Tracing evidence of rational investor behavior in water markets

Bjornlund, H. and Rossini, P.
Centre for Land Economics and Real Estate Research
University of South Australia

ABSTRACT

This paper analysis prices paid for water allocations and water entitlements and the relationship between the two prices in order to establish evidence of rational behavior in water markets. The analyses show some evidence that prices reflect economic fundamentals. However, the major factors influencing the prices paid for water by irrigators are the allocation level at the time of purchase and the evaporation factor. The allocation level determines how much water existing irrigators will have to buy to maintain production, and it thereby determines the competition for water in the market, while the evaporation level determines how much water irrigators need in addition to the water needs of their crops. Prices of water entitlements are also strongly influenced by the price of water allocations, as economic theory would suggest.

Analyzing the relationship between allocation and entitlements prices shows a strong relationship between the movements in the price of the two products. However, the price of water allocations fluctuates far more than the price of water entitlements since allocation prices reflect short-term fluctuations in allocation levels and climatic conditions. Irrigators seem to have a good feel for when prices of allocations are exceptionally low or exceptionally high and do not therefore capitalize such extremes into the value of water entitlements. Finally, cash flow analysis suggests that investors in water entitlements during the first eight years of trade would have made good returns on their purchases if they bought the entitlements with the intent of holding it for five years, and the selling the allocations each season. Returns for such investments seem to be between 15% and 25% per annum.

Key words: water markets, water as investment, return on water

INTRODUCTION

Markets in water entitlements have emerged in Australia since the mid 1980s in most instances without specific legislation, which was not introduced until much later. During the early years trade was relatively subdued and it took a long time for irrigation communities to come to terms with water as a commodity and understand its potential (Bjornlund, 2003a,b, 2004a; Tisdell and Ward, 2003). Not until the last half of the 1990s did market activities accelerate and water trading become a regular part of modern farm management practices. The Council of Australian Governments (CoAG) has driven water reforms since 1994, and as part of the National Competition Policy, State governments are committed, under the threat of severe financial penalties, to implement these reforms. Water markets, the separation of land and water rights, the establishment of secure and well defined entitlements to water consistent across jurisdictions, are all elements of the reform process. Ten years after its first water reform Communiqué (CoAG, 1994), CoAG issued a new communiqué in 2003 (CoAG, 2003) reporting on good progress on these reforms but emphasized that the lack of well defined property rights still impedes investments in irrigation and that present water products and market mechanisms still prevent water markets from achieving their full potential in directing water to its most efficient and highest value use. CoAG therefore agreed on a new National Water Initiative in 2004 (CoAG, 2004) trying to address these and other water reform issues.

The creation of more sophisticated water products, market mechanisms and market instruments such as long-term leases, lease-back, futures, options, and conditional contracts will require fundamental changes in the property rights structure for land and water. The nexus between land and water will have to be formally broken and the interest in water will need to be more clearly defined and secured, and should be unbundled into its components: 1) a water access entitlement; 2) a seasonal allocation; 3) a water use right; and 4) a supply capacity entitlement. Such interests in water should be recorded in secure registers such as the Torrens Title system, where transactions, mortgages, leases, etc., can be securely registered. Such frameworks have been widely promoted in Australia by researchers such as Young and McColl (2002, 2003), and Bjornlund (2000, 2004b,c). Elements of these frameworks have been included in the National Water Initiative, the NSW, Queensland and South Australian water legislation, and more elaborately in the recent Victorian White Paper (DSE, 2004). Such new structures have significant impacts on the property profession (Bjornlund and O'Callaghan, 2004). Even when such an appropriate institutional framework is in place efficient outcomes will only be achieved if competitive water markets exist in which water prices reflect economic fundamentals and the expected net present value of the future income stream generated by the water.

This paper will explore the extent to which prices in existing water markets reflect economic fundamentals and the expected net present value of the future rents (income stream) derived from its use. The rent (income stream) from a perpetual water entitlement can be measured in two different ways: a) by the income stream generated by the holder of the entitlement putting the water to beneficial use; or b) by the income stream that an investor in such an entitlement can generate by selling the seasonal allocation yielded by the entitlements each year. To test a) we will review the literature discussing the relationship between water market prices and economic fundamentals, including a number of previous papers by the authors, and to test b) we will provide some more elaborate analyses of the relationship between the price of seasonal allocations (hereinafter called allocations) and perpetual water entitlements (hereinafter called entitlements). In an efficient market the discount rate inferred from the relationship between the price of entitlements and the price of allocations should reflect the general level on return on other assets associated with a similar risk.

DO PRICES IN WATER MARKETS REFLECT ECONOMIC FUNDAMENTALS

If the price paid for entitlements and allocations reflects the net present value of the income stream generated by the user of the water when putting it to productive use, then the price of water paid in the market should be a function of the factors affecting such future income stream; that is,

$$W_P = f(C_P, P_C, W_D, W_S, E)$$

Where W_P represents the price of water, C_P the price of the commodities produced by the water, P_C the cost of producing the commodity, W_D the demand for water such as the level of supply, commodity prices, and the level of evaporation, W_S supply for water such as the seasonal allocation level and natural rainfall, and E the general economic environment impacting on the production such as interest rate, exchange rate between A\$ and US\$, inflation, and GDP growth. In the market for entitlements it could also be expected that the price should be influenced by the price paid in the market for allocations as is the case in the property market and, as was found in the market for fishing quotas in New Zealand (Kerr et al., 2003).

Searching the literature for markets in other commodities the market for transferable fishing quotas in New Zealand is probably one of the best comparisons. In New Zealand fishermen own perpetual individual transferable quotas (ITQ) to a certain proportion of the total allowable catch (TAC) each year for each individual fish species harvested. The authority will announce the TAC for each species every year and an annual catch entitlement (ACE) yielded by each ITQ. Two markets in fisheries quotas then exist. The market for ITQs in which the right to receive ACEs in perpetuity is traded and the market in which individual ACEs are traded (Kerr et al., 2003; Newell

et al., 2002). This is very similar to the water market where the entitlement, which is the right to receive allocations in perpetuity are traded in one market while individual allocations are traded in a different market.

Kerr et al. and Newell et al. analyzed fifteen years of market data and found that the market had been reasonably competitive with a number of participants similar to other markets such as the US SO$_2$ market, as well as the market for taxi licenses in the US, and that price dispersion decreased and the level of market uptake increased as markets matured, much at the same level as markets for other commodities. They also found that prices paid in both markets reflect economic fundamentals such as export price of fish, cost of fishing, demand and supply for fishing quota, and the GDP growth rate. Finally they found that the relationship between ITQs and ACEs reflect a capitalization rate much in line with the general interest level in New Zealand during the period.

Experiences from the fishing quotas market would therefore suggest that a similar market for water entitlements should be equally efficient. However, water markets, compared to fishing quota markets, have a couple of unique features and differences. In the fishing quota market a separate market exists for each species. Differences in profitability of the catch are therefore reflected in different prices for the quotas for the different species, which reflects a considerable range in price from about NZ$700 per ton for jack mackerel to 40,000 per ton for rock lobster (Newell et al., 2002). Therefore, rock lobster fishermen and jack mackerel fishermen are not competing for the same fishing quota. In water markets, on the other hand, all water is traded in the same market regardless of the value of the commodity produced by that water; say from wine grapes to pastures for wool production, with a significant dispersion in gross margin per unit of water used. Also it could be expected that the level of ACE for fisheries are more consistent than the level of seasonal allocations for water given its dependence on fluctuations in climate. Finally, supply and demand of water does not only depend on the level of seasonal allocations and commodity prices but also on the level of natural precipitation and evaporation. Therefore the pricing relationships in the water market are likely to be more complex that the pricing relationship in the fishing quota market. Furthermore, other players such as city water authorities and industries could participate in water markets with a far higher willingness/ability to pay than irrigators. This impact has clearly been demonstrated in the US. Here Pearson and Michelsen (1994), when analyzing mean annual prices paid for water in northern Colorado from 1961 to 1989, found that return on water in agricultural production seems to explain part of the price fluctuation in water prices until 1975, when urban growth increased around major cities. From then on other economic indicators such as the number of housing starts, population growth and the price of other commodities seem to explain the variation in price. Also, Colby et al. (1993), when analyzing individual water transfers in New Mexico, found that when the purchaser was what she termed a high profile buyer (such as urban water authorities or major industries such as power stations or mines) then the price was considerably higher than when the buyer was an irrigator. Also, anecdotal market evidence in the US suggests that prices in an area might stay at a level that reflects agricultural use, until a major industry enters the market causing prices to go up considerably until that industry has satisfied its demand, at which time prices seem to settle back at more or less its previous level (Colby, 1987). In water markets in Australia there is so far no or little evidence of non-agricultural water users driving water markets. Close to 99% of water transfers are between agricultural users (Bjornlund, 1999).

Bjornlund (2002) analyzed individual transfers of water entitlements to establish the factors influencing individual irrigators' willingness to pay and accept prices in the market for entitlements over two time periods within two different states. He found that as trading was opened up both spatially and between different types of water users and classes of water entitlements, and as market operations became more proficient and intermediaries more active in the market, prices increased and became more consistent across space and entitlement classes. This is consistent with earlier findings in US markets (Gardner, 1985; Brown et al., 1982). He also found that: 1) efficient and higher valued irrigators were willing to pay higher prices when buying water, and they were capable of demanding higher prices when selling; 2) buyers and sellers in the strongest bargaining position paid lower prices and received higher prices; and 3) older farmers sold at lower prices unless they

sold as part of a planned retirement process. Finally, he found that price dispersion in the market in South Australia declined sharply from 1987 to 1996, from about 18% during the period 1987 to 1992, to 12% during the period 1992 to 1995, and down to 6% during the 1995 to 1996 period, while markets in Victoria had a constant dispersion during the first nine years of trading of about 20%. This however is still within the range of what is experienced for other commodities where a range between 5% and 30% is quite common (Pratt et al., 1979). These findings indicate that when individual farmers are bidding for water in the same market at any given time then normal economic factors seem to determine the outcome of the market process.

With respect to market activity Kerr et al. found that market activities grew strongly during the early years and that the market for ACEs were far more active than the market for ITQs. The proportion of ACE traded per year increased from 14% to 40% over the first twelve years, while the proportion of ITQ traded per year decreased from 18% to around 4% once the initial structural adjustments encouraged by the introduction had taken place. Similar trends have been observed in the markets for water with little more than 1% of entitlement traded every year against up to 15% for allocations. Measured as percentage of total water use the market share has ranged from 2% when the seasonal allocation is at $200 and up to 24% when the allocation was at an historical low of 57% within one system (Bjornlund, 2004a).

Bjornlund and Rossini (2004a, 2004b) have analyzed mean monthly prices paid in the markets for allocations and entitlements respectively over a ten-year period. They found that prices in the two markets have increased significantly over the ten-year period with prices of allocations increasing by an annualized rate of 31.85%, while prices of entitlements increased at a more mundane rate of 15.08% pa. There was relatively little influence of commodity prices on prices paid in either market. There was a strong negative correlation between dairy prices and the price of water in both markets but the dairy commodity variables were not significant in any of the hedonic functions. The price of feeding barley had a significant positive impact on the price of allocations, and this reflects the fact that the dairy industry is the main buyer in the study region, and that these irrigators can substitute buying water to grow grass by buying substituted feed. As the price of substitute feed goes up the farmers' willingness to pay for water to grow grass also goes up. The main factors influencing prices in both markets are the level of seasonal allocation and evaporation. As the level of seasonal allocation goes down, the price in both markets goes up. As evaporation increases the price of allocations goes up, which reflects an increased demand for irrigation water. In the market for water entitlements there is a strong relationship between the price of entitlements and the price of allocations. As the price for allocations goes up so does the price of entitlements. Finally the level of interest rate has a significant impact on price in both markets, as interest rates go down the price of water goes up.

We can conclude that the water markets do not follow economic fundamentals to the same extent that the market for fishing quotas does, even thought there are some clear signs of this taking place. This is likely to be because of the impact of climatic fluctuations. The last six years of the ten-year study period were dominated by drought and very low seasonal allocations; markets have therefore been driven by 'protective' buying by high value users with significant investments in water dependent infrastructure such as permanent plantings, irrigation systems, milking herds, milking equipment etc. These irrigators are likely to suffer significant long-term losses if they do not irrigate. They are therefore willing to pay prices in excess of the productive value of water in order to protect their assets and stay in business for the next season. There is therefore little evidence during this period of opportunistic irrigators buying extra water because the prices of the commodities they are growing are good.

THE RELATIONSHIP BETWEEN TEMPORARY AND PERMANENT PRICES

In an efficient and competitive market the price of allocations and entitlements should reflect the general level of interest in the economy given a similar level of risk. Prices in the two markets

should therefore follow its other, with prices of allocations driving the price of entitlements, as the hedonic function for entitlements suggested (as discussed above).

In this section we will look more closely at this relationship by using the prices paid within the Goulburn Murray Irrigation District in Northern Victoria over the ten-year period from 1993 to 2002. This is considered in three different ways: 1) calculation and comparison of the earnings to investment ratio at the time of buying the water; 2) comparing and analyzing the cycle factors for the price of allocations and entitlements produced by the ratio to moving average (classical decomposition) method; and 3) by estimating the internal rate of return which could have been obtained by investing in water, selling the allocations yielded by the entitlement over a holding period, and the selling of the entitlement again at the end of the holding period.

Earning to investment ratio

This ratio was computed by dividing the mean monthly prices paid for allocations, less the cost of water supply, which is paid by the seller, by the mean monthly prices paid for entitlements. Two adjustments were made in computing this ration. First, the volume of allocation, which can be sold for each water entitlement purchased, has been adjusted for the allocation level at the time of purchasing the entitlement. That is, if the allocation level was 200% then 2 ML of allocation could be sold at that time for each ML of entitlement purchased, whereas if the allocation level was only 50% then only 0.5 ML of allocation could be sold for each ML of entitlement purchased. Second, the price paid for allocations has been lagged three months; this was done to reflect the fact that price signals in the allocation market are going to take some time to impact on prices paid in the entitlement market given the time it takes to transact water and investor hesitancy. This ratio should indicate the kind of return (ignoring capital gains) that investors in entitlements could expect to receive if they react to short-term price signals. The findings are illustrated in Figure 1
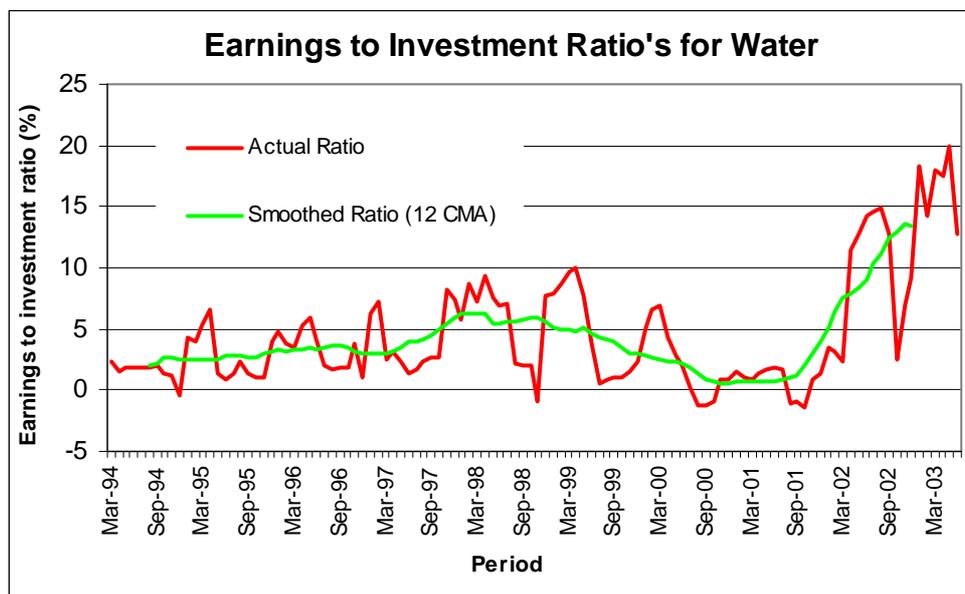

Figure 1: Earnings to investment ratios based on prices paid for seasonal allocations less cost of supply and adjusted for allocation levels

It can be observed that the ratio fluctuates widely due to the fact that the price of seasonal water varies significantly during the season (Bjornlund 2003a; Bjornlund and Rossini, 2004a). The data are deseasonalised using a 12 period centered moving average. A number of observations can be made from Figure 1. First, the 12 month moving centered average shows that the ratio was quite constant at around 3–4% until early 1997 and then increased to around 6% and stayed there until early 1999 when it started to trend downward towards 1% with increased variability during the seasons of 1998/99, 99/00 and 00/01, which all ended with prices below cost of supply towards the end of the season. Since the beginning of the 2001/02 season the ratio has increased sharply as

allocations were very low due to one of the worst droughts since white settlement, while the price of entitlements increased at a more moderate pace as farmers acknowledged that the present price of allocations did not reflect the long-term trend.

Second, towards the end of most seasons the price of allocations trends very low as the irrigation season comes to a close, farmers can therefore not use the water and there are only few buyers in the market. Irrigators cannot carry the unused water over to the next season and they have to pay for supply of their full allocation whether they use it or not. Irrigators with unused allocations therefore have a strong incentive to sell at any price to cover some or all of their unavoidable costs. We therefore see the ratio drop to below 0 towards the end of four seasons and remain very low during periods of good supply like the season of 2000/01 (Bjornlund, 2003a).

Cycle factor analysis
Using the classical decomposition technique, cycle factors were computed for both the price of allocations and entitlements. These show the variation in price, which is not explained by trend or seasonality. The two cycle factors are shown in Figure 2.
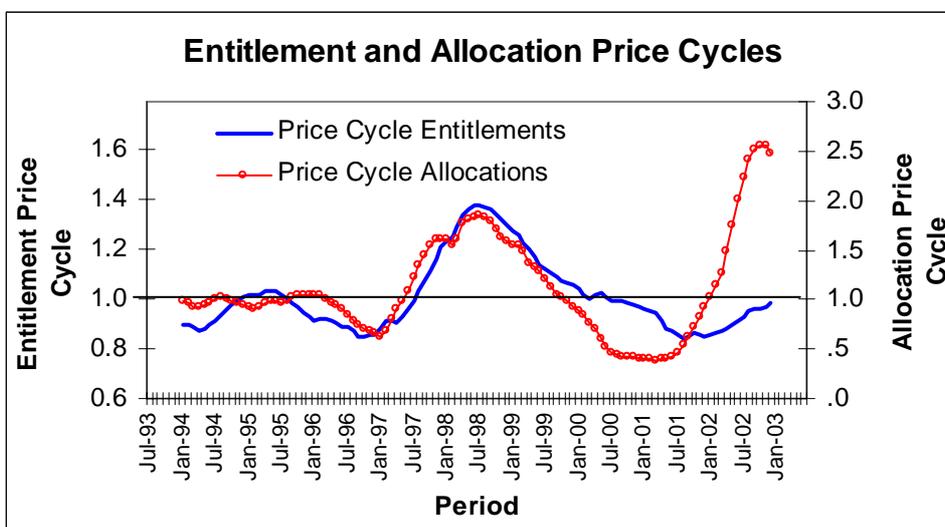

Figure 2: Cycle factors for entitlement and allocation prices

Figure 2 shows that the two cycles move together, which indicates a close relationship between the movements in allocation and entitlement prices and suggests that irrigators make financially sound decisions in the two markets. Four observations can however be made from Figure 2. First, the scale of entitlement and allocation cycle axis is significantly different. The scale for the allocation axis is almost twice that of the entitlement axis. This reflects the fact that allocation prices vary significantly more than entitlement prices. Second, it seems that the entitlement price leads the allocation price until 1997 whereas after the time the allocation price has led the entitlement price, as economic theory would suggest. Third, the allocation price cycle dips deeper and faster than the entitlement cycle during the 1999/00 and 2000/01 seasons. This is caused by the facts that during 1999/00 the allocation price stayed below $90 and dropped very early in the season in response to increasing allocations, while in 2000/01 prices stayed very low during the whole season in response to steady and high allocation and good spring rains (Bjornlund, 2003a). Fourth, during the seasons of 2001/02 and 2002/03 the allocation price cycle increases very sharply while the cycle for entitlement prices trends upwards at a much lower pace and at much lower levels. This confirms the findings of the analysis of the earnings to investment ratios in the preceding section, namely that irrigators are aware that when allocation prices are very low or very high, they do not represent long-term trends and therefore they do not capitalize such changes into entitlement prices. This indicates rational market behavior.

Water entitlements as an investment opportunity

In this section we will treat water as an investment opportunity, purchased by an investor with the intention of making a profit over a holding period. This is analogous to an investor in property who buys an investment property with the intention of leasing it out and eventually selling it again with a capital gain. The total earning over the holding period is the net annual lease income and the capital gain at the end of the holding period. In most investment markets the return of such an investment is computed using a cash-flow approach which computes the internal rate of return for the holding period. For an investment in water entitlements the investor will buy an entitlement, sell the allocation every year and then sell the entitlement again at the end of the holding period.

We constructed cash flows based on prices paid in the entitlement and allocation markets for the time period from 1993 to 2002. The computations are based on the same net prices adjusted for allocation levels discussed in the earning to investment ratio section. Internal rates of return were computed based on the water allocation being sold at the minimum, maximum and median average monthly prices respectively and the entitlement sold at the minimum, maximum and median price achieved in June 2002. The return is the annual rate where it is expected that the cash flow from the allocation be received at the end of the year and the investment sold at the end of the final cash flow period. This is a simplified cash flow similar to those typically used in property analysis where rental may be received monthly but annual cash flows are used to estimate the return. In figure 3 the solid line shows the rate that would have been achieved based on the median price while the vertical line for each month indicates the variation in return if the allocations and the entitlement are sold for the minimum and maximum price respectively.
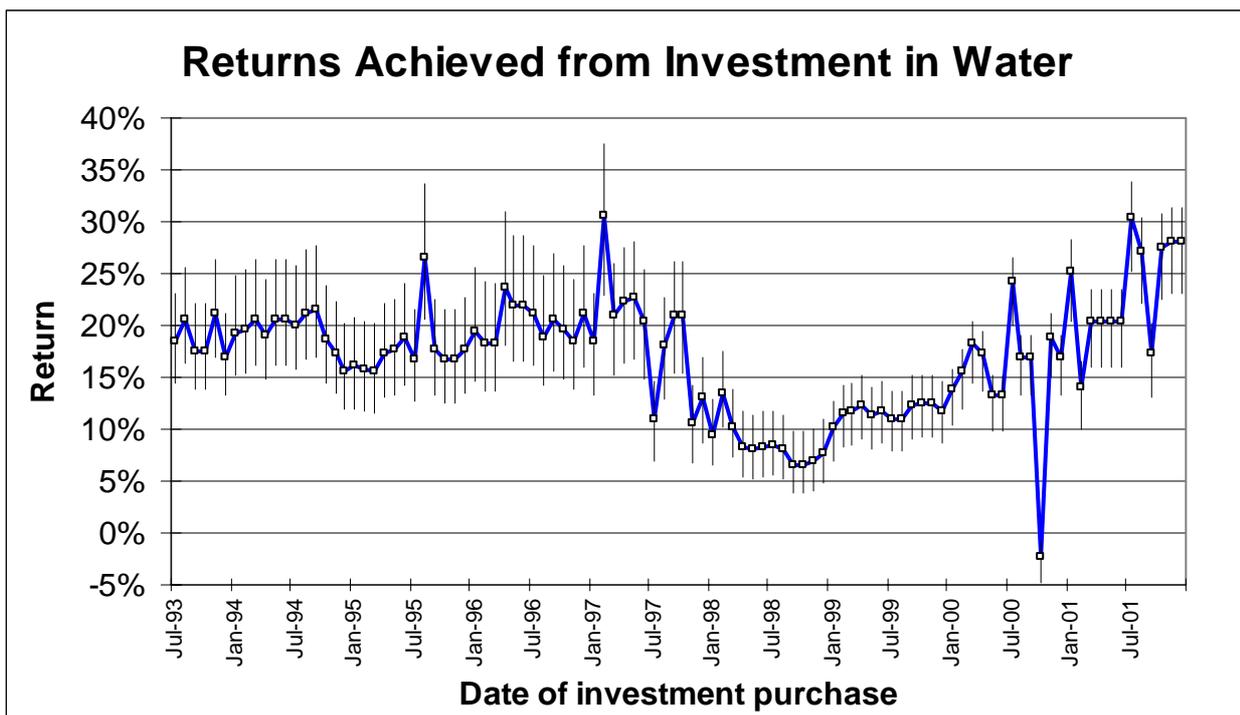
Note: returns are based on the entitlement being purchased the month listed on the X axis and then sold again at the June 2002 entitlement price.

Figure 3: Range of returns from investments in water entitlements

Figure 3 shows what the internal rate of return would be for an investment in water entitlements made in each month if the entitlement was sold at the end of the 2002 cash flow period at the June 2002 entitlement price. The graph shows that investors investing in entitlements during the period form 1993 to 1997 would have achieved a return of 15% to 25% with the median return close to 20% for much of the time. For investments made between July 1997 and August/September 1998 return trended downwards towards 6% to 7% as the price of water entitlements went far above the long-term trend line, which was driven by a surge in investments in grape wine production outside the study region in Victoria and South Australia (See Bjornlund and Rossini, 2004b). The rate of return then trended upwards again towards 15% as demand from the wine grape industry was

satisfied and the price of water entitlements returned to the long-term trend line in early 2000 (Bjornlund and Rossini, 2004b). For investments made since mid 2000 returns become very erratic due to the short holding period and the search in the price of allocations during 2001/02 and 2002/03.

To make a more stable and comparable computation of return a slightly different approach was taken. The internal rate of return was computed based on a five year holding period but using the same allocation and entitlement prices as discussed for Figure 3. The findings of this are shown in Figure 4. Given the time period available it was only possible to compute the returns from investments with a 5 year term on purchases during the 1993 to 1996 period.
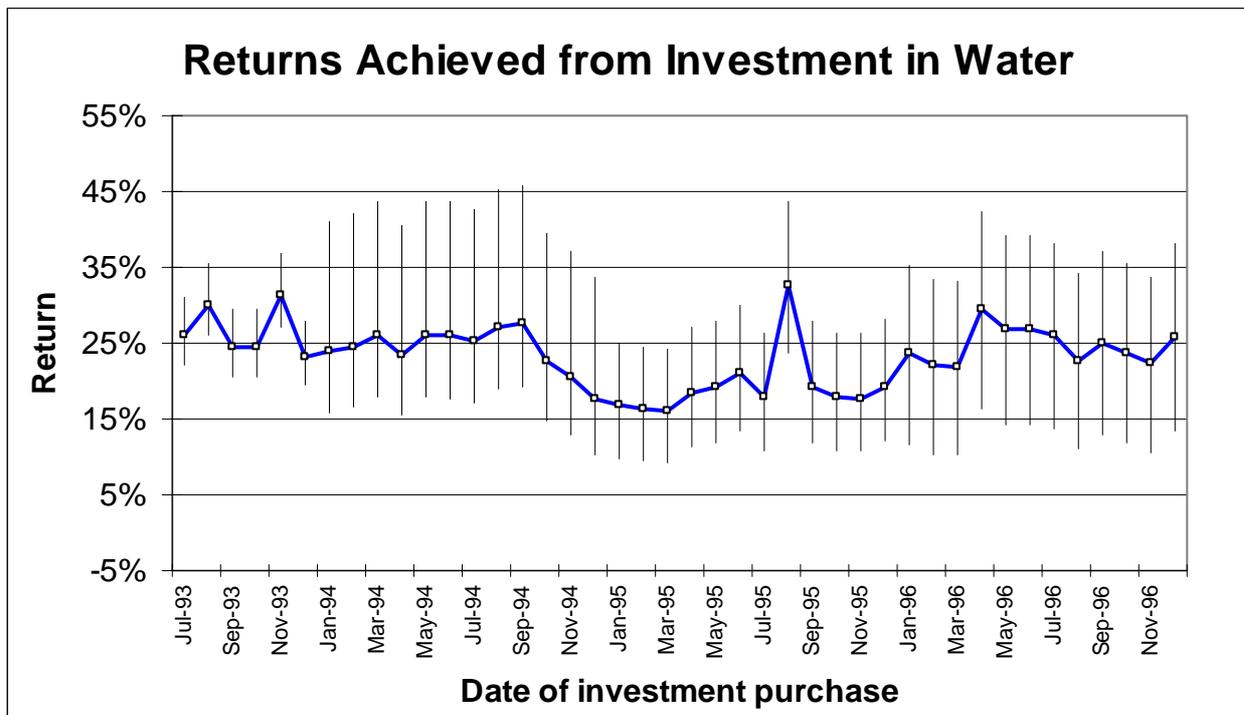

Figure 4: Return from investment in Water entitlements based on a five-year holding period

Using a five-year holding period returns seems more stable, but we are looking at the first three and a half years of water trading when markets were immature and very thin with widely fluctuating prices of entitlements with some uninformed irrigators sold at very low prices. This resulted in median returns of around 25% during the first two years. During that period entitlements were bought at low prices and sold in 1998 and 1999 when prices of entitlements were above the long-term trend line driven by the wine grape industry as discussed above. Returns dip down to close to 15% from third quarter 1994 to first quarter 1996 as the price of entitlements at the time of sale dropped down to below the long-term trend line as the wine grape industry stopped issuing new wine grape contracts (Bjornlund and Rossini, 2004b). Rates then returned to around 25% as these investors benefited from the very high incomes from sales of allocations during 2001/02 and 2002/03 as well a strong growth in entitlement prices.

These two analyses indicate that returns on investments in water entitlements during the first ten years of market operations have been in excess of the return that could have been obtained by investing in most other assets during the same period. The most realistic return from an astute investor would probably be based on something in between the median and maximum price. Minimum prices are normally obtained by irrigators selling small volumes of unused water towards the close of the season, at the point where prices are at their lowest, while it can be difficult to predict the correct time when price reaches its maximum for the season. However, prices are normally between the median and maximum price during the height of the irrigation season, so a conservative investor would be likely to sell during that period.

CONCLUSIONS

This paper analyzes prices paid for perpetual water entitlements as well as the seasonal allocations yielded by such entitlements to trace evidence of rational behavior in water markets. Two different types of investors are considered: (i) the conventional irrigator who buys entitlements in order to use the seasonal allocations to grow agricultural crops. The willingness of such investors to pay for entitlements should be driven by the economic fundamentals within the industry where the water is used; and (ii) the conventional investor who invests in an asset in order to obtain a return on the investment. Return on such investments is often computed using a cash flow approach over a holding period, with the initial investment at the beginning of the holding period, annual net incomes generated by the asset during the holding period (rent for an investment property and dividend from shares) and with a sales price at the end of the holding period. The internal rate of return is then computed. This return should then reflect return obtainable from investing in other assets with a similar risk profile over the same period of time.

From the literature there seems to be evidence that the water markets do not follow economic fundamentals to the same extent as the New Zealand fishing quotas market, even though there are some clear signs of this taking place. This is likely to be because of the impact of climatic fluctuations. The last six years of the ten-year study period were dominated by droughts and very low seasonal allocations, markets have therefore been driven by 'protective' buying by high value users with significant investments in water dependent infrastructure such as permanent plantings, irrigation systems, milking herds, milking equipment, etc. These irrigators are likely to suffer significant long-term losses if they do not irrigate adequately. They are therefore willing to pay prices in excess of the productive value of water in order to protect their assets and stay in business for the next season. There is therefore little evidence during this period of opportunistic irrigators buying extra water, because the prices of the commodities they are growing are good.

Comparing the relationship between prices paid for allocations and entitlements it is clear that the price of entitlements clearly reflects the price of allocations as rational market behavior would suggest. It is equally clear that the prices of allocations fluctuates at about twice the rate of the price of entitlements as allocation prices react to short-term changes in allocation levels, evaporation and rainfall. Given the long-term nature of the investment in entitlements they do not react to short-term changes in these factors but rather in long-term trends. During the last four years of the study period allocation prices fluctuated very widely both within and between seasons. The first two seasons saw reasonable allocation levels and rainfalls, prices were therefore relatively low, while during the last two seasons prices were at record high levels and remained so throughout most of the seasons; this was due to very low allocations and high evaporation levels. The analyses clearly indicated that buyers of entitlements were aware that prices during the first two years were very low and during the last two years very high due to climatic conditions, and therefore did not represent the long-term trend in allocation prices. The impact of the low and high prices was therefore not capitalized into the value of entitlements.

Cash flow analyses of investments in water entitlements during a holding period indicate that individuals who would have purchased entitlements as an investment would have received quite high returns during the study period, between 15% and 25% p.a. This could reflect the high level of uncertainty (and therefore risk) associated with the future stream of seasonal allocations that is likely to be yielded by such entitlements. The National Water Initiative, the Murray Darling Cap and the Living Murray Process, which all aim to achieve better environmental flows and more sustainable irrigation communities, have generated significant uncertainty about how much water will be left in the rivers for consumptive use, and therefore there is significant uncertainty about the future value of water entitlements. Investors seem to take this into account when pricing water entitlements.

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REFERENCES

Bjornlund, H. (2004a): Formal and informal water markets – Drivers of sustainable rural communities? *Water Resources Research* 40, W09S07.

Bjornlund, H. (2004b): *A framework for the next generation of water market policies*. Proceedings from the conference of the Irrigation Association of Australia – Irrigation coming of age. Adelaide May, CD-ROM.

Bjornlund, H. (2004c): *Where to from here? – A framework for the next generation of water market policies*. Industry Partner Report written as part of the ARC SPIRT project Draft Final Report Section 4. For a copy contact the author at henning.Bjornlund@unisa.edu.au.

Bjornlund, H. and O'Callaghan, B. (2004): Property implications of the separation of land and water rights. *Pacific Rim Property Research Journal* 10(1), 54–78.

Bjornlund, H. and Rossini, P. (2004a): Factors influencing prices paid in the market for temporary water. *Pacific Rim Property Research Journal* 10(4), in press

Bjornlund, H. and Rossini, P. (2004b): An empirical analysis of factors driving outcomes in markets for permanent water – An Australian case study. *International Journal of Agricultural Water Management*, submitted for review.

Bjornlund, H. (2003a): Efficient water market mechanisms to cope with water scarcity. *Water Resources Development* 19(4), 553–567.

Bjornlund, H. (2003b): Farmer Participation in markets for temporary and permanent water in southeastern Australia. *Agricultural Water Management* 63(1), 57–76.

Bjornlund, H. (2002): Signs of maturity in Australian water markets. *New Zealand Property Journal*, July, 31–46.

Bjornlund, H (2000): To Regulate or to Market – Striking the Balance for Sustainable Water Use. *Proceedings from the joint conference: Water and the Law*, Adelaide, October 18, 7–14

Bjornlund, H. (1999): *Water Trade Policies as a Component of Environmentally, Socially and Economically Sustainable Water Use in Rural Southeastern Australia*. Thesis submitted in fulfilment of the requirement for the degree of doctor of philosophy. Adelaide: University of South Australia.

Brown, L.; McDonald, B.; Tysseling, J and Dumars, C. (1982): Water Reallocation, Market Proficiency, and conflicting social values. In Weatherford, G.D.; Brown, L.; Ingram, H. and Mann, D. Eds. *Water and Agriculture in the West U.S. - Conservation, Reallocation, and Markets*. Studies in Water Policy and management, No. 2. Boulder: Westview Press, 191–256.

CoAG, Council of Australian Governments (2004): Communiqué 25 June 2004. Available at http://www.pm.gov.au.

CoAG, Council of Australian Governments (2003): Communiqué 29 August 2003.

CoAG, Council of Australian Governments (1994): Communiqué 25 February 1994.

Colby, S.B. (1987): Do Water Markets "Work"? Market Transfers and Trade-offs in the Southwestern States. *Water Resources Research* 23(7), 1113–1122.

Colby, B.G.; Crandall, C. and Bush, D. (1993): Water Right Transactions: Market Values and Price Dispersion. *Water Resources Research* 29(6), 1565–1572.

DSE, Department of Sustainability and Environment (2003): Securing Our Water Future – Green Paper for Discussion. Melbourne: DSE.

Gardner B.D. (1985): Institutional Impediments to Efficient Water Allocation. <u>Policy Studies Review</u>. 5(2), 353–363.

Kerr, S.; Newell, R.G. and Sanchirico, J.N. (2003): Evaluating the New Zealand Individual Transferable Quota Market for Fisheries Management. Paper prepared for a workshop on Ex-post tradable permit evaluation for the National Policies Division, Environment Directorate. Paris: OECD.

Newell, R.G.; Sanchirico, J.N. and Kerr, S. (2002): Fishing Quota Markets. Discussion Paper 02–20. Washington D.C.: Resources for the Future.

Person, P. and Michelsen, A. (1994): *Determinants and Trends in Water Right Prices: An Econometric Analysis*. Wyoming Water Resources Center, Laramie, Wyoming.

Pratt, J.W.; Wise, D.A. and Zeckhauser, R. (1979): Price Differences in Almost Competitive Markets. *The Quarterly Journal of Economics* 93(2), 189–211.

Tisdell, J.G. and Ward, J.R. (2003): Attitudes toward water markets: An Australian Case Study. *Society and Natural Resources*, 16, 61–75.

Young, M.D. and McColl, J.C. (2002): *Robust Separation a search for a generic framework to simplify registration and trading of interest in natural resources.* Adelaide: CSIRO Land and Water, Policy and Economic Research Unit.

Young, M.D. and McColl, J.C. (2003): *Robust Reform: Implementing robust institutional arrangements to achieve efficient water use in Australia.* Adelaide: CSIRO Land and Water, Policy and Economic Research Unit.