25 years as it has not yet reached full maturity.

Table 2 also highlights the variability in the estimates, with the rankings of MVP of water between crops dependant upon the costs and returns of each sector, and seemingly just as significant, the age of the specific crop being irrigated.

Table 3 shows that the MVP of water for production ranges between $3,000 - $7,500/ML, depending on the crop type. This figure represents the value of water used in a normal production regime. This figure is the same for all ages of crops except those that have not yet reached maturity (as the potential returns from water use are biophysically constrained). This is shown in table 3 above by the fall in MVP of water for citrus and stone fruit crops that have 25 years of life remaining, as these crops have still not reached maturity[6].

[6] Assuming that all crops are due to be re-planted every 30 years

Discussion

Drawing on the estimates provided in section 2.2 above, this section highlights the range of possible outcomes for a specific irrigator with a 10 hectare mixed horticulture/viticulture enterprise. This range of potential outcomes highlights the difficulty in predicting the actual response of irrigators, which will be dependant upon factors such as the irrigator's costs and returns, the level of management experience, other attitudinal/motivational factors and also whether he/she has a short-term vs long-term focus.

The purpose of this section is to show that decision-makers who use this type of analysis for policy formation may inadvertently create distortions or under/over-estimate the potential impacts of policy due to having incomplete information. That is, it is not only heterogeneity between crop types that create the potential for mis-allocation of resources/inefficient policy outcomes, but also the heterogeneity of same crop irrigators and the range of other non-economic motivations of these irrigators (Bjornlund and Kuehne 2008).

Case Study

This case study is based on a fictitious River Murray irrigator with a 10 ha property in the Riverland region of South Australia, with a crop mix consisting of 5 ha of wine grapes and 5 ha of citrus.

Assume that this irrigator has a River Murray water entitlement of 100ML, and that in light of current water scarcity a 18% water restriction means that this irrigator will only be allocated 18ML for use. It will also be assumed for this analysis that the irrigator does not have access to carry-over water or trade.

Given an allocation of 18ML, this 10ha irrigator has a myriad of options in terms of potential water application. Not only does the irrigator have to decide whether to use the water on the citrus crop or the wine grape crop, but he/she also has to decide whether to use the available water to ensure survival of the permanent plantings or achieve at least some positive level of production.

Table 4 below highlights the varying water requirements for a citrus and Riverland wine grape crop. The remainder of this section goes on to highlight the potential range of outcomes, in terms of returns to water use and crop deaths, given a different management response/option selected by the irrigator. Tables 5, 6 and 7 then summarise these results

Table 4: Water requirements for citrus and Riverland wine grapes

	Water Requirements	
	Survival Needs (ML/ha)	Normal Production (ML/ha)
Citrus	5.0	9.7
Riverland Wine Grapes	2.5	6.9

Option 1: Survival of an Equal Mix of Permanent Plantings

For option 1, the irrigator is assumed to apply the 18ML of available water to ensure the survival of as much of his/her permanent plantings as possible. It was assumed here that the water use was split 50:50 between the 2 crops, with 9ML going to citrus, and 9ML to grapes.

Results show that option 1 generates a theoretical return of between $57,000 and $174,000, depending on the age profile of the crops that the water is applied to. However, there is not enough water to keep all 10ha of trees alive. Net cost of tree deaths of around $149,000 to $220,000 leaves the irrigator between $46,000 and $92,000 worse off.

Option 2: Survival of Citrus Plantings

For option 2, the irrigator is assumed to apply the 18ML of available water to ensure the survival of as much of his/her citrus crop as possible. Given a survival need of 5ML/ha, this is enough to keep close to 4 ha of crop alive.

Results show that option 2 generates a theoretical return of between $109,000 and $163,000, depending on the age profile of the citrus trees that the water is applied to. However, there is not enough water to keep all 10ha of trees alive. Net cost of tree deaths of around $128,000 to $445,000 leaves the irrigator between $19,000 and $282,000 worse off.

Option 3: Survival of Wine Grape Plantings

For option 3, the irrigator is assumed to apply the 18ML of available water to ensure the survival of as much of his/her wine grape crop as possible. Given a survival need of 2.5ML/ha, this is enough to keep all 5 ha of wine grapes alive, as well as 1 ha of citrus.

Results show that option 3 generates a theoretical return of between $37,000 and $178,000, depending on the age profile of the trees that the water is applied to. However, there is not enough water to keep all 10ha of trees alive. Net cost of tree deaths of around $177,000 to $237,000 leaves the irrigator between $59,000 and $140,000 worse off.

Option 4: Maximise Short-Term Production of Wine Grapes

For option 4, the irrigator is assumed to apply the 18ML of available water to maximise the production of wine grapes in the current irrigation season. Given a full production requirement of around 6.9ML/ha, this is enough to fully irrigate around 3 ha of wine grapes.

Results show that option 4 generates a theoretical return of between $5,000 and $184,000, depending on the age profile of the wine grape trees that the water is applied to. However, there is not enough water to keep all 10ha of trees alive. Net cost of tree deaths of around $254,000 to $379,000 leaves the irrigator between $195,000 and $249,000 worse off.

Table 5: Returns to water use for each option

	Returns to Water								
	Citrus ($'000)			Grapes ($'000)			Total ($'000)		
Option 1	$54	-	$82	$3	-	$92	$57	-	$174
Option 2	$109	-	$163	$0	-	$0	$109	-	$163
Option 3	$33	-	$50	$4	-	$128	$37	-	$178
Option 4	$0	-	$0	$5	-	$184	$5	-	$184

Table 6: Net cost of tree deaths for each option

	Cost of Tree Death											
	Citrus				Grapes				Total			
	(ha)	($'000)			(ha)	($'000)			(ha)	($'000)		
Option 1	3	$132	-	$178	1	$17	-	$42	4	$149	-	$220
Option 2	1	$44	-	$237	5	$84	-	$208	6	$128	-	$445
Option 3	4	$177	-	$237	0	$0	-	$0	4	$177	-	$237
Option 4	5	$221	-	$296	2	$33	-	$83	7	$254	-	$379

Table 7: Net position for each option

	Net Position		
	Total ($'000)		
Option 1	-$92	-	-$46
Option 2	-$282	-	-$19
Option 3	-$140	-	-$59
Option 4	-$249	-	-$195

3 Predicting Irrigator Behaviour

In summary, the results of the analysis and associated case study presented in section 2 above highlight the uncertainty surrounding an irrigator's response to and the impact of a change in their operating environment. This change can be either a reduction in water availability, as is the current case with River Murray irrigators, or indeed a change in any other policy that will force irrigators to deviate from their 'normal' management/production regime.

While the analysis in section 2 of this paper highlights the result of a desktop study utilising a full crop lifecycle NPV approach, there are a number of other tools commonly used by analysts to predict the implications of proposed changes to the policy environment. These could include gross margin analysis, cost-benefit analysis, linear programming, surveys, or Computable General Equilibrium (CGE) modelling.

Policy/decision makers who base their opinions on the predicted outcomes of any such tool commonly disregard the heterogeneity of crop types and indeed individual irrigators. Hence while the desired outcomes of policy changes may be achieved for those irrigators who are reflective of industry averages, the actual outcome will be wide and varied depending on a number of attributes/motivations of irrigators.

As discussed widely in the literature, irrigators decision making processes can be influenced by a number of factors other than economic, including an irrigator's choice between instrumental, intrinsic, social or personal goals (Gasson and Errington, 1993). Instrumental goals relate to maximising income while intrinsic goals might be the value of the work; a social goal for example could be to maintain family tradition while personal goals could be being recognised as a good farmer (Bjornlund and Kuehne, 2008). Sovereign risk may be another influencing factor, and other authors have also suggested that an irrigator's attitudes and personality may impact on their management response (Shrapnel and Davie, 2001).

As a result, even the most informed policy analysts with access to the best available knowledge will not be able to accurately predict the consequences of policy changes.

4 Implications for Policy Formation

The implication of this is that policy makers will not necessarily know what's best for individual irrigators as they cannot base their assertions on the assumption that all irrigators will behave in an economically rational manner.

There are a large range of other factors that irrigators take into account when choosing the appropriate management response to a change in their operating environment.

Even if the irrigators did respond in an economically rational way, there is such heterogeneity between irrigators that the actual outcomes of the policy change are still likely to be significantly different from those that were pre-determined/expected.

As such, policy makers should avoid policy formation that attempts to steer a particular industry or sector towards a predetermined outcome based on individuals' expected responses. An industry's overall response to a change in policy is made up of the response of individuals within the industry, and these are the only people best placed to decide the optimal response. Rather, where appropriate, policy makers should draw upon the knowledge available at the individual irrigator/farmer level to help achieve outcomes that are best suited to individual circumstances.

An example of such an approach is the Victorian Bush Tender scheme.

"BushTender is an auction-based approach to improving the management of native vegetation on private land. Under this system, landholders competitively tender for contracts to better protect and improve their native vegetation. Successful bids are those that offer the best value for money, with successful landholders receiving periodic payments for their management actions under agreements signed with DSE. These actions are based on management commitments over and above those required by current obligations and legislation." (DSE, 2009)

Auctions are a process in which there is a sharing of information that would have otherwise been hidden in the decision making process, enabling better outcomes to be achieved. An auction would require a landholder to specify their costs or benefits (i.e. to achieve a certain biodiversity outcome as per BushTender or the amount of water they could provide for a given price in a water buyback scheme), depending on the nature of the auction in question.

"The Restoring the Balance in the Murray-Darling Basin Program"[7] of the Federal Government's "Water for the Future" plan utilises a similar tender process. "The principal water purchase method to be adopted is a public tender mechanism whereby irrigators considering selling their water entitlements can voluntarily submit a sell offer to the Department. Sell offers

[7] Or, water buy-back.

will be assessed every one to two weeks and vendors immediately advised of the outcome.” (DEWHA, 2008)

An independent review of the initial round of the water purchasing program (WPP) was conducted by Hyder consulting. The review found that the program had been well-managed, and was appropriate, effective and efficient in its purchases (Hyder Consulting 2008).

5 Conclusion

In summary, the findings reported above highlight how potential information asymmetry can lead to perverse policy outcomes. This is mainly due to the significant heterogeneity between individual irrigators and indeed irrigation sectors more generally, that may not be taken into account during the policy formation process.

Irrigators can respond to policy changes in numerous ways, depending upon a suite of attitudinal/personal/economic motivations. Policy makers can therefore not expect to be able to predict an industry’s aggregate response as it will be made up of a collection of individual irrigators, sometimes economically irrational, responses.

To improve the use of model estimates for decision making, policy analysts should invariably consider a range of potential outcomes, based around the sensitivity of the model to changes in key assumptions. Models are very useful in highlighting the potential scale and orders of magnitude.

Finally, when selecting instrument design for the achievement of policy outcomes, tenders and auctions are example approaches that aid in extracting vital information from individuals, potentially increasing the efficiency with which outcomes can be achieved.

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APPENDIX A – Example Development Budget

Riverland Wine Grapes Analysis

	Water Use ML	Normal	Production This Year Y1	Y2	Y3
Normal Water	6.9	24	90%	100%	100%
Minimum Water	2.5		0%	50%	90%
50% Yield Water					
Avg Price ($/t)	527				
Variable Costs 1	3750	Non-Yield Related			
Variable Costs 2	30	Yield Related			

Discount rate **8%**

River Grapes Re-Development Budget

		YEAR 0	1	2	3	4	5	6	7	8	9	10
	% of Full Production	0%	15%	50%	75%	100%	100%	100%	100%	100%	100%	100%
	Production (t/ha)	0	3.6	12	18	24	24	24	24	24	24	24
	Gross Income	0	1897	6324	9486	12648	12648	12648	12648	12648	12648	12648
Development Costs												
	Site Clearance	880										
	Drippers	4000										
	Vines	6000										
	trellising	11000										
	Other	1650	1700									
Annual Costs												
	Non-Yield Related	0	3750	3750	3750	3750	3750	3750	3750	3750	3750	3750
	Yield Related	0	108	360	540	720	720	720	720	720	720	720
Total Costs		23530	5558	4110	4290	4470	4470	4470	4470	4470	4470	4470
	Cash Surplus/Deficit	-23530	-3661	2214	5196	8178	8178	8178	8178	8178	8178	8178

IRR **20.8%**

Lifetime Remaining (Years) 25

NPV of Existing Planting:	$87,938
NPV of Replanting:	$46,383
NPV with Minimum Water This Year:	$71,938

	$	**$/ML**
Net Cost of Nil Water This Year:	$41,555	N/A
Benefit of Receiving Minimum Water This Year:	$25,555	**$10,222**
Benefit of Receiving Normal Water (on top of Minimum):	$16,000	**$3,636**