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# Water Policies and Rural Land Values

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**Abstract:** Permanent water markets have now been in place in South Australia, New South Wales and Victoria for a number of years. It is therefore possible to investigate whether the objectives of policy makers are being achieved or not. This paper investigates one of the objectives of water trading, to facilitate a re-allocation of water in a socially equitable way. The paper does that by comparing prices paid in the water market with the value of water when attached to irrigated farmland. The underlying philosophy applied to test this is that, in order to be socially equitable, prices paid in the water market have to equate the value of water when attached to irrigated farmland. If that is not the case, water sellers will erode the value of their property by more than they receive when they sell water.

In all three States, it seems that sellers of water, not used to support water dependent farm investments, are being over compensated. That is, prices paid in the water markets well exceed the value of unused water attached to land. In Victoria, there is evidence to suggest that sellers of actively used water, are not being compensated - that is, the price paid in the market does not equate the value of water when attached to irrigated farmland. In South Australia, the findings are less clear. It is indicated that farmers with low quality plantings and irrigation systems, and using the water for citrus, are being compensated, while irrigators with better plantings and irrigation systems, using the water for vines and other horticultural crops, are not being compensated. In New South Wales, prices in the water market equate water value when attached to land, and thus compensate sellers of both used and unused water.

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## INTRODUCTION

Within most semi-arid regions of Australia, irrigation water is essential for farm production and thereby influences farm values. Traditionally water has been appurtenant to land, and could therefore not be traded separately from the land to which it was attached. With increasing salinisation and waterlogging problems within many irrigated regions, as well as the exhaustion of available water resources, community pressure was brought to bear on policy makers to change these policies. This community pressure came from two directions: Proponents of new high value producing enterprises, such as viticulture and horticulture, needed access to water, and environmental organisations wanted to decrease the extraction of water for consumptive uses and have irrigation removed from unsuitable soils, to reduce the negative environmental impact.

The policy answer to this challenge was the removal of the nexus between the land and water components of an irrigated property, and the introduction of a separate market for the water component. Such policies were first introduced in South Australia in 1983, New South Wales in 1989 and Victoria in 1991. Both New South Wales and Victoria had the ability to trade or lease water for a single season prior to these years, but not an ability to do so permanently.

In 1994 the Council of Australian Governments (COAG) introduced a new Water Reform Agenda (COAG, 1994). This reform process became part of the National Competition Policy (NCP) and associated agreements, signed by all States and Territories. The NCP sets out a new framework for how water, as well as a number of other traditionally publicly provided goods and services such as electricity, gas, rail and telecommunications should be managed. Key elements of this framework are the introduction of tradable property rights, privatization, full cost recovery prices and the devolution of decision-making and management of many of these resources to local communities. To avoid significant financial penalties associated with non-compliance, State legislatures are presently working hard to introduce new legislation to provide for water markets as well as the other changes listed above, in fulfillment of the NCP.

A central policy expectation of introducing water market polices was the ability to transfer water away from low-value-producing, inefficient irrigators, on unsuitable soils, to high-value-producing, efficient irrigators, on more suitable soils. Research by Bjornlund and McKay (1995, 1996, 1998a, 1999, 2000a,b) into the early workings of water markets in South Australia, Victoria and New South Wales clearly indicates that this process takes place. Policy makers hoped that the buyers under this scenario would be willing and able to financially fully compensate the sellers for their losses (COAG, 1994). Permanent trade has now been possible for a number of years, and we should be able to establish whether this expectation has been fulfilled.

This paper investigates this issue based on transactions of irrigated farmland as well as permanent water rights/entitlements within the three States. Hedonic functions have been applied to transactions of irrigated farmland, to determine the value of the water component when transacted as part of an irrigated farm. Buyers and sellers of permanent water rights have been interviewed to establish the value of water when sold separately from land. Comparing the two values should answer the question.

## THE STUDY

This research is based on analysis of irrigated land transfers within three irrigated regions with different water use characteristics:

- The Riverland in South Australia (SA). This region stretches along the River Murray from Blanchetown to the SA/VIC border. The predominant water uses in this region are horticulture and viticulture. Irrigators have water entitlements, either as part of an irrigation district or as an individual irrigator pumping water from the river. These entitlements are generally accepted to be 100% secure - that is, they will be delivered in full every year.
- The eastern part of the Goulburn-Murray Irrigation District (GMID), Victoria (VIC). This area consists of the old government irrigation areas of Shepparton, Rodney, Rochester and Tongala. The predominant water use in this region is pasture for dairy. 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 96 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 but fluctuates widely;
- The Murray Irrigation Limited (MIL) in New South Wales (NSW). The predominant water use in this region is rice. Within the MIL irrigators have water entitlements which are attached to their shares in the company. Every year Department of Land and Water Conservation announces how big a proportion of the entitlement is available for use that year depending on how much is available in the storages. These allocation announcements are regularly updated during the irrigation system as supply improves.

The three study regions were chosen due to the significant difference in water use characteristics and thereby the magnitude of capital investment associated with irrigated farming. It was hypothesized that within a semiarid environment, the value of such investments would be largely lost if the water were removed from the land. To fully compensate the seller of water on which present plantings and irrigation and drainage infrastructure depend, the price paid would have to cover the capital value sunk into such capital investments. This argument will be further developed both in the Methodology section and the Riverland part of the Findings section of this paper. Sellers of unused water do not suffer such losses of capital investments and should therefore be willing to sell at lower prices.

Transfers of irrigated farmland were identified using the records of the Valuer General's offices in Adelaide, Melbourne and Deniliquin. These records include information about sales price, date of sale, and some property-specific data. Sales were analysed within the SA and VIC areas for the 1994-96 period and within the NSW area for the 1997-99 period. Permanent transfers of water during the same periods, as well as size of water right and water use information regarding the irrigated properties analysed, were identified using the records of Goulburn Murray Water in Tatura, MIL in Deniliquin and Department of Water Resources in Berri.

These records do not include prices paid for water. To obtain these it was necessary to interview the buyers and the sellers. 100 buyers and 100 sellers of water were interviewed in each of VIC, SA and NSW. This was done using telephone interviews. Within both the VIC and SA study areas, 100 buyers of farmland were also interviewed to establish property-specific data. This was not done in NSW, since experiences with the SA and VIC data showed that very little of this information was subsequently used in the hedonic functions. The data that was used was available in the more elaborate computer records held by MIL, making interviewing unnecessary.

It is important to note here that the product purchased vary from state to state as outlined in the three dot-points above. This to some extent explains differences in water prices between states. However, water entitlements sold as part of an irrigated property and those sold on the permanent water market within that state is the same product. The same rights and obligations are attached to the water entitlement in both instances. The only difference is that when sold as part of an irrigated property and actively used for irrigation, the water use is tied to a particular capital investment in irrigation infrastructure. If the water is removed from that location that infrastructure will not any longer have a value. On the other hand, water bought on the permanent water market can be applied under the most productive circumstances available to the buyer.

## METHODOLOGY

In this study, hedonic functions have been applied to transactions of irrigated properties, to identify the value of the water component. 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 analysing car prices, in order to improve the way price indexes are adjusted to distinguish the proportion of price increases caused by quality changes from inflationary price increases.

The theoretical framework is developed around the fact that many commodities are heterogenous goods, consisting of a bundle of characteristics in different quantities. These goods can not 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 $Z_n$ make up the bundle of product characteristics. Solving this function for a large number of transactions will establish the value of each of the Z characteristics.

Because the key emphasis of this study was on identifying the nexus between water and improvements in a price determining sense, interactive variables between water and improvements were tested. It was expected that interactive variables only would be significant between water and some of the property characteristics. Interactive variables were especially expected to be important within capital-intensive productions such as horticulture and viticulture. The reason for this expectation is that a prudent farmer will determine the market price of a property based on the net present value of the future income stream. If the improvements are poor, that is if plantings are of poor quality, badly maintained or of the wrong variety, productivity is going to be low and financial outcome reduced, until such conditions have been changed. If the irrigation or drainage systems are inadequate, water use will be inefficient and production per unit of water applied reduced. Such reductions in productivity will reduce the future net income stream, and thereby reduce the value of the property, including both the land and the water components. Within such an environment, it can not be expected that the hedonic price function for irrigated farmland should be separable in land, water and improvements and linear in water as suggested by Crouter (1985, 1987). Under such circumstances the nexus between land and water still exists, even though the law has formally removed it, as Hartman and Anderson (1962, 1963) suggested.

For less capital-intensive productions, such as broad acre and pasture-based productions, this interdependency was not expected to be as predominant. These productions can be easily converted from one commodity to another. If pastures are of bad quality, the time and cost invested in improving them are not considerable, and many of the improvements, such as cattle, machinery and equipment, can be sold separately. Increased familiarity with water markets, in such an environment, should therefore lead to the hedonic price function for irrigated farmland becoming increasingly separable in land and water, and linear in water as suggested by Crouter.

As a result of the above discussion, the property characteristics are grouped in two categories, namely non-water related (Zs) and water related (Ws) characteristics, plus interactive terms between these two categories (ZWs), measuring the interdependency between the water and non water attributes of an irrigated property. Empirically this can be written in the following way:

$$P(Z) = \alpha_0 + \sum_{i=1}^{n} \alpha_i Z_i + \sum_{i=1}^{n} \beta_i W_i + \sum_{i=1}^{n} \gamma_i Z_i W_i + \varepsilon$$

where $\alpha_0$ is the constant or intercept and $\alpha_i$'s, $\beta_i$'s and $\gamma_i$'s are regression coefficients to be estimated, and $\varepsilon$ is a normally distributed stochastic error term.

The issue of the functional form of the hedonic function has been widely discussed (Halvorsen and Pollakowski, 1981; Milon et al., 1984; Ellickson, 1981), and rather mechanical methods 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 suggested 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, Ws and ZWs 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 Langrane Multiplier Test and the Breusch-Pagan-Godfrey Test (Gudjarati, 1995).

Three other important issues in the model building process have to be discussed. First, the risk of mis-specification of the model, 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). In this study, this test was important because of the multitude of potentially significant variables, combinations of interactive variables, and the inherited level of multicollinearity between these variables. Secondly, in some instances, competing non-nested models were generated. This was especially the case when testing for the level of the interactive relationships between water and improvements. One model had water, land and improvements as separate variables, and another model had interactive variables. This was particularly applicable in Victoria and New South Wales, where it was hypothesised that the nexus between land, water and improvements is less significant. In these cases the Davidson-McKinnon J Test was used to determine the true model (Gujarati, 1995).

Finally, when testing for the inter-relationship between water use and water values, interactive variables were computed measuring how many ML were used for say dairy, sheep, cattle, cropping etc. on each property transacted. The coefficient of such variables should indicate the per ML value of water in the different uses. To conclude that there actually is different value placed on water in different uses, it has to be established that the difference between such coefficients is statistically significant from zero. To do this, a *t*-test was used (Gudjarati, 1995).

## FINDINGS

The final hedonic model, for the eastern part of the Goulburn-Murray Irrigation District (GMID), can be seen in Table 1, for the Riverland in Table 3, and for MIL in Table 5. Prices paid on the permanent market during the same periods can be seen in Table 2 for the eastern part of the GMID, and in Table 4 for the Riverland. In the following, only the coefficients related to water are discussed. For a more detailed discussion of the models, and the model building processes, for the VIC and SA models, see Bjornlund (1999).

All the models discussed in the Findings section of this paper were tested for multicollinearity, heteroscedasticity and mis-specification as discussed in the previous section. No model discussed in the Findings section of this paper is in violation of any of these assumptions based on safe and conservative parameters set in the literature (Gudjarati, 1995).

**Eastern part of the Goulburn Murray Irrigation District - Victoria.**

Within the study region in VIC, the model building process proved that the model separating the land and water component was superior, when compared to one using interactive variables between land use and water right, and one using location and water right (Bjornlund, 1999). The models using interactive variables showed mis-specification and the coefficients were not significantly different. This shows that within this region, with low level of capital investment in water dependent infrastructure, the hedonic function is separable in the water and land components and linear in water as suggested by Crouter (1985, 1987).

Table 1 Hedonic Functions, eastern part of the Goulburn Murray Irrigation District 1994-96.

| Variable | β | SEβ |
|---|---|---|
| Irrigated land (HA) | 942.12 | 231.92* |
| Dry land (HA) | 24.62 | 381.43 |
| Water right (ML) | 443.66 | 109.14* |
| Unused water (ML) | -203.45 | 54.94* |
| Quality of dwelling (1-7) | 7,758.83 | 1,867.66* |
| Distance to town (KM)[1] | 93,590.64 | 39,004.62** |
| VG building value ($) | 0.80 | 0.12* |
| Buy water (0,1) | -22,554.28 | 12.317.28** |
| Constant | 37,190.34 | 10,435.14* |
| SEE | 35,652.64 | |
| Adj. $R^2$ | 0.85 | |
| F | 60.58 | |

[1] reciprocal form, Significance levels: *0.01; **0.05; ***0.10

The final model has an adjusted $R^2$ of 0.85, and most coefficients are significant at the 0.01 level. The coefficient for water right indicates that the value of water, when attached to land, is $444 per ML, with a 95% confidence interval between $226 and $662. Analysing the prices paid in the permanent water market during the same period (see Table 2), it was found that 98% of all water transfers took place within this 95% confident interval. However, the purchases in the water market took place in the lower end of the confidence interval, with a mean price of $360/ML and a maximum price around $490/ML. The balance of 2.0% was sold for less than $226/ML. This suggests that even though approximately the same price dispersion exists within the two markets, water market prices are still too low to lure actively used water away from existing uses, unless the seller is either ill informed or under financial or other pressure to sell.

To further compare the two water values, it is necessary to look at the variable ‘unused water’. This variable was computed by subtracting the volume of water used from the size of the water right. If this variable was positive, the property had an unused proportion of water right. The hedonic model found that such unused component of the water right had a negative price influence of $203/ML, thereby generating two different water values: $444/ML of water used for production, and $241/ML of unused water. This could reflect the fact that the value of water-dependent capital investments has been capitalised into the value of water in use, but not into the unused proportion of the water rights. It could also explain the fact that prices in the water market are in the lower end of the price spectrum, since a large proportion of the water sold in the water market is unused (Bjornlund and McKay, 1998a; 2000a). This suggests, that prices paid in the permanent water market are determined by the large supply of unused water. Sellers of such water seem to be handsomely compensated by prices paid in the water market.

Table 2 Water prices paid on the permanent water market 1994-96

| Price | % of buyers within range |
|---|---|
| $200 or less | 3.8 |
| $201-$300 | 25.0 |
| $301-$400 | 61.5 |
| $401 or more | 9.6 |
| Mean | 360 |
| Standard Deviation | 56 |

If the variable 'unused' is negative, the variable measures the number of ML used on the property in excess of water right. That is, these properties use their sales-water allocation. Since the coefficient for 'unused' is negative and the sign of 'unused' in these cases is also negative, it indicates a positive value of sales-water allocations of approximately $203/ML, if they are used. Since sales-water allocations are less secure than water rights, it is logical that such allocations have a lower value. This brings the value of a ML of water right up from the $444 estimated above, since all water rights have associated a sales-water component and water rights sold in the water market have the same sales-water component attached. Conservatively estimating 30% sales-water allocations, each ML of water right will carry a sales-water component at a value of $61 (30% of $203) or $122 if using the expected mean sales-water allocation of 60%. This produces a total value of water rights, when attached to land, of $505, increasing the value difference between water sold in the water market and water sold together with irrigated farmland.

Finally, the variable 'buy water' indicates if additional water was acquired after the purchase of the property. This variable indicates that if the buyer had to buy additional water right to the property after purchase, the price of the property was reduced by $22,554. This again emphasises the importance of water as a value determinant. It also indicates that the value of $942/HA of irrigated land is based on sufficient water supply, suggesting that part of the value of water has been capitalised into the land value. Consequently, the $505/ML underestimates the true value of water when attached to land, if such water is actively supporting capital investments in irrigation and drainage infrastructure.

**The Riverland – South Australia.**
Within the study region in SA, the model building process proved that the model using interactive variables between crop type and water entitlement, and between planting quality and water entitlement, was the superior model compared to one separating the land, water and improvement components (Bjornlund, 1999).

The hedonic function shown in Table 3 indicates that price determination of irrigated farms in South Australia is more complex than in Victoria. This is as anticipated, due to the different nature of farming in the two areas. In Victoria, water and land are easier to separate. Pastures can be relatively easily converted to other productions if the water is removed. Long-term capital investments are not necessarily lost, because assets such as dairy herds and milking equipment, to some extent, can be sold separately on different markets. The hedonic model is therefore largely separable in land, water and improvements. In the Riverland, the horticultural and viticultural industries are very capital intensive. If water is removed, the capital loss is significant. The value of planting will be lost, since the plants will die if the water is removed. The plantings will be turned from an asset into a liability, since they will have to be removed in order to make room for dry land production. Dry land production in the Riverland is of very low value due to the very low level of natural precipitation. Significant investments are also lost in irrigation infrastructure. When attached to land, the value of the water is linked to the use to which the water is put, since part of the value of these water-dependent capital investments has been capitalised into the value of the water.

Table 3 Hedonic Function the Riverland – South Australia 1994-96.

| Variable | β | SEβ |
|---|---|---|
| Water allocation citrus (ML) | 176.85 | 92.7** |
| Water allocation vine (ML) | 383.84 | 72.8* |
| Water allocation other planting (ML) | 478.24 | 183.1* |
| Unused water allocation (ML) | -279.52 | 88.0* |
| Quality of dwelling (1-7) | 2,395.27 | 1,531.8***[1] |
| Quality of planting*water allocation | 38.17 | 13.6* |
| Quality of irrigation system (1-7) | 2,314.85 | 1,169.9** |
| Building value ($) | 0.69 | 0.11* |
| Perception of price (-3 to +3) | 3,091.36 | 1,800.2*** |
| Water table problems (1-7) | -2,683.73 | 1.258.4** |
| Months since sale | -1,023.04 | 291.3* |
| Constant | 54,306.82 | 8,342.9* |
| SEE | 22,966.63 | |
| Adj. $R^2$ | 0.71 | |
| F | 22.57 | |
| Significant at the 0.01 level *; 0.05 **; 0.10*** | | |

If water is applied to plantings, producing low value commodities such as a horticultural crop no longer in demand or the wrong variety of a crop in the present market, the profit produced from that water would be reduced. In the same way, if water is applied to plantings of poor quality or past their prime productivity, the profit produced by such water will be reduced until the quality of the plantings has been improved or the plantings replaced. Improving the plantings can take a long time and be very costly. Changing the use of the water by replacing the planting takes even longer and is more costly, due to the significant lead-time in horticulture and viticulture. As a consequence of these circumstances, the hedonic function for irrigated farmland is inseparable in water, land, planting and their quality.

The hedonic function indicates that farm size is unimportant, and stresses that what determines the value of irrigated farmland within an area of high value, capital intensive production with very low natural precipitation, is the water and the type and quality of plantings and irrigation system. Since these capital investments are lost if water is removed, their total value is linked to the value of the water (Summers, 1981).

Looking at Table 3, water values are determined by planting quality and by water use. If water is used for citrus, it is worth $177/ML, if used for vines it is worth $384 and for other horticultural uses $478. To these amounts can be added $152/ML if the plantings are of average quality, increasing to $267 for excellent planting and down to $38 for poor planting. The value of water used for vines of excellent quality will be $651 and $422 if very poor.

Table 4 Water prices paid in the permanent water market River Murray SA 1994-96.

| Price | % of water bought with price range |
|---|---|
| $301-$400 | 10.7 |
| $401-500 | 32.8 |
| $501 or more | 54.1 |
| Mean price | 500 |
| Standard Deviation | 70 |

Looking at Table 4, it can be seen that 54.1% of all transfers in the water market are for more than $500/ML, with an average of $500 and a standard deviation of $70, which gives a two standard deviation range of $360 to $640. These analyses suggest that owners of irrigated farms with low quality plantings, and producers of low value crops, should be sufficiently compensated by the prices paid in the water market, whereas irrigators with more valuable crops and better quality plantings will be reluctant to sell their water at these prices. The value component attached to the quality of the irrigation system should also be added to the water value, since the irrigation system will be useless without the water.

It was further found, as in Victoria, that unused allocations have a negative value influence of $280/ML. This further confirms the conclusion that unused water, not supporting the future productivity of water dependent capital investments, has a lower value than water actively being used.

The findings that unused marginal proportions of water attached to land, have lower values than water actively used for production, corresponds with the findings of Hartman and Anderson (1962, 63). The finding that prices in the water market are generally lower than the value of water when attached to land, is however contrary to the findings of Hartman and Anderson. This suggests that the water markets in the two study regions, and particularly within the GMID, are still immature and therefore might have a socially inequitable outcome.

**Murray Irrigation Limited – New South Wales**

Within MIL the analyses were based on secondary data only. The experiences from VIC and SA were that the main determinants were land area, water entitlement and the crop types on which the water was used. Within MIL, this information was available as secondary data. In the Riverland in SA, the quality of plantings was also significant. This was not expected to be an issue within the MIL, since it is a mainly grazing and rice/cereal producing area and therefore more similar to the VIC study area.

In NSW the model building process yielded the same outcome as in VIC (Table 5). Models, including interactive variables between water use and crop type, showed that the differences between the coefficients for the individual crops were insignificant, except when the water was used for permanent pastures. Otherwise the model was statistically acceptable in all respects. The model building process also showed that unused water has the same value as water used for purposes other than permanent pastures. This is contrary to the findings in VIC and SA. NSW does not have annual sales-water as in VIC, adding value to water used in excess of entitlement. If an irrigator in NSW uses above entitlement, that water must have been purchased on the temporary market.

Table 3 Hedonic Function MIL – New South Wales 1997-99.

| Variable | β | SEβ |
|---|---|---|
| Total entitlement (ML) | 405 | 47* |
| Water used for permanent pastures (ML) | 450 | 65* |
| Area (HA) | 344 | 78* |
| Within Wakool (0,1) | -186,398 | 30,159* |
| Within Deniboota (0,1) | -110,735 | 29,780* |
| Constant | 58,837 | 24,987** |
| SEE | 94,145 | |
| Adj. $R^2$ | 0.745 | |
| F | 61.146 | |

Significant at the 0.01 level *, 0.05 level **

That unused water does not have a negative value, as in VIC and SA, indicates that within MIL, capital investments in farm improvements have not been capitalised into the value of the water supporting existing production. This could be seen as a surprise, since rice production requires a lot of investments in infrastructure such as laser grading and other soil preparation. The finding, however, supports anecdotal evidence gathered when talking to farmers in the area buying properties for expansion. When they put a price on a farm, they do not consider improvements at all; they do not need the buildings and they want to totally rearrange the layout of the property to maximise water use and production. Existing works are therefore worthless. That water has an additional value if used for permanent pastures of $450.04 per ML could support this argument. Most permanent pastures are for dairy, and dairy production requires more capital investment in fencing, stock watering and dairy equipment.

Water, either unused or used for all other purposes than permanent pastures, has a value of $405 per ML with a 95% confidence interval from $311 to $499. Mean prices paid on the permanent water market for the same period increased from $298 (87) in 1997 to $404 (58) in 1998 and $414 (75) in 1999 (standard deviations in brackets). These prices fairly well reflect the value of water when traded together with irrigated farmland. A closer look at the prices paid in the permanent transfer market indicates that during 1997, only 41% of the water was sold within the above 95% confidence interval, while 59% sold for less than $311 per ML. However, during 1998, all transfers took place within the 95% confidence interval. These figures confirm that during 1998 prices paid in the permanent market match the value of water when attached to irrigated farmland.

A final measure of water prices is the price paid for water on an annual basis. During the 1998/99 period, the mean water price per ML was \$39.72. Prices fluctuated somewhat during the season, but the mean price reflects fairly well the price level during the October to January period. If we capitalise this price at a conservative 6%, we get a value of \$662 per ML. This is considerably higher than prices in both the permanent market and the land market. The explanation of this is likely to be found in the fact that temporary leases of water are totally tax-deductible in the year of purchase, while permanent water purchases are non-deductible and can not be depreciated. If we consider a tax rate of 40%, this brings the net price to the farmer down to \$397 per ML, which supports the above hypothesis. A further reason for this price difference is security of delivery. A farmer buying one ML of water on the temporary market can be certain on receiving one ML during that season. A farmer buying one ML of permanent water has no certainty about what proportion of that ML will be delivered during future seasons. A study by Marsden and Jacob (1999) pointed out that permanent trade within most valleys of NSW is substantially impeded and that major opportunities and economic benefits are foregone or delayed as a consequence. The above difference in prices on the temporary and the permanent market is one of the impediments to permanent trade. It could be suggested that tax changes as well as greater certainty of delivery of water entitlements would help overcome this problem (Bjornlund and McKay, 2000c,d).

## DISCUSSIONS AND CONCLUSIONS

Permanent water markets have existed in South Australia since 1983, New South Wales since 1989 and Victoria since 1991. It is therefore possible to analyse the outcome of these markets and to evaluate whether policy objectives seem to be achieved. Studies by Bjornlund and McKay (1999, 2000a,b) clearly indicate that markets have moved water toward more efficient and higher valued users on soils more suitable for irrigation. This process has generated both economic benefits for rural communities and ecological benefits for riverine systems (Bjornlund and McKay, 2001). It was, however, also an objective of policy makers that the use of market mechanisms would compensate the sellers for their losses, thereby being perceived as socially equitable. It was expected that the more efficient and higher-value-producing buyers would be willing and able to compensate the sellers in the process. More recently, it has been argued that more sophisticated market instruments are required to maximize the benefits from water trading and that a wider water management framework needs to be in place to safeguard social and environmental impacts (Bjornlund, 2000, Bjornlund and McKay 2000c,d).

The outcome in the three States varies significantly, reflecting the different water uses in the States and the different legacies of State water allocation policies. In both South Australia and Victoria, it was found that unused water, that is the proportion of a property's water right not supporting plantings and/or irrigation infrastructure, has a much lower value than water actively supporting production. This is due to the fact that if water is removed from the land, such infrastructure and plantings will be worthless. This supports the hypothesis that water-dependent farm improvements are capitalized into the value of the water on which they depend. Comparing the value of unused water when attached to irrigated farmland with prices paid for water on the permanent water market, during the same period, shows that sellers of unused water are being well compensated by the water market. In Victoria, it was shown that irrigators selling water on which their infrastructure depends, are receiving less for the water in the water market than it is worth when attached to land. These irrigators are therefore eroding the capital value of their property, and are doing so because they need the money (Bjornlund and McKay 1995,1996).

In South Australia, where irrigation is most capital intensive, land, water and improvements can not be separated in the hedonic function. Water's value is dependent on the type and quality of the plantings on which it is applied. Irrigators selling water used for citrus and low quality plantings, using low quality irrigation systems as perceived by the buyers, are being compensated by the price paid in the water market. Irrigators selling water used on vines or other horticultural crops, with good quality plantings and with good irrigation systems, are receiving less on the permanent water market than the water is worth when attached to land.

Finally, in New South Wales water market prices and water value, when attached to irrigated farmland, are much the same. Also, there is no difference between the value of unused water and used water when attached to land, unless such water is used for permanent pastures. This is likely to reflect the fact that many buyer of irrigated land for rice and cereal are buying the land to expand their property, upgrade the land and thereby increase water use efficiency. Under such conditions the values of existing capital investments in irrigation and drainage improvements are zero.

In conclusion, during the early stages of the water market, predominantly unused water has been traded. These irrigators set the price level and are being well compensated. Sellers of water, actively supporting existing infrastructure, are predominantly doing so because they are under financial pressure, and are eroding the value of their property by a larger amount than they receive for it. This is especially so within the GMID in Victoria while in SA the picture is more complex due to the interdependencies between land, planting and irrigation infrastructure and their quality as discussed above. Considering that most irrigators, selling water on which their existing production depends, have no intention of reducing their irrigated area as a result of the transfer, and use the proceeds from the sale to cover operating costs, this indicates that early water market outcomes might be socially inequitable (Bjornlund and McKay. 2000b).

This research indicates that this outcome is caused by the initial dominance of unused water in the market and is further influenced by present tax laws. After the initial trading period, and as the market takes up the initial slack of unused water, increased demand can only be satisfied by retiring actively used water from irrigation. There is evidence to suggest that the future will see an increase in cross-sectoral demand for water, especially from urban and industrial users, who will be able and willing to pay higher prices. Such prices are likely to be high enough to justify irrigators to sell water actively supporting capital investments in water dependent farm improvements.

## REFERENCES


Belsley, D.A. (1991): *Condition Diagnostics. Collinearity and Weak Data in Regression*. Wiley-Interscience Publication.

Bjornlund, H (1999): *Water Trade Policies as a Component of Environmentally, Socially and Economically Sustainable Water Use in Rural Southeastern Australia.* PhD Thesis, School of International Business, University of South Australia, Adelaide.

Bjornlund, H. (2000): *To Regulate or to Market – Striking the Balance for Sustainable Water Use.* Proceeding from the Joint Conference on Water and the Law, Adelaide 18 October 2000.

Bjornlund, H. and McKay, J. (1995). Can Water Trading Achieve Environmental Goals. *Water* 22(5), 31-34.

Bjornlund, H. and McKay, J. (1996). Transferable Water Entitlements: Early Lessons from South Australia. *Water* 23(5), 39-43.

Bjornlund, H. and McKay, J. (1998a). Factors Affecting Water prices in a Rural Water Market: A South Australian Experience. *Water Resources Research* 34(6), 1563-1570.

Bjornlund, H. and McKay, J. (1998b). Overcoming the Introspective Legacy of Tradeable Water Entitlement Policies in Southeastern Australia, In Just. R. and Netanyahy, S. Eds. *Conflict and Cooperation on Trans-Boundary Water Resources*. Kluwer Academic Publishers, Boston, 315-332.

Bjornlund, H. and McKay, J. (1999). Do Permanent Water Markets Facilitate Farm Adjustment and Structural Change within Irrigation Communities? *Rural Society*, 9(3), 555-571.

Bjornlund, H and McKay, J. (2000a). *Water Markets – An Instrument in Achieving a More Sustainable Water Use*. Proceeding from the Xth World Water Congress, Melbourne.

Bjornlund, H and McKay, J. (2000b). Do Water Markets Promote a Socially Equitable Reallocation of Water? A Case Study of a Rural Water Market in Victoria Australia. *Rivers* 7(2), 139-152.

Bjornlund, H. and McKay, J. (2000c). Problems with NCP Water Market Policies in Three Australian States 1995-2000 and Elements of Solutions-The Duty toward Water. Proceedings from the 1st Australasian Natural Resources Law and Policy Conference, Canberra, 179-188.

Bjornlund, H and McKay, J. (2000d). Current Issues and Future Directions for Australian Water Market Policies. *Water*, 28(2), 74-78.

Bjornlund, H. and McKay, J. (2001): *Environmental Flows and Sustainable Rural Communities Profitability & sustainability – conflict or coexistence?* Proceeding from AWA's 19th Federal Convention on a Water Odyssey, Canberra 1-5 April 2001.

Box, G.E.P., and Cox, D.R. (1964): An Analysis of Transformations. *Journal of Royal Statistical Society* 26(2), 211-243.

COAG. *Communique from the Meeting of COAG in Hobart 25.2.94.*

Crouter, J.P. (1985): *An Examination of an Implicit water Rights Market Using Hedonic Estimation*. PhD Economics Thesis, University of Illinois at Urbana-Champaign, Urbana, Illinois.

Crouter, J.P. (1987): Hedonic Estimation Applied to a Water Rights Market. *Land Economics*. 63(3), 259-271.

Ellickson, B. (1981): An Alternative Test of the Hedonic Theory of Housing Markets. *Journal of Urban Economics*. 9, 56-79.

Griliches, Z. (1971): Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change. In Griliches, Z. (Ed.) *Price Indexes and Quality Change. Studies in New Methods of Measurement.* Harvard University Press, Cambridge, Massachusetts.

Gujarati, N. (1995). *Basic Econometrics* 3rd Edition.

Halvorsen, R. and Pollakowski, H.O. (1981): Choice of Functional Form for Hedonic Price Equations. *Journal of Urban Economics* 10, 37-49.

Hartman, L.M. and Anderson, R.L. (1962): Estimating the Value of Irrigation Water From Farm Sales Data in Northeastern Colorado. *Journal of Farm Economics*. 44, 207-213.

Hartman, L.M. and Anderson, R.L. (1963): *Estimating Irrigation Water values. A Regression Analysis of farm Sales Data from Northeastern Colorado*. Technical Bulletin 81, Agricultural Experiment Station, Colorado State University, Fort Collins, Colorado, November.

Milon, J.W.; Gressel, J., and Mulkey, D. (1984): Hedonic Amenity Valuation and functional farm Specification. *Land Economics* 6-(4), 378-387.

Summers, L.C. (1981): An Economic Framework for Valuing Transient Water Rights in the Arid West. *The Appraisal Journal*. January, 9-14.