MONITORING THE IMPACTS OF WATER TRADING - SOME METHODS AND RESULTS FROM AN AUSTRALIAN WATER MARKET

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Introduction

Water markets have been introduced in many jurisdictions, and are still being promoted in many others, as a key economic instrument to facilitate a reallocation of existing water between competing users and to encourage water conservation. This is done to achieve two objectives: i) avoid or defer investments in supply infrastructure and thereby reduce the associated financial, political, social and environmental costs by voluntarily transferring water from existing to new users; and ii) reallocate exiting scarce resources from inefficient low value users to efficient high value users. It is anticipated that this will reduce the socioeconomic impact of reallocating water away from existing users (irrigation) to meet increased demand from new or expanding users (the environment, recreation, and urban).

However, the introduction of water trading has been widely opposed within irrigation communities and among environmental advocates. Community concern is associated with the social and community impacts in the regions depending on irrigation as their economic engine while individual irrigators are concerned about the future viability of their supply infrastructure. Environmental concern is associated with the potential impact of trading water from one location to another and from one use to another and from potentially increasing total water extraction as trade activates unused allocations. Proponents of water markets argue that the socioeconomic benefits from trading water into new areas and uses by far outweigh the potential cost of moving water out of existing areas and uses.

In response to both the social and environmental concern increased reliance is placed on monitoring the impact of trading so that policies can be adapted over time to ensure socially, environmentally, and economically sustainable or acceptable outcomes. Australia has implemented aggressive policy reforms since the early 1990s, this process of reforms gained momentum in 2004 with a National Water Initiative, which, among other things, calls for more efficient and sophisticated water markets. As part of this process, as well as the process of developing water sharing plans, the monitoring of the socioeconomic and environmental impacts of trading and new allocation outcomes has been an integral requirement of implementing authorities.

This paper reports on a research projects to develop a method to cost effectively monitor the operations, outcomes and impacts of water market within the Goulburn-Murray Irrigation District in northern Victoria, Australia (GMID). As part of this project water traders were surveyed over a three year period, water trading and entitlement registers were analyzed over a 13 year period, and water market prices and activities over a 15 years period. The first section briefly outlines the evolution of water markets in Australia; this is followed by a discussion of the development of water trading within the GMID. The third section provides a review of the existing literature. The fourth section describes the monitoring process while the fifth section provides an evaluation of key outcomes.

The evolution of water market policies in Australia

When discussing water markets it is important to understand that two different markets exist. There is the market in which the long-term entitlement to receive water allocations each year is traded- the entitlement market. In the second market the short-term right to use a certain volume of the seasonal allocation is traded while the long-term entitlement remains the property of the seller - the allocation market. Water markets both for entitlements and allocations were first introduced in South Australia in 1984 in response to the Government's decision to stop issuing new licenses and

to actually reducing existing licenses according to history of use. These decisions created a demand from new water users for a mechanism to enable them to access water. Water markets were proposed as this mechanism as it would facilitate a voluntary reallocation of water between existing and new water users. The same year Allocation markets were introduced in New South Wales. In 1987 allocation markets were piloted within the GMID. Entitlement markets were introduced in NSW in 1989 but trading involving district irrigators did not commence until the process of privatizing the districts was completed. In 1989 both allocation and entitlement markets were introduced by the new Water Act in Victoria. However, entitlement trading did not commence until new trading regulations were approved in September 1991.

With the new CoAG (Council of Australian Governments) Water Reform Framework in 1994 all Australian Governments were committed to introduce and promote the use of water markets. This reform process was strengthened with the National Water Initiative in 2004. As part of this initiative water markets were further promoted as a decision was made to ensure nationally compatible water entitlements, trading processes and entitlement registers as well as an unbundling of the rights embedded in the traditional water right. An important decision was to remove barriers to trade entitlements out of existing irrigation districts. Until then each state had different restrictions on such trade making it virtually impossible or very limited in South Australia and New South Wales, while restrictions in Victoria were more liberal, resulting in quite substantial movements of water out of some district. Originally water markets were predominantly promoted as a means to meet new demand and reallocate water from inefficient low value users to efficient high value users. Recently governments have placed great expectations on water markets an instrument to ensure water for the environment by allowing them to purchase water from existing users.

Throughout this process there has been significant opposition to entitlement trading especially export of entitlements out of districts or out of certain supply channels (Bjornlund, 2004a, Edwards et al, 2008). This concern is both from individual irrigators and the wider communities dependent on the irrigation industry. The concern of individual irrigators are three fold, they fear that if substantial volumes of water is traded out of any given supply system then: i) the cost of delivery of water would increase to levels where they could not afford to continue to irrigate; ii) eventually some supply systems will be closed; and iii) many irrigated properties would be left as unfarmed dry land which could develop into heavens for pest and weeds spreading to neighboring properties. Community concerns are two fold: i) irrigation creates a lot more economic activity and jobs than does dry land farming. Hence, export of water out of regions could result in reduced economic activity and fewer jobs. This could result in a migration of people, businesses and services; ii) if water is sold off a farm then its value will be reduced. Farm value is the basis for council rates; export of water out of districts could therefore result in a declining revenue base with two potential outcomes: i) other rate payers have to pay more; or ii) the level of services will decline.

Recognizing these concerns Victorian water reforms have introduced a separate supply capacity charge. This charge is set to cover the maintenance cost of the supply infrastructure and is linked to the land. If farmers sell their water they are still responsible for paying for the capacity share unless they can sell it to another farmer supplied by that channel. Hence, the income stream to pay for maintenance is secured to be constant. It was also for the first time acknowledged that some channels will have to be closed since a lot of water has been traded out, this will leave some farmers without supply. The government has guaranteed such farmers compensation for loss of land value as a result of the channel closure. The farmers will still retain their water right which they can sell in the water market. The compensation will therefore only cover the loss of land value associated with the fact that the property can not any longer be irrigated.

The development of water trading within the Goulburn-Murray Irrigation District

Looking at the volume traded in the two markets it is evident that trading in the allocation market was adopted much earlier than in the entitlement market. This has consistently been the case across Australia and also other countries such as the United States and Canada (Nicol et al. 2008). This

reluctance to adopt the entitlement market reflects initial concern about the potential impact of water trading and how much water should be trading for, unfamiliarity with the market process, relative complexity and associated transaction time and cost and uncertainty about final approval of entitlement transfers, as well as an inherent belief that water is an integral and inherent part of an irrigation farm (Bjornlund, 2003; Tisdel and Ward, 2003). Entitlement trading took 12 years of market experience to consistently trade above 1% of the total entitlement pool each year (2002/03). Since then activities has tripled to almost 3.5% by 2006/07. Compared to this it is apparent that activities in the allocation market have expanded very rapidly to account for 18% of the entitlement base each year.

Recognizing that until now it has been the allocation market that has been most active in moving water around between users, a second and very important measure of market activities is how important the allocation market is in determining who gets access to water in any given season. It is clear that as the seasonal allocation level declined since the mid 1990s water traded in the allocation market has accounted for a larger and larger proportion of total water use during any given season. When the allocation level remains at historical levels around 200% less than 5% of total water use is accessed through water markets. However, when allocation levels drops to 100% and below, then the allocation market plays an increasingly important role in determining who gets the right to use water. With water purchased in the allocation market constituting up to 20% of total water use when allocations is at 100% and up to 37% of total water use when the allocation dropped to as low as 29% in the Goulburn System during 2006/07. There is clear evidence that the allocation market are playing an extremely important role in who gets access to water during periods of scarcity.

Previous monitoring of outcomes of water trading

Until now monitoring of the outcome of water trading has not been instituted on an ongoing basis. Researchers have surveyed irrigators at various times to identify what is going on in the market to establish how irrigators perceived and used the market and identify the impact of trading, at a given time (Bjornlund 2002, 2004b, 2005a, 2006; Tisdel and Ward, 2003; Crase et al. 2000, 2004). This research was based on surveys during the early years of water trading and indicated that the entitlement market did facilitate the anticipated reallocation of water from lower valued and inefficient farmers to higher valued and more efficient farmers (Bjornlund 2004b). However, the majority of water sold had never been used by the sellers. This fact caused some concern and opposition among buying irrigators as they saw this as a wealth transfer since the selling farmers had never done anything to put the water to beneficial use. This concern was also driven by the fact that total use within the Murray-Darling Basin (MDB) had been capped and as trading activated previously unused water the seasonal availability of water for existing irrigators was reduced. In summary, due to the low level of trading within the entitlement market it had a low overall impact on how water is allocated and used.

Policy makers' initial expectation was that active entitlements markets were a precondition for markets facilitating substantial farm and structural adjustment in the irrigation industry. It was expected that farmers would require the long-term control over water to make the necessary investments in farm adjustment or to invest in new irrigation enterprises as such developments are capital intensive and require a long time period to provide a reasonable return on capital. However, experiences have shown that the allocation market has played a much more important role in facilitating farm and structural adjustment than the entitlement market (Bjornlund 2002, 2004b, 2006a). The research by Bjornlund (2002) indicated that irrigators use the allocation market very active to manage their position in the farm and structural adjustment process. There are three main categories of both buyers and sellers in the allocation market: the non-adjusters or strugglers, the adjusters and the comfortable farmers. The largest group is the non-adjuster or strugglers accounting for some 57% of all irrigators. This group has given up developing their properties to be long-term viable but try to avoid exit adjustment until intergenerational change. They try to stay on the farm and within the community for the rest of their life to retain their lifestyle, community, network of friends and family, and the only work they know how to do. The sellers try to do that by

generating a sufficient household income by combining off-farm work with water sales and some farming activity. Twelve percent of all sellers seem to sell all their water each year and never irrigate. The buyers in this group use the allocation market to buy just enough water to retain their production during a period of low seasonal allocations, to be able to retain their dairy herd and keep in business. The second largest group is the adjusters; these farmers are buying and selling water as part of a process of adjusting their farms to become long term viable. Some buy water allocations to facilitate this process as they can not afford to buy water entitlements as all their available capital goes into improving or expanding their production and irrigation and drainage infrastructure. They plan to buy more water entitlements once they have their farm developed and long-term viable. Others are in the process of developing their farm to increase their irrigated production, while doing this they have excess water available each year and therefore sell it in the allocation market to help finance the development cost. The final group consists of the more financially comfortable farmers. They have larger more profitable farms which have stayed in the family for several generations. These farmers are already developed to be long-term viable. They are using the allocation market to adjust their water availability on the margin each year depending on the price of water in the market and the price of the commodities they can produce. In some years they sell in others they buy depending on how they consider they will be best off each season. Other farmers have large entitlements with limited irrigated production in cereal or grazing for cattle and sheep, they have permanent excess water most years which they sell in the allocation market as they perceive that they are better of holding on to their entitlements.

There is clear evidence that the impact of the allocation market is that the use of water (if not the ownership of water entitlements) is moving to more efficient and higher valued use on a seasonal basis. This has been a very important feature as water scarcity within the MDB has worsened progressively since about 1997 (see table 2). Without the allocation market the socioeconomic impact in many regions would have been a lot worse as many dairy farmers and horticulturalist would have been without adequate water which could have had significant negative impacts on the long-term viability of their enterprises as permanent plantings suffer long-term consequences of under watering and in the worst case can die with significant reestablishment costs. For dairy farmers without adequate feed they might have to sell part, or all, of their dairy herd. This would have been a very poor outcome at a time where many dairy farmers would have been in similar positions depressing the market for dairy cattle, also developing a productive dairy herd is a long process. For the low value users, which predominantly have annual crops, the sale of their reduced allocations during periods of drought when prices are very high is likely to bring them more revenue than using their water for production.

Both the allocation and the entitlement markets have been used as risk management tools as drought and policy changes have placed increased risk management responsibilities on the irrigators (Bjornlund, 2006a). Some irrigators have used the entitlement market to buy more water entitlement to increase their supply security. During seasons of high allocations they have excess water which they sell in the allocation market, during seasons with low allocations they will be less dependent on purchases in the allocation market or not need it at all depending on how much entitlement they buy. Others have used the entitlement market to sell parts of their total entitlements and then rely more heavily on the allocation market during periods where it is profitable for them to produce more of a certain irrigated crop. These farmers are increasing their supply risk, but might be willing to do so as they are mainly growing annual crops which they can expand or reduce from year to year. Some will use such sales as a way out of debt to stabilize their finances or to finance farm improvements. From a catchment wide water use efficiency perspective this is a positive outcome. The existence of both high and low value water users will ensure that all the water available for consumptive use is put to economic use. During years of plenty grain and more meat will be produced, during periods of severe scarcity permanent plantings and investments will be protected.

In its own right the allocation market has been used to assist irrigators to manage an increased supply risk during the season as water authorities since 1998 have taken a more conservative

approach to announcing seasonal allocations. Prior to 1998 the authority would announce the seasonal allocation level at the beginning of the season taking into account historical levels of inflow. The authority took the risk management burden of actual inflow during the season while irrigators were given security of supply prior to planting and committing water for the season. Since 1998 the authority only announces an opening allocation at the beginning of the season depending on actual availability in the reservoirs. These allocations are then revised as more water enters the reservoirs during the season. The responsibility of managing the risk of variable inflow during the season now rests with the irrigator rather than the authority. Many of the increases announced during the season happen after the irrigators have committed their area under irrigation and thereby their water needs for the season. As a result irrigators have to make planting decisions without full knowledge of how much water they will get access to. Risk aversive irrigators with the financial means will therefore buy water early in the season to ensure they have enough to cover their needs. If allocations are subsequently increased they will sell some of it again. If there is a reduction in price from buying to selling then this loss represents an insurance premium. Other irrigators who are more willing to take a risk, or who do not have the money to buy early in the season, will make their planting decisions knowing that they might not have water enough. They will hope that the allocations will be increased during the season, that there will be summer rains or that the break in the season comes early so that they do not need to buy. If they run out of water they will have to buy more water in the allocation market later in the season taking the risk of price increases and possible lack of supply in the market. More recently two major reports have been released Fenton (2006) and Frontier Economics et al. (2007) as well as work published under this research project (Edwards et al. 2008a,b, Bjornlund, 2007, 2008a).

Developing a monitoring framework

The purpose of this research project was to develop an ongoing monitoring process which would make it possible to follow changes in impacts over time as well as changes in the way in which market are being used so that policy makers can access these changes and if necessary make changes in response to any undesirable impacts or to better promote positive impacts.

To develop a workable framework to monitor the socioeconomic impact of water trading within the irrigation sector a web-based questionnaire was first developed. If a web-based tool could be used then the cost for both mailing and processing could be reduced significantly. However, it was anticipated that while conceptually sound it might still not be technically feasible due to slow speed of internet connections outside major centres, lack of computer access and a general aversion against using the web among water users.

For the first year, 2003/04, a dual approach to monitoring was used. At the end of the season questionnaires were mailed to all farm businesses which had traded during the year. Separate questionnaires were sent out to: allocation sellers, allocation buyers, irrigators who had both bought and sold allocations, entitlement sellers, and entitlement buyers. The questionnaires were with a reply paid envelope and a cover letter. In the cover letter respondents were encouraged to go to the website and fill in the questionnaire or if they were uncomfortable doing this, to fill in the hardcopy and send it in the pre-paid reply envelope. No reminders were sent to traders. The purpose of the study was to look at the impact of water trading; consequently only irrigators involved in trading with partners external to their farm business were included as inter-farm business transfers were possible before the introduction of water markets. Given the problems associated with identifying entitlements in same ownership, an initial screening question was included. If respondents had only traded within their own farm business they were asked not to complete the questionnaire but simply return the first page in the pre-paid envelope. The outcome of this process is reported in table 1.

To prevent the mailing of multiple questionnaires to the same entitlement holders, multiple traders were eliminated by consolidating multiple holdings into farm businesses. This was done by sorting the entitlement register by name and address and then grouping entitlements in the same ownership. Same ownership was assumed if two or more entitlements were held by the same person

or by persons with the same surname and with at least one of the initials identical and registered on the same address. This process is, however, not totally accurate as entitlements in different ownerships and registered at different addresses are operated as one farm business. It was then identified which of these farm businesses had both bought and sold water in the allocation market. If that was the case they were send a questionnaire asking questions about both buying and selling.

Table 1: Statistics 2004/05 survey

	2003/04					2004/05				2005/06			
	Alloc buyer	Alloc seller	Buyer and seller	Ent. buyer	Ent. seller	Alloc buyer	Alloc seller	Ent. buyer	Ent. seller	Alloc buyer	Alloc seller	Ent. buyer	Ent. seller
Population of traders	2154	2561	988	239	367	3080	3699	176	413	2213	2596	230	365
No address	0	0	0	0	0	0	0	0	29	0	0	0	0
Available for survey	2154	2561	988	239	367	3080	3699	176	384	2213	2596	230	365
sample	2154	2561	988	239	367	600	600	176	384	800	800	230	365
Sample as % of population	100	100	100	100	100	20	16	100	100	36	31	100	100
Return to sender	11	18	5	2	14	4	4	4	19	8	11	4	6
Only internal trade	37	58	37	0	0	0	0	0	0	0	0	0	0
Have not traded	0	0	0	0	0	0	3	1	2	0	0	0	1
Actual sample	2106	2485	946	237	353	596	593	171	363	792	789	226	358
Responces	243	205	64	29	15	85	71	36	25	124	119	32	31
response rate	11.5	8.2	6.8	12.2	4.2	14.3	12.0	21.1	6.9	15.7	15.1	14.2	8.7

The trading register indicated that there were 9,235 allocation transactions and 468 entitlement transactions in 2003/04 or a total of 9,703 transactions or 19,406 buyers and sellers. Eliminating multiple transactions by same farm business and consolidating multiple entitlement holders 3,587 different allocation sellers and 3,192 allocation buyers were identified. Separating farm businesses that had both bought and sold allocations during the year the final sample of allocation traders were as follows: 2,561 sellers, 2,154 buyers and 988 that had both bought and sold.

The overall response rate was 11.7% but some of the responses were not completed, others reported that they had only traded internally within their farm business, and others said that they had never traded. The useable response rate was therefore only 8.8%. The problems associated with consolidating entitlements into farm businesses were illustrated by the fact that, despite the efforts made, as many as 18% of all the responses received were irrigators informing us that they had only participated in internal trade. This indicates that for monitoring purposes it would be useful if the water authority had some way of issuing entitlements under same management or ownership with a base number as well as the individual entitlement numbers. This would enable a more accurate consolidation of entitlements into farm businesses. Despite this relative low response rate the number of responses from allocation traders is high enough for the analytical purpose. A response rate of about 10%, when surveying the population rather than a sample, provides a statistically satisfactory sample. For the entitlement traders the response rate for buyers was equivalent to that among allocation traders, but for sellers the response rate was lower. This follows the trend that was experienced during previous surveys. Irrigators selling their entitlement are far less interested in participating as many of them are on their way out of irrigation for various reasons and many have left the property. As a result, a very high number of envelopes were returned with the message that the person was not any longer at the address.

Comments provided by respondents on the questionnaires as well as by e-mails and phone calls suggest that the reasons for the low response rate and the low level of use of the website are:

- The length of the questionnaire. We had included too many questions and it took respondents too long to complete it. It was our original thought that a regular survey instrument like this

could, apart from the standard monitoring questions, also provide the vehicle for a set of questions measuring irrigators' opinions on current policy issues. The questionnaire therefore included one page of questions on the Victorian White Paper which had just been released.

- The inclusion of a sliding scale to report the respondent's level of agreement with or importance of various statements, rather than ticking a box from one to five, added complexity. This approach was attempted to experiment with a measuring devise which would provide measurements more suitable for a number of statistical and econometric methods of analysis.
- Many irrigators were suspicious of the purpose of the questionnaire. Some believed that we represented South Australian interests others that we represented the water authority or the state government. Given the controversy over the White Paper at the time of the survey, some irrigators rejected the survey.
- Some irrigators reported that a comment in the cover letter was offensive. Since we strongly encouraged the use of the website we suggested that if they were uncomfortable with the web they might seek help at the library or from a child who had been introduced to the web at school. Some believed that we were looking down on irrigators.
- Some irrigators reported that they were frustrated with using the internet in general as Telstra's services were hopelessly slow and they did not have time to sit there for hours.
- There were some problems with the web questionnaire, mainly due to the use of the sliding scale. Some problems emerged which were not identified during the piloting process.

Due to these experiences the following changes were made to the questionnaire:

- removed the section dealing with current policy issues;
- removed the sliding scale and reintroduced the standard one to five Likart Scale with tick boxes;
- consolidated and rephrased other questions to reduce the questionnaire to four pages printed on two sheets of A4 paper;
- improved the layout and readability of the questionnaire; and,
- eliminated the both buying and selling category. We instead identified whether irrigators were net buyers or net sellers and then categorized them accordingly.

Based on the experiences with this particular use of the web and mail questionnaire, and in order to experiment with other approaches to develop the most efficient and cost effective approach we decided to use different data collection approaches for 2004/05 and 2005/06, as follows. For 2004/05 it was decided not to use the web based questionnaire at all but to send mail questionnaires at the end of the season to a sample of traders. For 2005/06: it was decided to use the web based questionnaire during the year trying to get irrigators to fill in the questionnaire as the completed their trades. The following measures were undertaken by GMW to alert and encourage irrigators to fill in the questionnaire: i) placed a notice on all approval letters; ii) placed three notices in the news box in the local news papers; iii) included a notice in the regional news letters; and, iv) placed a link on the WaterMove website. At the end of the trading season a mail questionnaire send was to a sample of traders to ensure a sufficient number of responses for meaningful analysis. Undertaking these procedures allowed us to test three different monitoring methods and to evaluate the feasibility of implementing this kind of monitoring more widely.

Some conclusions on collection method

All the approaches used for this research has problems associated with them. The web is clearly the most effective and efficient way of doing it, but the experience from this project is that this is not yet a viable option. This is the case for two reasons; i) irrigators in general are not yet familiar enough with this media. The internet is increasingly being used by irrigators for water ordering, collect weather data and pay bills. However, for the purpose of this kind of survey where a broad representation is necessary to get a true picture of the impact of water trading, the use of the internet will introduce a serious bias in the final sample; ii) the general speed of internet in the bush for those without access to broad band is still too slow for this purpose.

The use of mail questionnaires has proven reasonable cost effective and resulting in a reasonable response rate. There is evidence of survey fatigue among irrigators; the interval between surveys is therefore going to be important. Each year, from a 'fatigue' perspective, seems to be too frequent. For mail questionnaires to be successful it is important to pay much attention to instrument design, length and clarity. One of the objectives of the survey was also to improve knowledge about how irrigators' rational for buying and selling changed through the seasons. We tried three different ways of designing and phrasing the questions; none of them were particularly successful. The issue is simply too complex for that medium. This leads us to another of the main problems with mail questionnaires namely consistency in answers. Respondents tend to only answer the questions that they think that they have a reasonable answer to which they want to communicate. For example, if asked how important they find a number of issues on a one to five scale, many only rate those they find important and leave the others unanswered. This creates serious problems with missing data when it comes to the analyses.

Telephone interviews would help overcome many of these problems since an interviewer can ensure that all questions are answered and can provide prompts and help when the respondents don't understand the question. In a different part of this research project telephone interviews were used with the result that 100% of the interviews could be used in all the analysis as no answers were missing. However, telephone interviews are more expensive. The second important issue when considering a monitoring framework is timing. This project does not support the need for annual monitoring. The analyses indicate that there are very few significant differences in responses to survey questions from year to year during the three year period. The comparison between the finding from a 1998/99 survey conducted as part of a previous research project and the 2003/06 survey suggests that a five year interval might be the most prudent (for a discussion of this comparison see Bjornlund 2007 and 2008a for allocation and entitlement markets respectively).

If the government is serious about the need to monitor the outcome of water trading then a legislative requirement of entitlement holders to return a simple questionnaire in connection with each trade each fifth year would be the most effective way of doing it. It would reduce cost significantly and collection boxes could be available at the authority's office. The requirement could be to fill in the questionnaire at the end of the irrigation season so that irrigators with multiple trades could fill in one general questionnaire for the season and one specific question for each individual transfer. If the questionnaires were prepared to be scanned into a data processing program then data entry and initial analyses should be cost effective. This would provide excellent and reliable material for extensive analyses. All responses could be truly anonymous and could therefore be made available to selected consultants and academics.

Findings

The Adoption of water trading

This section is based on an analysis of the entitlement and trading registers of Goulburn-Murray Water for the period from July 1991 to June 2004. The two registers were merged to identify which trades each farm business had been involved in each season. This made it possible to identify how big a proportion participated in which kind of water trading each year and how big a proportion of all farm businesses that had participated in any kind of water trading at the end of each year. The full details are reported in Bjornlund (2005b) and in a condensed form in Bjornlund (2006b).

The rate of participation as buyers and sellers in the entitlement and allocation market has gone up or down over the years in response to policy changes, climatic variability, familiarity with the market concept, supply and demand in the markets, and market prices. The trend in market participation in both markets and as both buyers and sellers has been increasing. Policy changes that influenced the participation rated includes: i) easing of trading restrictions such as removing spatial restrictions within the GMID and allowing trade to outside of the GMID; ii) increasing the cap on trade out of districts, iii) allowing trade between different classes of entitlements such as district irrigators and private irrigators; iv) changes to allocation policies as discussed above; and v) the

introduction of the water exchange in 1998. These changes were influential in a significant jump in participation rate in 1994/95 from 4% to 20% both as buyers ands sellers as well the increase from 1999 to 2004 from 15% for both buyers and sellers to 45% for sellers and 30% for buyers. Low allocation rates increased the participation rate during 1997/98 and fueled the continued increase since 2000. Looking at the participation rate in any kind of water trading it fluctuates as discussed above, but the overall participation in any kind of trade each season increased from around 10% during the first three years to over 60% from 2002 to 2004.

Looking at the adoption rate of water markets, that is how quickly do new farm businesses enter the market, we find that the adoption follows an S curve not unlike the adoption curve for new innovations in agriculture. The adoption curves indicates the same jump in participation as discussed above with significant increases with the easing of trading restrictions in 1994, the first year of very low allocations in 1997, the changing to allocation rules in 1998 and continued low allocations since 1997 but culminating with the very low allocations in 20021/03. By 2003/04 about 82% of all farm businesses had adopted the water market in one way or the other, about 62% had sold allocations, 40% bought allocations and 8% have sold and 8% had bought entitlements. By this time the allocation market must be considered to be quite mature.

Water market prices

Monitoring of water market prices has been undertaken from 1989 to 2007. Trends in price developments have been analyzed as has the relationship between allocation and entitlement prices (Bjornlund and Rossini, 2008). Prices up to 2004 has been analyzed to establish the factors influencing irrigators willingness to pay and accept prices for water allocations (Bjornlund and Rossini (2005) and water entitlements (Bjornlund and Rossini; 2007, Wheeler et al, 2008a). Price elasticities and what influences such elasticities have also been analyzed for both water allocations (Wheeler et al., 2008b) and water entitlements (Wheeler et al, 2008c).

The price of both entitlements and allocations has increased considerable from 1992 to 2007 with an average annual growth of 12.3% and 20.2% respectively (Bjornlund and Rossini, 2008). The two prices fluctuate within and between seasons but follow the same cyclical movements. However, the price of allocations fluctuates twice as much as the price of entitlements as it responds more to short-term fluctuations in supply and demand. The main factors influencing prices in the market are water availability measured by the allocation level and demand for water in response to changes in precipitation and evaporation (Bjornlund and Rossini, 2005, 2007). There is little evidence of a causal relationship between the price of agricultural commodities and the price of water entitlements and allocation. During this period dominated by low levels of seasonal supply irrigators have had little opportunity to buy additional water to increase production in order to maximize profit, the buying side has been dominated by defensive buying by dairy farmers and horticulturalists purchasing water to protect their long-term investments in plantings, herds and equipment. They buy to minimize losses and stay in business rather than to maximize profits.

Exploring the opportunities of buying water entitlements as an investment asset with the intention to lease it out and then sell it after a holding period with the expectation of a capital gain (much as it is done with other assets such as shares or property) indicates very healthy returns. With average annual returns based on five years holding periods over the 15 year period shows return well in excess of what could have been obtained by investing in the S&P ASX (the Australian Stock Exchange) (Bjornlund and Rossini, 2008). During the early years most of the return was generated by capital gains, whereas during the latter years the contribution to total return are shared well between annual cash-flow and capital growth.

Socio-economic impact

This section provides a brief discussion of the profiles of property and production characteristics of buyers and sellers in the allocation and entitlement markets. Due to space constraints the underlying tables will not be shown. The full discussion as well as the table is available in Bjornlund (2008b).

Farm size

There are significant differences both in farm and entitlement size between the four trader groups during all three time periods (p=0.01). The allocation sellers are significantly smaller than the other traders with a mean irrigated area of 54 ha compared with 128 ha for allocation buyers and 170 ha for entitlement buyers. One explanation for this difference is the fact that there are many allocation sellers with no irrigation at all during any given season and only about 25% have more than 50 ha.

Both allocation and entitlement sellers have around 20% with no irrigation. It can also me noted that the proportion of allocation sellers with no irrigation varies significantly between irrigation seasons from 29% during the very dry year of 2003/04 with 13% and 11% during the two following seasons. This clearly demonstrates the adaptive capacity of this group of irrigators. On the other hand the proportion of entitlement sellers with no irrigation is pretty constant at 20% across the three seasons. This could suggest that these sellers might have stopped irrigating quite some years ago selling their allocations each season, but now with increasing entitlement prices have been convinced to sell their entitlement. Also some sellers are deceased estates and developers who have purchased farms for non-agricultural purposes and therefore have sold the water separately.

Very few allocation buyers have no irrigation whereas a large and increasing proportion of the entitlement buyers, up to 13% during 2005/06, have no irrigation. This suggests that the allocation market is predominantly used by larger active irrigators to adjust to annual fluctuations in their demand for water. On the other hand many entitlement buyers are either establishing new irrigation enterprises or buy water for non-irrigation purposes such as golf courses.

Entitlement size

Allocation sellers have much smaller entitlements than other trader groups with a mean entitlement of 180ML against 420ML for allocation buyers and 606ML for entitlement buyers. For both allocation buyers and sellers the entitlement size varied significantly between the seasons. During the worst drought of 2003/04 relatively few larger entitlement holders were selling allocations indicating that many of these preferred to maintain their own production rather than selling their allocations, whereas far more small irrigators choose to stop irrigation all together as clearly illustrated by the significantly larger proportion of allocation sellers not having any irrigation at all that year. On the other hand during the season of 2004/05 with higher allocation levels more of the large entitlement holders sold in the allocation market. Also among the allocation buyers was it apparent that the smaller irrigators dominated the market during 2003/04. This could indicate that many of the smaller dairy farmers were forced to buy to keep their dairy herd while many of the larger irrigators had water enough to maintain minimum fodder production and then cut down on non-essential crops rather than buy water.

Land and water use

There are significant differences in land and water use between the three trader groups (p = 0.01). However, there are no significant changes in land and water use from year to year. The allocation buyers are by far the group most dominated by dairy production with 74% being involved in this production and 50% having dairy as their only irrigated activity followed by entitlement buyers with 30% using all their water for dairy production. On the other hand only 18% of allocation sellers were involved in the dairy industry and only 12% used all their water for that purpose.

Cattle and sheep productions are dominated by allocation and entitlement sellers, 39% and 43% respectively have some cattle production and 24% and 28% respectively have all their water use in that production. For sheep/wool production15% and 26% use some water for that production while 7% and 10% respectively use all their water for that purpose. The findings with respect to cereal production are a more complex with the largest proportion of allocation sellers and entitlement buyers using some water for cereal production with 29% and 31% respectively. On the other hand allocation and entitlement sellers have the largest proportion of farms with more than 50% of their irrigated area in that production with 17% and 12% respectively.

Finally, the findings for horticulture are interesting even though it is the production where the smallest proportion of irrigators is involved, 12% across all four categories with 19% for allocation sellers and 17% for entitlement buyers. As many as 15% of all allocation sellers have all their land in horticulture compared to 9% for entitlement buyers. The large number of allocation sellers in this category is likely to represent new horticultural enterprises which have bought entitlements enough to supply their full mature development and until then sell their unused allocation. While the large number of entitlement buyers in this category are likely to represent new and expanding horticultural enterprises. This reflect the findings by Frontier Economics et al. (2007)

Irrigation and drainage infrastructure

Again there are very significant (p=0.01) differences between the trader groups when it comes to the presence of the various irrigation and drainage infrastructures. The absence and presence of this infrastructure and the proportion of the irrigated land serviced by that infrastructure is an indicator of water use efficiency. Irrigators were asked how big a proportion of their farm had laser grading, re-use system, surface drains and other means of irrigation than gravity.

Allocation buyers are significantly more likely to have the four types of infrastructure related to gravity irrigation on a larger proportion of their irrigated land with 91% having some laser grading, 79% some surface drainage, 76% some re-use system 62% access to off-farm drainage, with 35%, 42%, 20% and 27% having more than 75% of their irrigated land benefiting from these services respectively. On the other extreme, allocation sellers are least likely to have this infrastructure and with a smaller proportion of their irrigated area benefiting from it 62%, 54%, 37% and 41% having some of the respective infrastructure and 35%, 42%, 20% and 27% having more than 75% or their irrigated land serviced by it. Both entitlement buyers and sellers have more of this infrastructure than the allocation sellers with entitlement buyers having more than entitlement sellers.

The findings with respect to other irrigation methods reflect the findings reported above with respect to land and water use. Other irrigation is predominantly for horticulture, the proportion having 100% of their irrigated land in horticultural production therefore almost perfectly corresponds with the proportion having more than 75% of their irrigated land with other than gravity irrigation. The only exemption is allocation buyers where a larger proportion has other than gravity irrigation than has 100% of their irrigated land in horticulture. This is likely to be due to the fact that larger and more efficient dairy and cropping farmers are shifting to centre pivot irrigation which is the most efficient irrigation methods for cereal and pastures.

Farm adjustment activities of farm businesses

The respondents were asked a number of questions about what they have done the last five years and what they intend to do the next five years in order to adjust their farms to become more viable or to reduce their irrigation

Past and future changes to irrigated area

As could have been expected a significantly larger proportion of entitlement buyers (25%) and allocation buyers (19%) have increased their irrigated area over the last five years. Entitlement sellers are least likely to have expanded (10%) followed by allocation sellers (12%). This indicates that for at least a quarter of the entitlement buyers the purchase of water, at least, partly is associated with an expansion program and also that the allocation market is used to support expansion. This naturally was least pronounced during the drought year of 2003/04. The relatively high number of both allocation and entitlement sellers expanding represent irrigators which use water markets to help finance their expansion and adjustment process

The expectation of expansion the next five years are approximately the same as during the last five years within all four trader groups and with a similar proportion being uncertain. It can be noted that while entitlement buyers and sellers both have a level of uncertainty of about 16% for entitlement sellers it is only 8%, probably reflecting that most of these irrigators are reducing or

stopping irrigation while those expanding already have the necessary entitlements while it is as high as 21% for entitlement buyers who are buying as part of an expansion program.

Looking at actual and intended reductions to the irrigated area the effect of the extended period of drought and policy changes resulting in declining allocation levels are becoming more apparent. While the differences in intentions are significant at the 0.01 level the actual reduction in irrigated area over the last five years has been almost the same for allocation buyers (27%) and sellers (23%). Maybe unexpectedly a larger proportion of allocation buyers than sellers has reduced their irrigated area. This is maybe not as unexpected as it first might sound like; allocation buyers are far more likely to be dairy farmers which have established their farms with the expectation of 160% allocation. Many of them have responded partly by reducing their irrigated area and partly by relying on allocation purchases. On the other hand many allocation sellers have excess allocation each season and sell it each year with no need to reduce their irrigated area in response. Comparing these findings with the findings discussed under size of irrigated area clearly indicate that there are three main groups of sellers in the allocation market: i) those selling all their allocation each year; ii) those selling their excess allocation each year; and iii) those deciding whether to reduce their irrigated area and sell all or part of their allocation in any given year based on a business decision. Looking at traders in the entitlement markets the findings are much clearer with 41% of entitlement sellers having done so while only 10% of entitlement buyers have. That 10% have reduced their irrigated area further emphasizes that many buyers are under stress due to a prolonged period of low allocation levels and no expectations of significant improvements

Looking at the expectation of reducing the irrigated area over the next five years the finding suggest that only about 5% of allocation traders and 2% of entitlement buyers expect to do so, while 14.5% of entitlement sellers anticipate continuing to reduce their irrigated area.

Past and future changes to entitlement size

Past and future changes to entitlement size also differ significantly between trader groups (p=0.01) but some findings at first glance appear to be surprising. Among the entitlement sellers 13% have increased their entitlement over the last five years and 11% intend to do so over the next five years. This can reflect two different reasons: i) it can be because of speculative trading with irrigators both buying and selling entitlements as good market opportunities emerges; therefore, while having sold entitlement during this period they have also bought; or ii) irrigators selling entitlement over the last five years might have done that to finance expansion or improvements and now want to buy it back. The highest proportion being certain about buying more entitlements over the next five years are the entitlement buyers showing that these irrigators are in an ongoing expansion process. Eighteen percent of the allocation buyers expanded their entitlements over the last five years and 18% are certain and 30% uncertain about buying more entitlements over the next five years. This suggest that many buyers in the allocation market need the water on a permanent basis and are buying and consider continue to buy to ease their reliance on the increasingly volatile allocation market. This is further supported by the finding that the proportion expecting to continue to buy entitlements is significantly higher during 2005/06 than any of the other two seasons (43% compared to 17% and 24% for the two preceding seasons). There are 7-8% of allocation sellers that have bought entitlements the last five years and intend to do so over the next five years. These are likely to be the irrigators who are going through an expansion process buying entitlements as they can afford it or as opportunities arise and then use the allocation market to get rid of their excess allocation until they have completed the expansion process or plantings have reached maturity.

When looking at those expecting to continue to reduce their entitlements as many as 16% are certain that they will continue to sell and 14% are uncertain. Among most other trader groups there is a low level of certainty of further entitlement reduction (between 1 and 4%) but between 12% and 15% are uncertain again reflecting the high level of economic and supply uncertainty.

In general there is evidence that water markets are used for a variety of reasons, to contract, to expand, to stay afloat and to stay on the property and within the community.

Past and future changes to water use

There are significant differences (p=0.01) between trader groups when it comes to whether they have changed their water use (the crops they are growing) over the last five years, with the least changes taking place among the allocation sellers with 26% reporting some cropping changes and most predominant among entitlement sellers with 43%. It could be expected that the high proportion of change among entitlement sellers represents dairy farmers opting out of dairy production as part of the adjustment package offered to that industry and general hard time within that industry especially among the smaller farmers.

There are no significant differences between the expectation to change water use over the next five years with between 22% and 31% expecting to do so, with the highest percentage among the entitlement buyers and the lowest among the allocation sellers.

Past and future improvements to irrigation and drainage practices

There are significant differences (p=0.01) between the trader groups both when it comes to actual improvements over the last five years and expected improvements over the next five years. There are also significant differences between the years within most trader group but at lower significance level (p=0.05 or 0.10).

The highest level of improvements over the last five years are among entitlement and allocation buyers with 74% and 72% respectively and the lowest among allocation and entitlement sellers with 48% and 53% respectively. The order when it comes to future improvements is the same as for past improvements but the differences are not as pronounced as the level of certainty about future improvements is much lover than in the past, with a large number being uncertain. This again is likely to reflect the increased level of uncertainty about future allocation levels. In total 62% have improved their infrastructure over the last fiver years, 45% intend to do so over the next five years, and 21% are uncertain. So there is evidence that the irrigation sector is in continued improvement. Also, the facts that about half the sellers have improved and 40% intend to improve in the future indicate that the industry is going through a period of improving irrigation and drainage and use the market to do so.

Conclusions

This paper reports on the findings from a research project monitoring the outcome and uptake of water markets within the Goulburn-Murray Irrigation District in Victoria. The adoption of water markets by irrigators and then development of water market prices have been monitored since the beginning of trade while the socioeconomic impacts have been assessed based on a survey of irrigators over a three year period from 2003 to 2006.

Water market activities have increased substantially over time as has the adoption of water markets by farm businesses. By 2004 80-90% of all farm businesses had participated in some kind of water trading. The adoption has been encouraged by easing of restrictions on trade, increased familiarity with the market concept, changing allocation policies, the introduction of a water exchange, but foremost by increasing scarcity.

Three different methods of surveying irrigators were tested. It was found that use of the web during this period was not effective due to inexperience with the web and low speed of web connection in the country. It is recommended that if water authorities and governments are serious about monitoring the impact and use of water markets based on water user surveys then the most efficient way of doing so is by a legislative requirement to fill in a questionnaire as part of the transfer process once every five years. Based on this project and based on a comparison with a 1998/99 survey it is proposed that a survey frequency of each five years would be suitable. This would prevent survey fatigue, while ensuring that major shifts in outcomes and use can be measured so that policy changes can be introduced to alleviate potential negative impact or to further promote positive impacts of water trading.

There is clear evidence that water markets is used by irrigators to manage their supply risk as well as to deal with inevitable structural changes taking place within the irrigation industry. The allocation market is used to manage irrigators supply risk during the season while the entitlement market is used to manage the long-term supply risk. The allocation market is used by irrigators to i) sell all or most of their seasonal allocation to help them stay on their farm and within their community while retaining their asset; ii) sell excess allocations while they are developing their farm to help finance the process; iii) buy allocations to help irrigators to maintain production and stay in business and stay on the farm and within their community; iv) buy allocations to expand or develop their property to be long term viable; v) buy or sell water allocations in an opportunistic manner to benefit from changes in commodity prices and the price of water; vi) buy entitlements to expand their production; vii) buy entitlements as supply security to ease their reliance on allocation purchases; viii) sell their water entitlement to fund their retirement or pay their debt; and ix) maximize the revenue from selling all their assets by selling the water and land separately.

Water markets have been instrumental in allowing irrigators to stay in business and stay within their communities and thereby minimize the overall impact of scarcity while facilitating that water is put to its most beneficial use each year.

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