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Are Water Markets Maturing

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Abstract: In a mature water market with many active buyers and sellers and with a free flow of information about supply, demand and prices paid, prices should not vary greatly at any given time. Willing buyers should always be prepared to pay the going price set by the most efficient and highest value producing irrigators. This paper will analyse the prices paid in two water markets in Australia and identify which factors affect the prices offered and accepted by buyers and sellers. The buyers and sellers perception of the purchase and sales price will also be analysed as an indicator of the market participant's knowledge of the prevailing market prices. The paper shows that in the emerging market prices fluctuated widely and markets generated some inefficient outcomes. As markets matured and restrictions on trade were eased, price fluctuations were reduced and market outcomes became more rational. Major determinants of water prices are differences in market restrictions, water use efficiency, value of commodity produced and the buyers and sellers bargaining strength.

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INTRODUCTION

Market maturation is an important consideration when investors evaluate risk and thereby determine their required discount rate for acceptable investments. This decision in turn determines value. Within immature markets, price dispersion is high and investors require a high discount rate, whereas in mature markets investors are willing to accept lower discount rates. As more sophisticated and diversified property rights are defined, market liquidity is improved and the potential number of investors widened, thereby increasing the marginal utility of any property right. Water markets provide a unique opportunity to study this process from infancy.

Markets in water rights or entitlements emerged in Australia in 1983 and have since increased in use and operations. This process was caused by the need to reallocate an increasingly scarce resource to higher valued uses and away from unsuitable soil. Water was traditionally appurtenant to land and could not be sold separately thus preventing the above reallocation. This has changed dramatically during the last 20 years to a degree where today all Australian States either have formally separated the land and water rights, or are in the process of doing so. The National Competition Policy has spurred this process on. This paper will briefly discuss this process and show how impediments to trade have been slowly lifted, while brokers and various forms of water exchanges have emerged to facilitate trade and the flow of market information toward more mature markets. An analysis of water market prices based on interviews with buyers and sellers of water rights in Victoria and South Australia will be discussed. Hedonic functions have been applied to such transactions to see what influences buyers' willingness to pay and sellers' willingness to accept prices. Hedonic functions were first applied to trade prior 1995 and then to the 1995-96 period to see how the easing of spatial and other restrictions on trade in 1995 influenced price dispersion and the factors affecting price.

THE STUDY AREA AND THE DATA

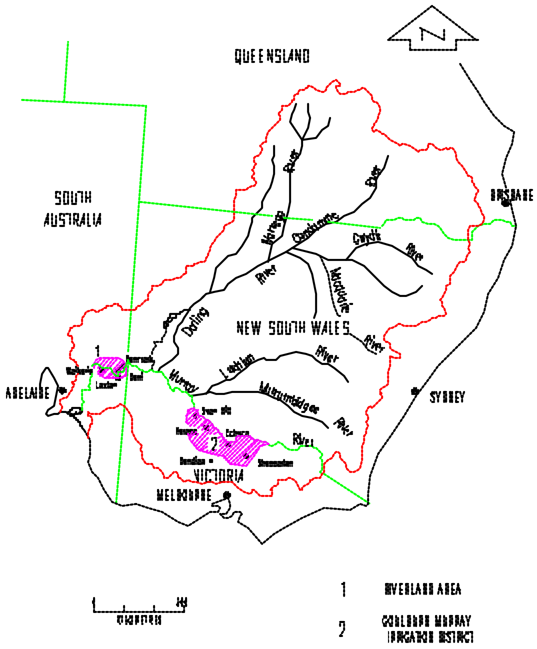
This research is based on an analysis of transfers of permanent water entitlements in two irrigated regions with different water use characteristics and water allocation policies. Both areas are located in the southern part of the Murray-Darling Basin (Figure 1). In June 1995 the Murray-Darling Basin Commission decided to place a Cap on water extraction within the basin set at the 1993/94 level of development (MDBC, 1998). This decision will have an impact on future water allocation levels. At the end of the study period for this project, in December 1996, the Cap had not yet had an actual impact, but irrigators had started to come to terms with its inevitable long-term implication, causing some to start buying permanent water in preparation for this impact.

The River Murray in South Australia (SA). This region has three sections: the Riverland, stretching along the River Murray from Blanchetown to the SA/VIC border, dominated by horticulture and viticulture, the lower reaches of the river dominated by broad acre farming and dairy, and the lakes area with broad acre farming and emerging viticulture. Irrigators have water entitlements, either as part of an irrigation district or as an individual irrigator pumping water from the river (a private diverter). These entitlements are generally accepted to be 100% secure - that is, they will be delivered in full every year. Trade was introduced on both a permanent and temporary basis in 1983, the first Australian state to so. From the beginning trade was only possible among private diverters. In 1989 trade was expanded to allow irrigators within irrigation areas to trade with each other. This ability was put into legislation with the Irrigation Act 1994. Trade between irrigators within irrigation areas and private diverters was made possible in 1995 when irrigation area authorities were issued with a license under the Water Resources Act 1990. Finally trade was fully included in legislation with the Water Resources Act 1997. (Bjornlund and McKay, 2000a).

South Australia took very early voluntary steps to reduce water extraction from the River Murray in the 1970s by reducing water entitlements down to actual or committed use (Bjornlund and McKay, 1998). As a result of this conservative and responsible behavior by the SA government, the MDB Cap was set at the 1993/94 level of entitlement rather than the 1993/94 level of water use (MDBC, 1998). As a result water trading in SA has been able to activate unused water without any impact on the general level of annual allocations to all irrigators.

Information about water transfers including: date of transfer, volume traded, water use prior to trade, entitlement size, and name and address of buyers and sellers were obtained from the Department of Environment and Natural Resources' office in Berri for private diverters and in Barmera for irrigation area irrigators. In order to obtain information about prices in both study areas it was necessary to interview the buyers and sellers, since prices are not registered in any public register. During the interviewing process property and personal characteristics were also gathered. For the period from 1987 to 1994 mail questionnaires were used, and responses were obtained from 146 or 58% of all buyers and 122 or 52% of all sellers. For the 1994 to 1996 period telephone interviews were conducted with 100 or 72% of all buyers and 103 or 45% of all sellers.

Figure 1: The Murray-Darling Basin



The Goulburn-Murray Irrigation District (GMID) in northern Victoria. The predominant and high-value water use in this region is permanent pastures for dairy, with large areas of low value production such as broad acre cropping and annual pastures in the western part. To understand the following discussions, it is necessary to explain the allocation policy in Victoria. All irrigators have a water right, with a security of delivery of 97 out of 100 years. In addition, sales-water allocations are announced every year, as a percentage of water right, depending on the availability of water in the storages. The long-term mean of sales-water is expected to be about 60% of water right (Murray Water Entitlement Committee, 1997), but fluctuates widely. The GMID is supplied by two different systems: the Goulburn and the Murray system (Figure 3), with the Murray system traditionally having higher sales-water allocations. Annual water trading was introduced on an experimental basis within some irrigation areas in 1987. Both permanent and temporary trade was included in the new Water Act 1989, but regulations for permanent trade were not in place until 1991, and the first permanent transfers were registered in January 1992. Trade was both possible within irrigation areas and between private diverters, but not between the two groups. This was made possible when the Water Act was amended in 1995 (Bjornlund and McKay, 2000a). Over the years spatial restrictions on trade between different rivers and irrigation areas have been eased but some restrictions are still in place. Trade can't take place from the Murray system to the Goulburn system but can in the opposite direction.

The Victorian Government's reaction to the MDB Cap was to retain the high level of reliability of supply of water rights and adjust total water use to stay within the Cap by reducing annual sales-water allocations. As water trading activates traditionally unused water, total water use increases, with reductions in annual sales-water allocations as a consequence.

Information about water transfers including: date of transfer, volume traded, water use prior to trade, size of Water Right and name and address of buyers and sellers were obtained from Goulburn-Murray Water. For the period from 1992 to 1994 mail questionnaires were used and responses were obtained from 188 or 64% of all buyers and 149 or 53% of all sellers. For the 1994 to 1996 period telephone interviews were conducted with 100 or 35% of all buyers and 100 or 41% of all sellers.

METHODOLOGY

In this study, hedonic functions have been applied to transactions of permanent water entitlements, to identify the factors determining the buyers' and sellers' willingness to accept prices. The hedonic theory sets itself apart from property appraisal, by shifting the focus of interest from determining the value of the commodity to determining the partial value of its underlying characteristics. Griliches (1971) did some of the early work on hedonic price functions when analyzing car prices. He did so in order to improve the way price indexes are adjusted to distinguish the proportion of price increases caused by quality changes from those caused by inflationary price increases.

The theoretical framework is developed around the fact that many commodities are heterogeneous goods, consisting of a bundle of characteristics in different quantities. These goods cannot be un-bundled, and the characteristics sold separately; neither can they be re-packaged. Buyers in the market are therefore shopping around; finding the bundle of characteristics, which best suits their purposes. If enough of such packages including different quantities of each characteristic are sold in the market, a hedonic price function can be identified:

$P(Z) = f(Z_1.................Z_n)$,

where $P(Z)$ is observed product prices and Z_1 to Z_n is the bundle of product characteristics. Solving this function for a large number of transactions will establish the value of each of the Z characteristics.

The issue of the functional form of the hedonic function has been widely discussed (Halvorsen and Pollakowski, 1981; Milon et al., 1984), and rather mechanical methods have been developed to establish the best fitting form (Box and Cox, 1964). However, in this study, it was attempted to keep variables in a linear form, unless strong theoretical arguments or empirical evidence suggest that a non-linear form should be used. This approach ensured the most consistent interpretation of the coefficients. Even though this approach can be at the expense of a drop in explanatory power, it has often been followed in the literature because of the easier ability to interpret the outcome and especially make comparisons between models.

In the process of building the final models, a number of issues have to be considered. One key assumption is that the independent variables, the Zs, in the equation, are truly independent, that is, no multicollinearity exists. This is especially important in a study like this, where the emphasis is on the relative magnitude of the estimated coefficients, rather than the predicted value of the dependent variable. To ensure this, scaled condition indexes, and their associated variance-decomposition proportions have been used (Belsley, 1991). The advantages of this approach are that it identifies the variables involved in interdependency, and provides measures of their severity. This enables the analyst to better identify the potential impact of such interdependencies on the outcome. If the involved variables are not of key concern for the analysis, the remaining coefficients can still be used. The second key assumption is homoscedasticity, which means that the population disturbances have the same variance or that there is no pattern in the residuals. Since there is no universally accepted way of testing for this and several methods exist, often yielding contradictory results, two different methods have been applied - the Langrange Multiplier Test and the Breusch-Pagan-Godfrey Test (Gudjarati, 1995). Finally the risk of misspecification of the model has to be considered, that is the omission of relevant variables, inclusion of irrelevant variables or the use of wrong functional form. For this purpose Ramsey's Reset Test has been used (Gujarati, 1995). No model discussed in the Findings Section is in violation of any of these assumptions based on the above tests and conservative parameters set in the literature (Gujarati, 1995).

FINDINGS

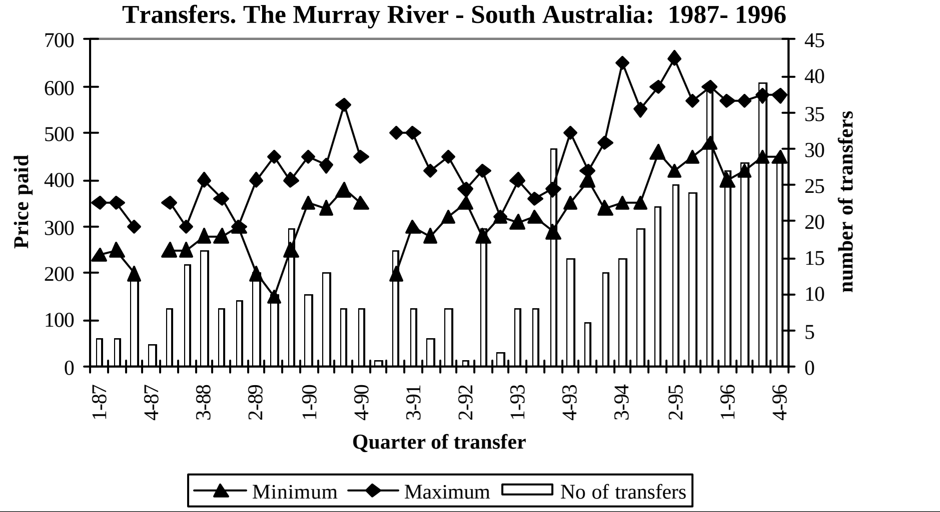
This section will discuss the outcome of the hedonic models for permanent water transfers within the two study regions. The first part will discuss price dispersion and trends, while the second part will discuss the overall outcome of the hedonic functions and draw parallels to the two other studies of this kind reported in the literature. The following parts will discuss the various value determinants.

Price dispersion and trends

To give an impression of price dispersion and trends as well as market activities, Figures 1 and 2 show the minimum and maximum prices paid, the number of transactions on a quarterly basis and the volumes traded on an annual basis. Trade in SA shows a much stronger growth in volume traded, number of transfers, and prices as well as lower price dispersion. Figure 1 shows that until 1994 trade had its seasonal fluctuations, but stayed at much the same overall level with trade escalating after 1993/94. The year of 1988 saw very high volumes traded due to a single buyer, a new major almond grower. Until the beginning of 1991, maximum prices went up and down but with a slow upward trend. During 1991 and 1992 the trend tended to go slowly downward, while from 1993 to 1996 prices went up at a rapid pace. This continued until 2000, when prices culminated at $1,100-1,200/ML, but has since declined to around $1,000/ML. The maximum and minimum prices indicate substantial price dispersion during some periods. Minimum prices seem to have stabilised over the period, whereas maximum prices still show some high blips caused by individual buyers willing to pay above market prices. As an example, one milk processor, buying water for industrial purposes, caused the high purchase price of $560/ML in the third quarter of 1990. Both minimum and maximum prices seem to be quite stable during the period from mid 1995 to the end of 1996, indicating a maturing market.

Figure 2 indicates that within the GMID the dispersion between minimum and maximum prices remained high throughout the five-year period. Minimum prices were very volatile whereas maximum prices remained stable with a slowly increasing trend from the first quarter 1994 and then accelerating during 1996 toward $500/ML. This could suggest that the efficient dairy producers, which are the major water buyers and the highest value producers within the GMID, set the maximum at a level they can justify. The fluctuating minimum prices reflect a thin market, where some irrigators are under pressure to sell at times when no efficient and high-value producing irrigators are buying and therefore have to sell to opportunistic buyers at lower prices. This fluctuation suggests an inefficient market. The trend of increasing prices continued until 2000, when prices culminated at around $800/ML driven by demand from the vine industry in Sunraysia downstream of the GMID. Prices have since come down to a level around $600-700/ML, due to reduced demand caused by a decline in new contracts for wine grapes. The general price level, with exemption of the very low minimum prices, seems to reflect the ACIL report's (1984) expectations of between $200 and $400 per ML. The large price dispersion seems to reflect the potential buyers' opinion when interviewed by ACIL, proposing a price level between $50 and $500/ML.

Figure 1: Minimum/Maximum Prices and Number of Permanent Transfers. The Murray River - South Australia: 1987- 1996



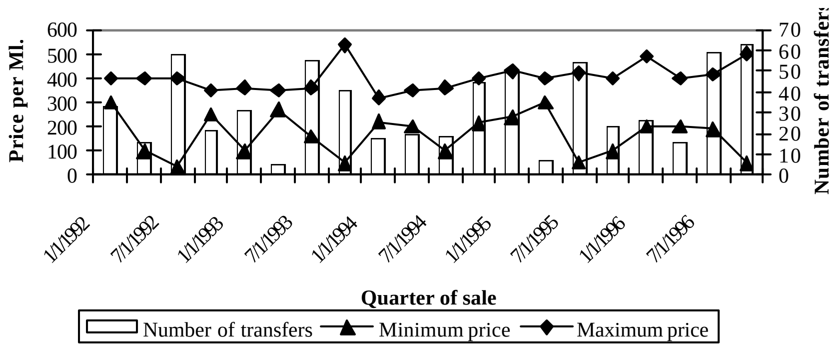
Volume (ML):

1987	3290
1988	5861
1989	3149
1990	2769
1991	963
1992	2398
1993	6908
1994	5422
1995	7490
1996	4176

The price dispersion between minimum and maximum prices appears higher within the GMID. This could reflect the greater diversity of the nature of water rights within the GMID. The sales-water component varies between private diverters and irrigation areas and between regions. Also different spatial restrictions on trade exist. In comparison water rights in SA are more uniform and no spatial restrictions exist. This corresponds with the findings of Colby et al (1987) and Gardner (1985). Telser (1978) suggested that under such market conditions proper price levels would not be formed and prices therefore fluctuate widely.

The minimum and maximum prices displayed in Figures 1 and 2 still indicates some price dispersion raising doubt about whether the market has actually matured. However analysing standard deviations of annual mean prices in South Australia shows that the standard deviation as a percentage of annual mean prices reduced significantly from around 18% from 1987 to June 1992, down to around 12% from June 1992 to June 1995 and further reduced to around 6% from June 1995 to December 1996. This analysis indicates that price dispersion has reduced significantly and Figure 1 shows that both volume of water traded and number of transfers increased further indicating a maturing market. A similar analysis of annual mean prices within the GMID shows steady and very high standard deviations at a level consistently around or above 20% of annual mean prices. The reasons why individual quarterly minimum and maximum prices still fluctuates are analysed in the Findings sections of this paper and show some signs of a maturing market within the GMID. Market activities within the GMID have also increased significantly since 1996 to a level where volumes of water traded have been consistently between 16,000 ML and 24,000 Ml per annum since June 1997 (See Figure 2)

Figure 2: Minimum/Maximum Prices and Number of Permanent Transfers GMID - Victoria: 1992-96



Volumes (ML):	
1992/93	2715
1993/94	8100
1994/95	6369
1995/96	9941
1996/97	8230
1997/98	16349
1998/99	23283
1999/00	18173
2000/01	16851

Hedonic analyses of permanent water market prices

The hedonic models for sellers and buyers within both study areas and for both study periods are displayed in Tables 1, 2, 3 and 4. For simplicity, linear models have been preferred. The only exception is the sellers' model within the GMID (Table 1). In the linear version of this model most of the variables were insignificant. Therefore, a non-linear model has been reported even though it is more difficult to interpret. The model fulfils all statistical requirements and when tested proved superior to the linear model. Individual variables follow non-linear forms where such transformations were anticipated due to the nature of the variable and empirical observations. These exceptions are 'time since sale', where the graphs in Figures 1 and 2 indicate that a non-linear relationship was present and the variable 'size of transfer', where economic theory suggests that economies of scale will cause this variable to be non-linear.

The models have quite good explanatory power (based on adjusted R^2) ranging from 44.1% for the sellers' model during the first period in SA to 77.2% for the buyers' model during the first period within the GMID. Generally, the buyers' models have the highest explanatory power, with the exception of the models for the second study period within the GMID. This could be an indication that the market was a buyers' market, where the buyers set prices depending on their individual circumstances. Variables are generally significant at the 0.01 or 0.05 level. In some instances a one-tailed test was used, since the coefficient had the anticipated sign.

Comparing these results with the two other applications of hedonic models to water transfers identified in the international literature, namely the studies by Colby et al (1993) and Challen (2000), the above results become very acceptable. The study by Colby et al achieved an explanatory power of 54% using a sample of 97 water purchases and the study by Challen an explanatory power of 64% using a sample of 178 observations. Both of these studies base the explanatory power on the R^2 and not the adjusted R^2 resulting in a comparatively higher explanatory power than the one reported in this study using adjusted R^2 values.

The study by Colby et al used only secondary data preventing the model from accounting for individual personal or water use characteristics. The study analysed water transfers within a study area, which was dominated by cross-sectoral transfers under the prior appropriation doctrine in the Southwestern part of the US. The data set, however, included two important variables, which intuitively should have a significant impact on the buyers' willingness to pay. The first was the presence of high profile buyers such as a municipality, a power station or a mine. The second was the priority date of the water right, which indicates how certain the holder of the right is of actually receiving the water every year, and therefore is an obvious determinant of the willingness to pay. Anecdotal evidence within the study region as well as economic theory, suggests that these two variables should be major price determinants. The model also included a non-linear transformation of the quantity of water sold using a logarithmic transformation. The variable had a negative sign showing that prices decrease with volume traded reflecting the general economic law of decreasing marginal return and economies of scale.

The two first variables were not relevant in this study. First, almost 100% of all transfers were rural to rural. Non-farming users were only significant in the buyers' model during the first study period in SA. This model indicated that non-farm buyers were willing to pay an additional $39. Considering that non-farm buyers were only involved in 8% of all transfers and only purchased 2.2% of all the water, this can't be said to have a major impact on water prices. However, it could in the future. Second, Australia does not operate under the prior appropriation doctrine. All irrigators have a water right or a licence, and all have the same annual allocation.

The study by Challen (2000) was based on water transfers along the River Murray in South Australia during the 1987 to 1996 period. This study area is the same as one of the study areas in this paper and covers the same time period. Challen based his analysis on surveys of water buyers and agents facilitating water transfers and secondary data provided by the relevant Department. This survey provided information about prices and some information about the intended water use and the involvement of brokers. The model also used information about prices of major commodity prices and information about volume of water trade and date of transfer provided by the Department. Challen found: 1) there was a relationship between some commodity prices especially citrus for processing and chardonnay vine grapes showing a positive but less than linear response of water prices to commodity prices; 2) the involvement of a broker resulted in an increase in price of $20 per ML or about 5% on an average price of $425 per ML. It could be note here that 5% proved to be the standard brokerage fee for permanent trading during the first two years of the Interstate Water Trading Pilot Program (Young et al, 2000); 3) the rehabilitation levy paid within some districts caused a decrease in water prices; 4) that buyers in the Riverland paid lower prices which was opposite to expectations; and 5) that buyers intending to apply the water to vegetables and orchards paid a premium. When comparing this analysis to the one discussed in this paper it should be noted that: 1) the analysis is based on buyers only; 2) not all information is provided by the buyers themselves but by the involved broker; 3) 85% of the buyers in the sample used brokers, while research has shown that only about 60% of all buyers during the period used brokers (Bjornlund and McKay, 1999); 4) the analysis involved only one model covering the entire period.

Another factor discussed in the literature is related to the ability of water to trade freely both spatially and between different classes of irrigators. Any attenuation placed on the free movement of water will reduce the exposure to market participants and the variety of users able to bid. Such limitation of trade will reduce the price of water as well as the volume of water traded (Gardner, 1985). The proficiency and efficiency of the market is another important determinant of prices and price fluctuations. Brown et al (1982) found that water prices increased the more proficient the market operated.

Other characteristics influencing price within the study area should be associated with factors related to the individual buyers' and sellers' ability to use the water to produce a profit. The highest value producers should be willing to pay the highest prices and thereby outbid the lower value producers. The same line of logic also suggests that the more efficient water users should be willing to pay a higher price, since they can produce more output per unit of water applied. Two more factors were anticipated to have an impact on the price of water. The first is the size of transfer. The general rule of economies of scale suggests that the larger the quantity of water traded the lower the per unit price as found by Colby et al (1993). Howe et al (1990), however, argued that larger transfers save the buyers the trouble of identifying and negotiating with several sellers and many transfer costs are constant regardless of the quantity of water transferred thus reducing the cost per ML for larger quantities, both of these issues should increase the buyers willingness to pay for larger volumes.

The final reason is associated with the buyers and sellers bargaining strength. Dragun (1983) argued that the final transfer price should be determined by the bargaining position of the parties. This is supported by the fact that many irrigators sold because they were in financial difficulties: the most important reason for selling water was because the seller needed the money (Bjornlund and McKay, 1995, 1996), about a quarter of the sellers sold water on which their existing production depended and had no plans to reduce their irrigated production, and 71% of the sellers used the proceeds from the sale to pay this year's bills (Bjornlund and McKay, 2000b). Likewise, many buyers within the GMID purchased water to support their significant investments in permanent pastures, milking heard and equipment when annual sales-water allocations declined (Bjornlund and McKay, 1995). Irrigators under such pressure to buy or sell should be wiling to pay higher prices or accept lower prices.

This section has discussed the various factors or characteristics potentially influencing price based on existing literature. The following sections will analyse to which extent these factors have actually influenced price within the two study regions based on the hedonic functions. When building the models, attempts were therefore made to include significant variables measuring the impact of these factors either directly or as proxies. The models for the two periods do not contain the same variables since changes to policies, and the relative profitability of various crops, have changed over time, and insignificant variables have been eliminated in the model building process.

Spatial restrictions and restrictions on transfer between different classes of irrigators

Restrictions on transfer between different classes of irrigators were removed within both study regions and within the GMID spatial restrictions were eased from the first to the second study period but some still remain. The analyses confirm the findings of Gardner (1985) that the larger the geographical area within which the water can be traded, the higher the price. Within the GMID, during the first study period, this was expressed in three different ways. Within the Northwestern Region (see Figure 2), where trade could only take place within and between the three irrigation areas (Kerang, Cohuna and Swan Hill), water was traded for $85.79 less according to the buyers' model and $107.07 less according to the sellers' model (Table 1). The reasons for the lower price within this region are: 1) the inability to trade water to the Eastern Region, where most of the high value producers are located and therefore most of the demand; and 2) the fact that this region is supplied from the River Murray, which traditionally has received consistently higher annual sales-water allocations.

No changes took place to the spatial restrictions within the Northwestern Region from the first to the second period, but the MDB Cap and water markets started to make an impact. It became apparent that the level of annual sales-water allocations would be reduced and a maximum level made standard throughout the GMID. The Northwestern Region would therefore no longer be able to receive sales-water allocations in excess of 100%. Irrigators having relied heavily on the higher sales-water allocations therefore came under pressure to purchase additional water rights. Demand for water within the Northwestern Region therefore increased from the first to the second study period with the effect that the price reduction came down to $66.62 in Cohuna and to $33.29 in Kerang. In the sellers' model the reduction came down to $60.24 and was only significant in Kerang, which is most severely suffering from salinity problems (Table 2).

Table 1: Hedonic Models - Water Transfers within GMID, 1992-94

Variables:	Buyers model β	Buyers model SEβ	Seller model β	Seller model SEβ	Functional form/sellers
Private diverter	-167.93	11.70*	-84.82	14.48*	Dichotomous
Co, Ke, S.H.[7]	-85.79	7.35*	-107.07	11.06*	Dichotomous
P.H. and Boort	-32.33	14.08**	-16.57	11.17ψ	Dichotomous
Quantity (ML)[1]	-141.35	72.72**			
No allocation[2]	59.49	12.11*			
Use % of all[4]	0.14	0.03*	-0.0018	0.0012ψ	Squared
PP dairy (ha)	0.11	0.06**			
AP dairy (%)			-2.06	0.98**	Linear
PP sheep (%)			8.35	3.42**	Log
Property size (ha)			3.29	0.66*	Square root
Drainage cost	4.87	1.91*	1.37	0.67**	Squared
Quarter of transfer	-3.13	0.96*	-0.39	0.11*	Squared
Increase ex. Crop[5]	2.55	1.02*			
Decrease irrigation[6]			9.38	4.00**	Log
Perception of price[8]	6.28	2.25*			
Constant	268.85	14.96*	307.13	7.53*	
n	144		106		
Adj. R^2	0.77168		0.6709		
SEE	29.83		31.57		
F	44.94		22.4		

*Sign. at the 0.01 level, ** Sign. at the 0.05 level, ψ Sign. at the 0.1 level (note these two variables are significant using a one tailed test, which can be justified since the signs are as expected). (ha) = number of hectares in that land use; (%) = % of total irrigation area in that land use; PP = permanent pastures; AP = annual pastures [1] reciprocal functional form, [2] the buyer had no allocation prior to this purchase, [3] The buyers or sellers total allocation prior to this transaction, [4] The buyer's or seller's water use as a percentage of their total allocation prior to this transaction [5] The importance of Increasing the area of existing crop (as rated by the buyer on a 1-7 scale, 1= not important; 7= extremely important), [6] The importance of decreasing the irrigated area (as rated by the seller), [7] The buyer or the seller are within the Northwestern part (Kerang, Cohuna and Swan Hill). [8] the buyers perception of the price as being very cheap = 1 to 7 = very expensive

During both study periods, it was possible to trade water from the Eastern Region to the Northwestern Region. This however did not take place. The high value producing irrigators in the dairy areas of Cohuna have been able to compete successfully for water within the Northwestern Region. They have apparently been able to satisfy their demand from sellers within the region and have seen no reason to purchase additional water at higher prices from the Eastern Region.

During the first study period it was not possible to trade water between private diverters and irrigation areas. This prevented the high value producers within irrigation areas from buying water from private diverters who traditionally have large volumes of unused water. Private diverter irrigators wanting to sell water therefore had to sell to other private diverters, and accept the price they were willing to pay. The buyers' model suggests that private diverters paid $167.93 less while the sellers' model suggests that private diverters received $84.82 less. As a consequence, volumes traded among private diverters were quite low.

Table 2: Hedonic Models - Water Transfers, GMID, 1994-96

	Buyers model		Seller model		
Variables:	β	SEβ	β	SEβ	
Private diverter (0,1)	-40.68	15.25*			
Buyer private diverter (1,0)			-34.27	10.17*	
Cohuna (0,1)	-66.62	10.22*			
Kerang (0,1)	-33.29	16.03**	-60.24	9.28*	
Shepparton (0,1)			-21.20	7.97*	
Rochester (0,1)	31.15	11.34*			
Hectare irrigated (ha)			- 0.06	0.02*	
Off-farm drainage (0,1)	18.12	10.14ψ	18.22	6.63*	
Years of Farm ownership			- 0.40	0.17**	
Quarter of sale (squared)	0.76	0.12*	0.74	0.09*	
Perception of price (1-7)[1]	15.83	3.02*			
Water quality problems[2]	5.90	1.90*			
PP dairy (number of ha)				1.07	0.39*
PP dairy (%)	0.50	0.12*			
Dairy (%)			-0.44	0.11*	
Sheep (%)			0.29	0.08*	
Reduce cattle (ha)			1.06	0.24*	
Expand cattle (ha)	5.23	1.69*			
Constant	319.27	13.78*	387.22	6.89*	
n	125		114		
Adj. R^2	0.58604		0.63475		
SEE	39.98		27.64		
F	18.55		18.85		

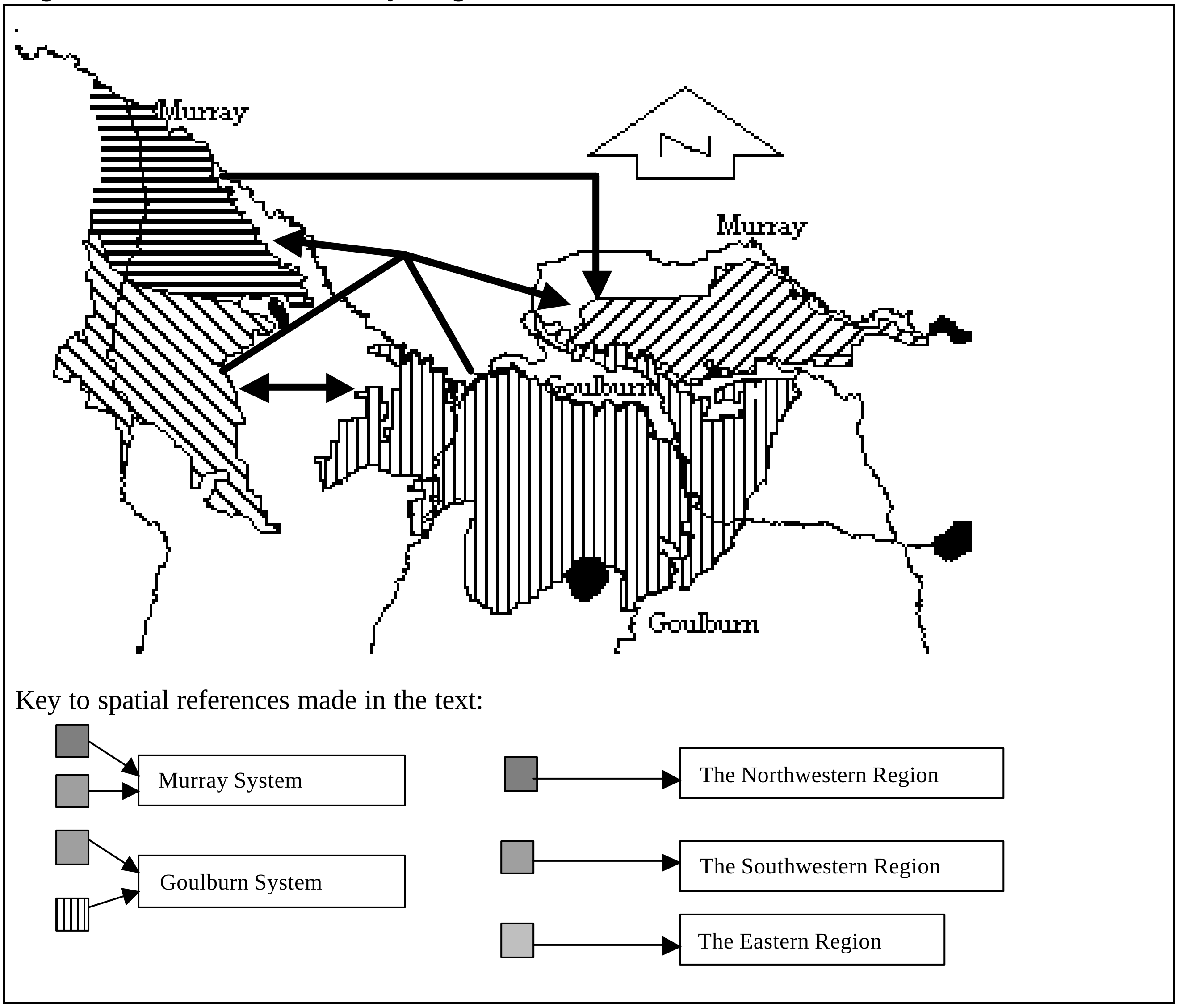
*Sign. at the 0.01 level, ** Sign. at the 0.05 level, ψSign. at the 0.1 level.
(%) = % of total irrigated area; (ha) = number of hectares in that land use; [1] see Table 1;
[2] 1= no water quality problems, 7 = severe problems.

During the second study period trade between private diverters and irrigation areas was introduced with the effect that the volume of trade involving private diverters increased by 167%, and the price reduction declined to $40.68 in the buyers' model, and to $34.27 in the sellers model. This decline in the Sellers' model was only if a private diverter was selling to a private diverter. If a private diverter was selling to an irrigation area buyer the price paid was equivalent to other sales. This again shows that the price level is reduced if spatial or other restrictions are placed on water trade. The changes from period one to two show the impact of increased competition for water introduced by the removal of impediments to trade, but also indicate imperfections in the market. The private diverter selling for $34.27 less must be ill informed of the recent policy changes and the price level within irrigation areas.

The final spatial impact is within the Southwestern Region (see Figure 3). During the first study period the findings indicate that irrigators within that region purchased water for $32.33 less than irrigators within the Eastern Region (Table 1). On the other hand irrigators within the Southwestern Region selling water only sold for $16.57 less than water sellers in the Eastern Region. The difference between the sellers' and the buyers' price reduction must be caused by internal trade. Some sellers within the Southwestern Region are obviously not aware of the price level in the Eastern Region and therefore allow buyers within their region to purchase at lower prices. Other irrigators selling to buyers in the

Eastern Region are getting better prices, with the effect that the coefficient in the sellers' model indicates a smaller price reduction with a much larger standard error representing the higher level of variation. This reduction in prices in the Southwestern Region is not significant in the second study period. This can be caused by two factors. First, some spatial restrictions on trade have been removed and second, sellers in the market might be better informed about their options and about price levels within the GMID. This suggestion could be supported by the fact that the use of water brokers went up by 47% from the first to the second study period. In conclusion, early markets failed to be efficient due to inefficient information flows and spatial and other restrictions on trade.

Figure 3: The Goulburn-Murray Irrigation District and directions of trade



In SA, spatial restrictions were not imposed during any of the study periods. However, it was not possible to trade between irrigation areas and private diverters during the first period. As a consequence, only 26% of all transfers took place within irrigation areas during the first study period. During the second period, 26.3% of the buyers were from irrigation areas compared to 70.9% for the sellers. The proportion of irrigation area sellers thus increased by 170%, while the proportion of buyers remained unchanged. Price variations caused by location were not as predominant in SA. In the first study period, the only spatial variable of significance was that buyers within the Waikerie Irrigation Area paid $90.71 more (Table 3). This is the major citrus growing area and during the first study period the citrus industry experienced good profits compared to other commodities.

Table 3: Hedonic Models - The Water Market -The River Murray – SA, 1987-1993

	Buyers model		Seller model	
Variables:	β	SEβ	β	SEβ
Non-farming user (0,1)	38.83	17.09**		
Furrow irrigation (ha)	- 1.96	1.12ψ		
Overhead sprinklers (ha)	- 0.63	0.36ψ		
Drip irrigation (ha)	5.17	1.63*		
Under canopy (ha)	- 0.15	0.04*		
Micro jet sprinklers (ha)			20.02	7.20*
Quantity sold (ML)[1]	76.90	36.50**		
Quantity sold (ML)			-0.10	0.04*
Allocation (ML)			0.03	0.015ψ
Quarter of sale (1-28)	2.06	0.59*	1.39	0.73ψ
Perception of price (1-7)[2]	24.79	4.19*		
In Waikerie IA (0,1)	90.71	21.12*		
Land in citrus (%)			-1.21	0.28*
land in stone fruit (%)			0.37	0.24
Land with sandy soil (%)			0.34	0.13*
Water salinity problems (1-7)[3]			-14.02	3.27*
Constant	210.90	20.89*	339.19	15.46*
n	114		84	
R^2	0.545		0.441	
F	16.05		9.19	
SEE	45.60		51.39	

*Sign. at the 0.01 level, ** Sign. at the 0.05 level, ΨSign. at the 0.1 level (all two tailed)
(ha) = number of hectares in that land with that characteristic, (%) = % or irrigated land with that characteristics [1] Size of transfer were included in the reciprocal functional form.. [2] see Table 1; [3] same as for water quality problems in Table 2

During the second study period, when irrigation area irrigators became more active in the market, spatial issues as well as irrigator type became more significant in the models. The models in Table 4 indicate that private diverter paid $46.65 more than irrigators within irrigation areas. The sellers' model indicated that private diverters sold for $17.33 more than sellers within irrigation areas. As in the similar model for the sellers within the GMID, it was found that the standard error of the coefficient in the sellers' model was quite large and the coefficient therefore only significant at the 0.1 level. This is caused by the fact that most irrigation area sellers sold to private diverters and therefore sold at higher prices, while irrigators selling within and between irrigation areas sold for less. This difference in market behaviour produces higher variation and must be a result of lack of information flow in an inefficient market. This is also reflected in the variable 'use broker'. If the seller used a broker the seller received $22.17 more corresponding with the findings of Challen (2000) among the buyers. Within irrigation areas the irrigators selling to private diverters used brokers more frequently than those selling to other irrigation area irrigators. The use of broker is a proxy for market proficiency as discussed by Brown et al (1982). The sellers using a broker benefit from the broker's market knowledge.

Table 4: Hedonic Models - The Water Market, River Murray in SA, 1994-96

Variables:	Buyers model β	SEβ	Seller model β	SEβ
Quarters since sale (1-12)[1]	-0.88	0.06*	- 1.03	0.11*
No prior allocation (0,1)	-19.06	8.42**		
Land in vine (%)	0.15	0.08ψ		
Land vegetables or horticulture excl. citrus (%)	0.28	0.09*		
Land in vegetables (%)			- 0.39	0.11*
Expand under canopy (ha)	- 0.30	0.13**		
Land with centre pivot (%)			- 0.58	0.25**
Private diverter (0,1)	46.65	7.33*	17.33	9.65ψ
Lakes Area (0,1)			-40.47	20.29**
Quantity sold (ML)[2]	-89.15	30.49*	-46.68	24.39**
Irrigated land (ha)			0.29	0.05*
Increase area of existing crop (1-7)[3]	- 3.08	1.18*		
Increase water on existing crop (1-7)[3]	3.12	1.20*		
Grow new crops (1-7)[3]	2.01	1.24ψ		
Retire (1-7)[3]			3.91	2.22ψ
Sellers age (years)			-1.15	0.32*
Use broker (0,1)			22.17	8.42*
Constant	506.12	11.76*	580.53	16.48*
n	156		101	
R^2	0.689		0.600	
F	35.55		16.00	
SEE	34.71		32.49	

* Sign. at the 0.01 level, ** Sign. at the 0.05 level, ψSign. at the 0.1 level (all two tailed)
(ha) = number of hectares in that land with that characteristic, (%) = % or irrigated land with that characteristics. [1] using a squared functional form, [2] using a reciprocal functional form, [3] reasons for selling and buying: 1=not important to 7 = very important

Finally, water sold out of the Lakes Area sold for $40.47 less. This is not a reduction caused by restrictions on trade or different classes of irrigators. It must be an expression of market inefficiencies. Water sellers within the Lakes Area were mainly low value producers with broad acre production or no water use at all. Water therefore had a relative low value to these sellers. They must have accepted lower prices out of ignorance about the real value of water for high-value producing irrigators in the Riverland approximately 400-600 km upriver. In reality an irrigation area irrigator in the Riverland sold water for $23.14 more than a private diverter in the Lakes Area. These findings are contrary to those of Challen (2000) but in accordance with expectations. The difference in the findings could be due to the fact that the result in this study is based on analysis of irrigators selling water out of the Lakes Area while Challen's model is based on irrigators buying water into the Lakes Area. The sellers within this area are low value inefficient irrigators or irrigators who never used their water, while the buyers within this area predominantly are vineyard both new greenfield developments and expansions of existing operations

Water use efficiency and high value production

Various measures of and proxies for water use efficiency and production type were included in all models. During the first study period in SA irrigation methods were included in both the buyers' and sellers' models (Table 3). The buyers' model clearly indicated that the more efficient the irrigation method the more the buyers were willing to pay. For each hectare the buyers had with drip irrigation, they would pay an additional $5.17. The other irrigation methods had a negative impact on the willingness to pay: micro jet sprinklers by $0.15/ha, overhead sprinklers by $0.63/ha and furrow or flood irrigators by $1.96/ha. That furrow and flood irrigators were capable of buying water at a lower price indicates inefficiencies in a thin market where no other buyers are present, or where lack of market information prevents sellers and buyers from identifying each other. This lack of information caused the Department of Environment and Natural Resources to publish a list of all licence holders giving information about entitlement and actual water use in 1994 to assist buyers in identifying potential sellers.

The sellers' model indicated that irrigators using micro jet sprinklers, which is one of the most efficient irrigation methods for horticultural crops, sold water for $20.02 more for each hectare being irrigated by micro jet sprinklers. This could represent irrigators selling water, which has become surplus due to the introduction of a more efficient irrigation method. Such irrigators were in a position where they did not have to sell. They were located within the Riverland, where most of the demand was and therefore were most likely to establish contact with potential buyers.

During the second study period (Table 4) the issue of irrigation method was not significant. This represents a maturing in the market. That the inefficient irrigators were not any longer capable of buying at lower prices might be a result of better knowledge about supply and demand along the river. This could reflect the increased use of brokers as well as the release of the list of water entitlement and water use figures in 1994. This is a positive development from both an economic and environmental perspective. The only irrigation method represented during the second study period was centre pivot in the sellers' model. Sellers having 100% of their irrigated area under centre pivot sold for $50 less. Centre pivot is the most efficient irrigation method for broad acre and vegetable crops and therefore most commonly found in the Lower Murray and the Lakes Area. This price reduction is therefore likely to be a proxy for the low value producing broad acre farmers in the lower reaches of the river.

Within the GMID it was not expected that irrigation methods would be an important issue due to the predominance of gravity irrigation. However drainage, laser grading and re-use systems were likely measures for water use efficiency. Within both the sellers and buyers models and during both study periods the presence of and extent of off-farm drainage access were significant price determinants. During the first study period the measure was the cost of drainage. The higher the drainage cost paid to the GMW the higher the price. The drainage cost depends on how big a proportion of the irrigated area is connected to public off-farm drains. During the second study period both the sellers and buyers paid and got approximately $18 more if they had access to off-farm drainage either in the form of public or private drains.

Within SA, sandy soils are considered the most productive soil type for horticultural crops, especially citrus. It was therefore not unexpected that the sellers' model during the first study period showed that the price increased with the proportion of the irrigated area with sandy soils. This is likely to be a measure of the more efficient farmers selling marginal proportions of unused water and therefore not in a position where they have to sell below going prices. It is also likely to represent the fact that citrus was the economically best performing crop during the first study period.

The sellers' model during the first study period also showed that sellers, perceiving that they had severe water quality problems, were selling at lower prices. This is likely to represent inefficient producers farming in unsuitable locations such as anabranches or other backwaters, where water quality is worse than in the main river. Such irrigators will have a low production and their planting and other irrigation infrastructure will therefore have lost all or part of their value. Irrigators in this position are often in financial difficulties and under pressure to sell, and are therefore willing or forced to accept lower prices.

The type of production of the sellers and buyers also entered all models. In SA, water use was only significant in the sellers' model during the first study period. The sales price decreased the larger the proportion of the irrigated area in citrus, and increased the larger the area in stone fruit. That some citrus growers sold water for lower prices during that period, when the citrus industry was otherwise experiencing a good time, must reflect inefficient irrigators with low quality planting not capable of maintaining production and profits at a level representative of the citrus industry in general.

During the second study period, vegetable and horticultural growers, except citrus, paid highest prices followed by vine growers. Vine growers paid less for water because they purchased large volumes of water for major new developments and therefore operated from a position of strength. That citrus growers paid less reflects the findings in the irrigated land market during that period that water used for citrus production did not command its previously higher prices (Bjornlund, 2001) and reflect the changing fortune of the citrus industry due to increased competition for cheaper imported concentrates as tariffs were reduced. The findings regarding citrus are also supported by the work of Challen (2000) who found that prices for oranges for processing (Valencia) was the most significant commodity price affecting the price of water.

The buyers' model showed that irrigators wanting to increase the application of water on existing crops were willing to pay higher prices. This could indicate that these buyers expected to increase productivity from existing infrastructure without any further cost. The marginal value of water applied for this purpose is likely to be high. Buyers wanting to apply the water on new crops were also willing to pay higher prices. This could reflect that these buyers are going to apply the water on choice soils, using the most productive varieties and most efficient irrigation technology. Finally, buyers wanting to expand existing crops paid less for water. These buyers are mainly within irrigation areas where the price level generally is lower and where soils are likely to suffer from the long-term impact of irrigation reducing the productivity of water.

Within the GMID both the first and second study period showed that price was related to the area of permanent pasture for dairy, which is the highest value water use in the area. The buyers' willingness to pay, increases with the area in permanent pastures for dairy, while the sellers are willing to accept lower prices the larger the area in annual pastures. During the second study period, dairy had a dual impact on sales prices. First, the larger the proportion of the selling farm in dairy production the lower the sales price. Second, for each hectare the selling property has in permanent pastures for dairy the higher the sales price. This reflects the findings of the first study period, that the more land the sellers had with annual pastures for dairy the lower the price, since the presence of annual pastures for dairy raises the percentage of the farm in dairy production. This was tested by replacing the variable 'percentage of irrigated land in dairy' with the variable 'number of hectares with annual pastures for dairy'. In this model the latter variable was significant with a negative sign, confirming the findings of the first study period. Introducing this variable into the model however resulted in the variable 'number of hectares with permanent pastures for dairy' being insignificant and an overall reduction in the explanatory power. The test however confirmed that the two dairy variables in the model reflect that irrigators with many hectares of permanent pastures for dairy are selling at a premium, whereas the presence of annual pastures for dairy cause a reduction in price. This suggests that efficient dairy farmers with excess water sold at a premium, whereas less efficient dairy farmers sold at lower prices.

Buyers who intended to expand their irrigated area for cattle production and sellers who intended to reduce their irrigated area for cattle as a consequence of the water transfers, bought and sold for higher prices. This could indicate that the cattle industry has niches of high profitability. Irrigators expanding into these segments of the market are willing to pay good prices. For the buyers it could also reflect the fact that a significant proportion of the buyers expanding their cattle production consisted of non-commercial farm properties. Other irrigators electing to reduce their irrigated area for cattle must be doing so as a rational business decision rather than out of financial distress and therefore able to sell at higher prices.

Volume traded and the buyers and sellers bargaining strength

The volume of water traded was significant in more than half the models. However, the impact on price was not consistent, reflecting both the findings of Colby et al (1993) and the arguments presented by Howe et al (1990). During the first study period in SA prices decreased with volume traded. In the buyers model this was reflected by the coefficient having a positive sign and a reciprocal functional form. Buyers were willing to pay almost $77 more, if they bought one ML and $7.7 extra if they bought 10 ML. One of the reasons could be that most of the small volumes were traded within irrigation areas, where buyers did not have to produce an Irrigation Drainage and Management Plan as a part of the transfer process thus lowering transfer costs and increasing the willingness to pay, and probably also because many of the buyers of small volumes were hobby or 'lifestyle' farmers willing to pay a premium in pursuit of their non-economic objectives. In the sellers' model, this was reflected by the coefficient having a negative sign and linear form indicating that for each ML increase in the volume traded, sellers received lower price following the findings of Colby et al (1993).

During the second study period, both the sellers' and the buyers' model showed that small volumes traded at lower prices. The coefficients had a negative sign and followed a reciprocal functional form. Buyers would pay $89 less if they purchased only 1 ML and $8.9 less if they purchased 10 ML. This could reflect that the department tightened the transfer procedures for small transfers significantly increasing per ML costs for small transfers. The same trend was found in the buyers' model during the first study periods within the GMID. The reduction for 1 ML here was $141 reducing to $14.10 per ML if 10 ML were purchased. Both of these findings support the arguments of Howe et al (1990). That most models had volume in a reciprocal form clearly indicates that the price differences are most important for very small volumes, as the volume increase the price difference decreases rapidly.

The bargaining position of the buyers and sellers can be difficult to measure and quantify. A number of variables indicating the market power and financial strength of the buyer and seller or variables functioning as proxies for such factors were included in most models. Size of the sellers and buyers either in form of the number of irrigated hectares or the volume of water entitlements were significant in most models. The theory was that the larger buyers and sellers were negotiating from a position of strength. The larger irrigators are more likely to be able to conduct the sale or purchase at a time of their choice, that is, when better prices can be achieved.

During the first study period in SA, the entitlement of the sellers were significant, showing that the larger the entitlement the higher the sales prices. During the second study period, the sellers' model included the variable 'number of irrigated hectares', which is closely related to the size of the entitlement. That model indicated that the larger the sellers' irrigated area, the higher the sales price. The buyers' model for the second study period showed that buyers who did not have any prior entitlement, paid $19 less. This reflects that many of the buyers not having any prior entitlement, were large new enterprises such as vineyards, purchasing large quantities of water. This again must represent a position of strength in the bargaining process.

Within the GMID a similar relationship was found. During the first period sales prices increased with property size. The functional form of the variable indicates that the increase was most significant for small farm sizes. The second period found a negative relationship between the number of irrigated hectares and sales price, the variable followed a linear form and the reduction was only minor with a reduction of 6 cents per ha or $6.00 for a property with 100 ha. This is likely to represent the large extensively farmed irrigated properties in the two Western Regions.

Irrigators within the GMID have a tradition of using large quantities of annual sales-water and in many instances have established permanent pastures on the strength of such annual allocations. It was therefore considered that the extent to which the buyers and sellers used their water right prior to sale should be an indicator of their bargaining position. A buyer using in excess of 130% of their water right prior to purchase must have been under some pressure to increase their water right within an environment of declining annual sales-water allocations. In the same way, it must be considered that sellers having used in excess of 130% of their water right prior to sale must be under some kind of pressure to sell. Such a sale will cause a reduction of their existing irrigated area or increased exposure to future cuts in annual sales-water allocations.

During the first study period the percentage of allocation used was significant in both the sellers' and the buyers' models. The buyers' model indicated that the larger the proportion of their water right the buyers used, the more they were willing to pay. A buyer using 200% of water right was willing to pay a premium of $28/ML. The sellers' function followed a squared form. This indicated that the price reduction accelerated, the larger the proportion of the water right the seller used. A seller using 200% of water right was willing to accept at price reduction of $72/ML.

The impact of age and other personal factors on the willingness to pay and accept prices

The final factor analysed was the sellers' personal characteristics. These are factors such as age, length of farm ownership and the reasons for selling and buying. In SA, the model for the second period reflected two factors: the sellers' age and the importance of 'retire' as the reason for selling. Older farmers sold at lower prices with an irrigator of 70 years selling for $30.50 less than a seller at 40. This could reflect inefficient farmers, who have not kept their farm up to date and are now selling, because the farm has become unviable. On the other hand, older farmers, who are selling because they make a conscious decision to retire, and therefore intend to use the proceeds from the sale as part of their retirement plan, are selling for higher prices by as much as $27. This difference might reflect their different position in the bargaining process. The older farmer selling to retire might more properly have investigated what water prices were and be able to time the sale to get a better price. On the other hand, the inefficient older farmer might be under financial, health or family pressure to sell and therefore did not find out what the proper market price was, or was unable to hold on to the water until a higher price was offered.

Within the GMID, the sellers' model for the second study period included the variable 'years of farm ownership'. This variable indicated that the longer the sellers have owned the property the lower the sales price. As with the variable 'hectare irrigated' in the same model, 'years of farm ownership' has a fairly insignificant impact on sales prices. It is likely to represent farms in the Southwestern Region where the largest proportion of the sellers (75%) had owned their properties for 10 or more years. The sellers' model also indicated that sellers who made a conscious decision to reduce the irrigated area, possibly as part of a restructuring of the property and as part of a whole farm plan, sold at higher prices.

The buyers' and sellers' perception of the price

During the first study period only the buyers were asked to rate how they perceived the price as being very cheap to very expensive on a one to seven scale. The variable was significant at the 0.01 level within both study areas, clearly indicating that the buyers were well aware when they managed to buy water at a good price, and when they had to pay a high price to get what they needed. During the second study period, both the sellers and buyers were asked about their perception of the price. In SA, this variable was significant in neither the buyers' nor the sellers' model. This could reflect the graphs in Figure 1 showing a narrowing of the gap between the minimum and the maximum prices as well as the sharp fall in standard deviations. This indicates that the market has matured and that bargains are not available any more.

Within the GMID, the buyers' perception was still significant at the 0.01 level reflecting the significant dispersion between minimum and maximum prices shown in Figure 2. The variable fails to be significant in the sellers' model. This could indicate that the sellers are less aware of the prevailing market conditions and are not aware when they sell water at less than the going price which correspond with the general lower adjusted R^2 values of the sellers model. This indicates a still immature water market.

Signs of a maturing market

The following provides a review of the major indicators of a maturing market within the two study regions both based on the hedonic models discussed in this paper and events in the permanent water markets since the end of the study period.

Within the GMID:

- The removal of barriers to trade between irrigation areas and private diverters resulted in higher volumes of water traded and a reduction in the price difference between the two types of water entitlements.
- The price difference between the eastern part and the southwesten part disappeared from the first to the second period indicating a better flow of information and the easing of some restrictions on trade.
- The use of market facilitators increased from the first to the second study period by 36% for buyers and 47% for sellers (Bjornlund and McKay, 1999).
- Significant increase in market activity since the end of the study period.

Along the River Murray in SA:

- Also in SA the removal of barriers to trade between irrigation areas and private diverters resulted in an increase in the volume of water traded.
- Irrigators within irrigation areas aware of the ability to sell to private diverters obtained a better price.
- The use of brokers increased from the first to the second study period by 35% for sellers and 8% for buyers (Bjornlund and McKay, 1999).
- During the first study period inefficient irrigators were able to buy water at much lower prices due to lack of market information. This was not the case during the second study period when the relevant department had increased the information level about supply and demand and the use of brokers had increased.

- Price dispersion was significantly reduced: the standard deviation of prices went down from 18% to 6% of the mean annual price.
- The buyers' perception the price as cheap or expensive ceased to be efficient in the second study period reflecting the reduced price dispersion.

Conclusions

This paper has analysed transactions in the permanent water markets in Victoria and South Australia prior to December 1996. Hedonic models were applied to transactions during two time periods: before and after 1995. This year was chosen because in both states trade was made possible between irrigation area irrigators and private diverters, significantly freeing up market operations. In both states market activities increased significantly in the previously subdued section of the market. In South Australia this section was irrigation areas where significant volumes of excess water existed and limited space was available for expansion. As a result of the changes in 1995 the number of water sales by irrigation area irrigators increased by more than 170%, with all the increase being sold to private diverters, where the bulk of expansion took place within viticulture and horticulture. In Victoria the subdued section was among private diverters with significant volumes of unused water and predominantly low value water uses. Sales by private diverters therefore increased significantly after 1995, with the increase predominantly going to irrigation areas, where demand was high from the dairy industry. The price difference between the two sections in the market evened out, however, if trade took place between a buyer and a seller both within the subdued section, water was still trading at a lower price. Spatial restrictions on trade also exist in Victoria. The analysis showed that the more restricted the market, the lower the price and as restrictions eased and annual allocations were evened out as well, prices became more uniform. Within a sector of the GMID, with low value production and significant salinity problems, water sold at lower prices during the first study period. This difference was reduced after 1995. However, again it was found that if trade took place between buyers and sellers both within the low value producing area, water was still traded at lower prices.

The above findings suggest that price dispersion did decline over time as irrigators gained more experience with market operations, suggesting that markets have matured. However, it is also suggested that there is still an inefficient flow of market information causing some irrigators to sell at lower prices. Since 1996 markets have matured further with increased use of water brokers and the emergence of water exchanges (Bjornlund and McKay, 2001b) and this process is ongoing (Bjornlund 2000 and Bjornlund and McKay, 2001a).

Three other main findings emerged: 1) efficient and higher valued irrigators were willing to pay higher prices and capable of achieving higher prices when selling; 2) buyers and sellers in the strongest bargaining position paid lower prices and received higher prices; and 3) older farmers tended to sell for lower prices unless they did so as part of a planned retirement process.

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