Transaction Costs and Welfare in the Permanent Water Market in NSW

L. Crase[1], B. Dollery[2] and M. Lockwood[3]

Abstract

Many economists and policy makers have begun to question the efficacy of water reforms that rely on markets as the principal mechanism for allocating the resource to its highest value use. One of the principal concerns in this regard has been the relative paucity of permanent trades despite ex ante analyses that have identified substantial and quantifiable gains. This phenomenon has been attributed to the transaction costs pertaining to deals in the permanent water market. Whilst some empirical evidence is now emerging on the quantum of these transaction costs, only limited attention has been given to the broader welfare implications of policies that might alter these costs. This paper examines the welfare implications of the transaction costs in the market for permanent water entitlements in NSW by employing a threshold valuation approach. Drawing upon empirical estimates of transaction costs by Crase et al. (2001), choice data are manipulated to provide estimates of foregone market surplus as the foundation for establishing threshold environmental values.

1 Introduction

The water sector in NSW continues to undergo significant reform. Amongst the motivations for reform are the environmental claims on the resource. However, in the face of considerable uncertainty about the quantum of these claims water managers have been reluctant to strengthen the property rights of individual irrigators, preferring instead to maintain a 'flexible' approach to water resource allocation (see, for example, DLWC 1999). Accordingly, the resulting institutional mix provides a challenging conundrum for legislators.

On the one hand, it can be argued that a strengthening of individual property rights would enhance the allocation of the resource from an extractive perspective (Crase *et al.* 2000; 2001). For example, market institutions, which have been widely promoted as a pivotal element of reform, generally produce a more efficient allocation when property rights are stable or, at least, clearly defined. Alternatively, ceding stronger property rights seems likely to increase calls on the public purse to allocate more water to the environment. The question therefore arises as to the optimal level of discretion that the state needs to preserve to satisfy the future [and largely uncertain] needs of the environment whilst giving attention to the call for stronger [more certain] property rights by extractive users.

One way to approach this problem is to examine the current structure of property rights by employing the concept of transaction costs. Dahlman (1979, p. 144) contends that the transaction cost concept has itself assumed the analytical status of a 'catch all' that describes unspecified interferences with the price mechanism. However, in the present circumstances we focus attention specifically on the transaction costs borne by water

[1] School of Business, La Trobe University, Wodonga
[2] School of Economics, University of New England, Armidale
[3] Johnstone Centre, Charles Sturt University, Albury

market participants and the informational uncertainties that form their genesis. More specifically, we argue that 'policy flexibility' bestowed on the state simultaneously leads to a particular genre of uncertainty. Uncertainty arises from leaving amendments to bulk entitlements at the discretion of the Minister and constraints on extractive users access to the courts for compensation[4]. In turn, this uncertainty imposes costs on potential buyers and sellers of water which manifest themselves, in part, in a reduction in the quantum of permanent trades.

However, focussing solely on the costs borne by extractive users ignore the potential benefits [lower costs] of being able to assign water to the environment in the future. This is of particular significance given the incomplete knowledge about the riverine environment and the advantages of being able to respond to environmental concerns without the delays associated with calling on the public purse. A holistic approach would involve an examination of the static transaction costs, associated directly with the market, in concert with the wider environmental benefits of attenuating water rights to facilitate a higher level of policy flexibility. This paper explores these issues by treating the transaction costs of the *status quo* as the threshold environmental values to justify the existing institutional arrangements.

The paper itself comprises eight main parts. In the following section we review the transaction cost approach as a means of developing a conceptual framework for analysing these issues. An extension of Challen's (2000) transaction cost taxonomy is offered in part three to encapsulate the notion of threshold environmental values whilst part four examines the welfare implications of this approach. Section five reviews the results of a choice experiment which enumerated a specific transaction costs in the NSW permanent water market. These results are subsequently extended to provide welfare estimates within the transaction cost/threshold valuation framework in part six. Limitations are examined in section seven before offering some brief concluding remarks.

2 Transaction Costs and the Permanent Water Market in NSW

The New Institutional Economics [NIE] approach has revived interest in the importance of institutions and their role in economic development (North 1990; 1997; Rutherford 1994; 2001). In NIE, institutions can be defined as a set of constraints and rules which govern the behavioural relations among individuals and groups. Organisations such as water users associations and arrangements that lead to water markets are all institutions because they embody rules and regulations, formal and informal, which govern their operations (Ostrom 1992). Williamson (1985) combined bounded rationality and opportunistic behaviour in defining institutions. He defined institutions as transactions cost minimising arrangements. Transactions costs can be described as the costs, other than purchase/sale price, involved in using the institution [say the market], such as in search, verification, trial-error and the like. Different institutions have different transactions costs and theoretically economise under bounded rationality and minimise opportunistic behaviour.

[4] For a comprehensive discussion of the concept of policy flexibility and its relationship to transaction costs see Crase *et al.* 2001.

The focus on comparisons between real world alternatives and recognition of the bounded rationality of human nature are central themes within the emerging literature examining institutional organisation and change. In the context of water institutions Crase *et al.* (2001) have argued that policy flexibility in the NSW water sector results in a form of uncertainty which, in part, constrains the behaviour of water market participants. Moreover, they contend that uncertainty derives from policy flexibility in three main forms. Firstly, since the legislative arrangements are relatively new, participants in the water market have not had sufficient time to establish the probabilities associated with different forms of intervention. Secondly, the behaviour of legislators may itself not follow a stochastic [ergodic] process. Thirdly, buying and selling water permanently is often a crucial decision for irrigators and is usually characterised by a level of innovation which is difficult to duplicate. These sources of uncertainty form the foundation of constraints on the behaviour of buyers and sellers in the water market. In this context, it is then possible to treat policy flexibility as a form of transaction cost which impacts on the ability of the market institution itself to efficiently allocate the resource.

Portraying policy flexibility as a transaction cost borne by potential buyers and sellers in the permanent water market provides a vehicle for assessing the impact of policy flexibility. However, in developing this framework attention was paid almost exclusively to the transaction costs associated with the current institutional arrangements. More specifically, this approach fails to recognise the costs arising from altering institutions themselves. In the context of water management in NSW this is a significant issue since knowledge about the future environmental demands for water is incomplete. One way of reconciling this issue is to employ the framework developed by Challen and Schilizzi (1999) and later Challen (2000) that seeks to extend the analysis of transaction costs to a consideration of the dynamic transaction costs of institutional change.

Challen and Schilizzi (1999) offered a two-fold taxonomy of dynamic transaction costs, which arise from the process of institutional change, as distinct from static transaction costs, which pertain to the current institutional arrangements. The two-fold typology of dynamic transaction costs comprises transition and inter-temporal opportunity costs. Firstly, transition costs arise from constraints relating to the history of institutions. Moreover, path dependencies can arise since the possible changes to institutional structures have differing transition costs which are largely determined by the current institutional arrangements themselves. For example, Challen (2000) cites the institutional arrangements for the allocation of water resources in the Murray-Darling Basin, where states have been reluctant to cede the property rights to water to a higher authority, consequently impeding the development of institutional structures with lower static transaction costs. In effect, high transition costs appear to have prevented the development of institutional structures with lower static transaction costs. Thus, the history of the institutional arrangements, at least in part, determines the transition costs of institutional change which, in turn, influence the level of static transaction costs (Challen and Schilizzi 1999, p. 4).

The second category of dynamic transaction costs relates to the capacity to reverse institutional change. In developing this category Challen and Schilizzi (1999) note the political costs associated with transferring property rights and draw upon the work of Horn (1995). Institutional history suggests that devolution of property rights from the dispersed many to the concentrated few has relatively low costs, since the intense preferences of the few encourage them to mobilise political resources to secure such a redistribution. By way of contrast, it is relatively difficult and therefore costly to reverse property rights from the few to the many. To this extent institutional change must also consider the 'quasi-option' costs of change and the extent to which reversibility may be required under conditions of uncertainty. This issue is of particular significance in the allocation of water resources in NSW where the stated aim of the DLWC has been to retain an adaptive approach to water management, in part because of the environmental uncertainty pertaining to the riverine environment (DLWC 1998, p. 11).

Challen and Schilizzi (1999, pp.9-10) formalise the problem from the perspective of the policy maker with the aid of equation 1.

$$\min_{z} V = \forall\{Z\} + \exists\{Z\} - (\{Z\} \text{ for } 0 \# Z \#1 \qquad [1]$$

where V is the sum of static and dynamic transaction costs associated with a new institutional structure and Z represents the level of delegation of property from the state to private individuals. In the same equation $\forall\{Z\}$ represents the static transaction costs which measures the extent to which current allocation decisions fall short of the efficient allocation that would arise if transaction costs were zero. In the context of water resources, such costs may occur because of imperfect information upon which to base state government allocation decisions. From an individual perspective, information failure in water markets and other market failures may also give rise to static transaction costs. Transition costs in the current period are denoted by $\exists\{Z\}$ and encapsulate the effects of institutional history and path dependency constraints. Finally, quasi-option values associated with the delegation of property rights are represented by $(\{Z\}$ and are considered strictly non-negative (Challen and Schilizzi 1999). Since $\forall\{Z\}\exists$ 0 and $\exists$ $\{Z\}$ = 0 for the *status quo*, the transaction costs for the institutional *status quo* can be expressed as equation 2 below:

$$V\{0\} = \forall\{0\} - (\{0\} \qquad [2]$$

More generally, welfare improvements can be expected to arise from institutional change where

$$V\{Z'\} < V\{0\} \text{ for } 0 \quad Z' \quad 1. \qquad [3]$$

Put simply, Challen and Schilizzi's (1999, p. 10) formulation describes institutional policy choice as a "...trade-off between current benefits [reduced static transaction costs], transition costs, and quasi-option values associated with flexibility in future institutional change". Challen and Schilizzi (1999, p. 11) also advance their taxonomy as unique and "...a cohesive framework for analysis".

3 Threshold Environmental Values and Transaction Costs

Notwithstanding the insight brought by Challen and Schilizzi (1999) and later Challen (2000), there are a number of limitations associated with its application in the current context. Most importantly, the framework is likely to be frustrated by measurement and estimation problems. Challen and Schilizzi (1999, p. 11) themselves observe that:

> "...a lack of techniques and methodology for *ex ante* estimation of transaction costs [and]...quasi-option values represent probably the greatest challenge in estimation".

Whilst it might be possible in this instance to use the compensating payment buyers and sellers are willing to pay to reduce the level of policy flexibility as a proxy for static transaction costs deriving from policy flexibility, measuring option/quasi option values deriving from policy flexibility is more complex. Option values [benefits] of policy flexibility are realised in the *status quo* and, in large part, accrue to the environment because of the likely need to adjust environmental flows in the future. And yet, if the state foregoes these options, by adopting less policy flexibility [or reducing the attenuation of the rights of extractive users], it may be forced into re-purchasing water for the environment in the future. This creates several measurement conundrums.

Firstly, since the option benefits accrue now but the cost of re-purchasing may need to be borne at some time in the future, an appropriate means of discounting is required to provide a comparison between the two. Establishing an 'appropriate' discount rate is likely to be especially problematic. Secondly, comparing the options foregone now with the cost of re-instating some of those option in the future overlooks the surplus that accrues to options by maintaining the *status quo*. More specifically, any future purchase price may not adequately reflect the reservation price of the current generation's willingness to maintain those options. Thirdly, reducing policy flexibility could result in either a leftward or rightward shift in the supply of entitlements in the water market. In these circumstances it is difficult to estimate the likely purchase price if the state wished to re-purchase water at some time in the future. To overcome these difficulties, we extend the Challen and Schilizzi (1999) framework to consider the impact of policy flexibility in concert with the concept of threshold values.

Suppose an alternative institutional state with greater policy certainty for extractive users is defined by equation 7.4.

$$V\{1\} = \forall\{1\} + \exists\{1\} - (\{1\} \qquad [4]$$

A threshold valuation approach implies that this is compared directly with the *status quo* defined in equation 2[5]. For the *status quo* to be preserved in preference to a more certain policy environment it is required that:

$$V\{0\} < V\{1\} \qquad [5]$$

Alternatively, this may be written as:

$$\forall\{0\} - (\{0\} < \forall\{1\} + \exists\{1\} - (\{1\} \qquad [6]$$

Rearranging equation 6 yields:

$$\forall\{0\} - \forall\{1\} < (\{0\} - (\{1\} + \exists\{1\} \qquad [7]$$

Thus, the threshold value approach reveals that the *status quo* should be preserved if the loss of option values and transition costs required to realise the new institutional setting are greater than the likely reduction in static transaction costs. The advantages of the threshold value approach are apparent. Our focus has shifted away from the *unobservable* to the *more observable* static transaction costs. Moreover, given sufficient knowledge of transition costs, the empirical issue reduces to measuring the change in static transaction costs that accompany reduced policy flexibility. This measure then becomes the foundation for questioning the *unobservable* environmental values that derive from attenuating the property rights of extractive users.

4 Welfare, Transaction Cost Considerations

Whilst this transaction cost framework makes the empirical task more manageable a cautionary note still applies when comparing changes in transaction costs with changes in societal welfare. In particular, a reduction in transaction costs cannot always be assumed analogous to a welfare gain. Suppose that policy flexibility in the water market is reduced thereby making it "cheaper" for buyers and sellers to develop complete contracts for the exchange of a water entitlement. This might manifest itself in a rightward shift in the demand function for entitlements. However, the response of suppliers is critical in determining whether more "welfare" results from the shift in the demand function. If suppliers now regard entitlements as more valuable and are reluctant to part with them, a leftward shift in the supply function may simultaneously accompany the rightward shift in demand. Alternatively, previously reluctant sellers may now choose to sell part of their entitlement in the knowledge that any remaining portion is now more secure. Thus, definitive predictions about the change in consumer and producer surplus [as a measure of welfare] cannot be drawn from a potential reduction in single static transaction cost.

In effect equation [7] runs the risk of 'comparing apples with oranges'. More specifically, the loss of environmental options [$(\{0\} - (\{1\}$] more closely accords with a change in welfare rather than transaction costs *per se*. Accordingly, a more useful

[5] The transition cost term, $\exists\{1\}$, implies that transition costs are incumbent on the altered institutional state, $V\{1\}$ not $V\ \{0\}$, since these are required to realise the amended institution.

analysis in the present context would include the development of measures of welfare change that pertain to the alteration of static transaction costs.

In the case of the market for water entitlements there is a *prima facie* case for expecting that this may be a relatively straightforward task. Transaction costs in this instance displace the demand and/or supply functions which, in turn, generate changes to consumer and producer surplus[6]. Accordingly, a useful extension of the research of Crase *et al.* (2001) would be to transpose the LHS of equation [7] into a measure of consumer and producer surplus. This measurement would more closely accord with the welfare loss attendant on environmental degradation that must be considered by policy makers.

In the case of the NSW permanent water market, this could be accomplished by examining adjustments to market surplus that arises from different levels of transaction costs. The resulting variation in market surplus would thus provide a more appropriate foundation for measuring the threshold environmental values that policy makers might ascribe to a given level of policy flexibility.

5 Estimating the Impacts of Transaction Costs

Crase *et al.* (2001) reported the results of a choice experiment that was used to quantify the transaction costs attendant on buyers and sellers in the permanent water market in the Murray Irrigation and Murrumbidgee Irrigation districts of NSW. The choice experiment presented potential buyers and sellers with choice sets which comprised various prices and differing guarantees of policy stability with respect to water rights. The latter variable was described in a temporal context with market participants asked to consider the number of years without amendment to their existing access and use rights.

Several models of buyer and seller behaviour were generated from the choice data, including logarithmic and linear forms for the policy flexibility variable, YEARS. In the case of the seller models there were no compelling grounds for employing non-linear specifications. In the current context, interpretation of the logarithmic buyer model complicates the estimation of welfare change, since implicit price estimates vary according to the values of the YEAR attribute under examination. Accordingly, to simplify the analysis of welfare estimation we employ only the linear models of buyer and seller behaviour reported by Crase *et al.* (2001). These are summarised in Table 1, below:

[6]Of course this assumes that market surplus is an adequate proxy for measuring welfare. Provided that we are prepared to invoke the findings of Willig (1976) this should not prove too restrictive.

Table 1: Choice Models of Buyers and Sellers in the Permanent Water Market

Variable	**Buyer Model**	**Seller Model**
Alternative Specific Constant [ASC]	0.351 (0.220)	-2.016*** (0.247)
PRICE	-0.137E-02*** (0.103E-03)	0.107E-02*** (0.774E-04)
YEARS	0.109E-01*** (0.119E-02)	
[7]AGE * ASC	-0.196*** (0.666E-01)	-0.196*** (0.689E-01)
AREA * ASC	0.247E-04* (0.133E-04)	-0.292E-03*** (0.883E-04)
Log-Likelihood	-1211.108	-1073.909
Rho 2	0.192	0.317
Adjusted Rho 2	0.19	0.315
Observations	1364	1431
Chi-Square	574.798	996.410

Standard errors in parentheses
***Significant at the 1% level
**Significant at the 5% level
*Significant at the 10% level

Source: Crase et al. (2001 pp. 19-21)

Generating implicit prices from these data revealed that buyers discounted their bids for water entitlements in the face of policy flexibility. More specifically, buyers reduce their offers for water entitlements by about $8.00 per ML or $133 per ML if policy certainty was changed from 2 YEARS to 15 YEARS[8]. Alternatively, suppliers were unmoved by changes in the extent of intervention by the state [hence the omission of this variable from the sellers' model] but were motivated to chose a sell option by offering higher prices. These data support the hypothesis that a more active water market was likely to result if the state's ability to amend water entitlements was constrained. These predictions stem from the likely rightward movement of the demand function [that derives from the lower level of static transaction costs borne by buyers] and the apparently stationary supply function.

[7] The process of including socio-economic variables in choice models differs from that of conventional regression techniques. Since socio-economic variables do not differ across the choice sets they cannot be used to predict the option chosen (Blamey *et al.* 1999, p. 350). There are two main ways of including socio-economic variables in the analysis. Firstly, they can be interacted with attributes in the choice sets. Secondly, they can be included through interactions with the ASC. The latter is employed in these models.

[8] These years were chosen on the basis of the historical pattern of change and the proposed enhancements of property rights in the Water Management Bill.

6 From Transaction Costs to Welfare

In most instances choice modelling techniques multiply the individual compensating surplus of the 'average' respondent by the total population to produce a measure of total welfare change. However, in the present context we contend that this approach is unduly restrictive. In the current circumstances it is not possible to derive an estimate of compensating surplus for potential sellers since the YEARS attribute proved insignificant for this group. Assuming that no welfare accrues to sellers from more stable rules would ignore the producer surplus that might accompany an increase in price, as buyers adjust their bids in response to policy certainty. A way forward would appear to reside in using the individual estimates of compensating surplus to predict movements in the demand function in the permanent water markets and then relate these to changes in consumer and producer surplus for the market. It might then be possible to draw comparisons with the welfare attendant on the current level of policy flexibility and consider the threshold environmental values of the policy conundrum.

A number of challenges arise form this task. Most notably, the data collected in the study by Crase *et al.* (2001) are not defined in traditional Marshallian price/quantity space. The CM data describes the probability of a respondent choosing a buy [or sell] option under different scenarios, including different prices. However, these data do not inform us about the quantum of water likely to be sold or purchased under those conditions. Accordingly, a vehicle is required to transpose the current information into quantity data that accords with the market framework for measuring consumer and producer surplus. In this instance we employ estimates of market share from the choice experiment in concert with some qualifying assumptions about the extent of the total permanent water market in the study area.

6.1 The extent of the market

Total water entitlements in the study area amount to some 2,650 GL. However, a number of issues arise from attempting to use this as the foundation for describing the potential permanent water market. Firstly, this would imply that all water in the Murray Irrigation and Murrumbidgee Irrigation districts was likely to be tradeable. The models presented in previous sections pertaining to seller behaviour do not support this view. Such an assumption would also ignore the existence of the limited trade under the current institutional arrangements and the impact of local rules, channel capacities, and other impediments, that may prevent market participation. In addition, an assumption of this nature would overlook the extent of temporary trade, which is only in the order of 10% of the volume of entitlements. To account for these issues we assume that only 3% of the total entitlement in the study area could be traded on a permanent basis[9].

An estimate of the current price of permanent water may also be useful in developing a measure of consumer and producer surplus. As we will see shortly, this assists in

[9] The present level of permanent trade is less than 1% of entitlements in NSW. Accordingly, a total market of 3% of entitlements with lower transaction costs appears plausible.

determining an appropriate range for measuring the responsiveness of buyers and sellers to price variations. Earlier studies in this field have identified the absence of price information and information asymmetry as important market failures in Australian permanent water markets (see, for example, Challen and Petch 1997; Bjornlund and McKay 1996). However, a body of knowledge is developing in the study region from increased use of water agents, public auction of entitlements, advertised sale prices and the like. In this instance advice from water agents trading in both the Murray Irrigation and Murrumbidgee Irrigation districts was used to establish the approximate current price of water entitlements. A review of advertisements in the rural press was also used to validate these data. At the time of writing the quoted price of permanent water in the Murrumbidgee Irrigation district was about $525 per ML whilst permanent water in the Murray Irrigation area was being traded for around $460 per ML. Differences in price reflect location specific factors such as variations in the reliability of supply between the two irrigation companies. On the basis of this information we assume that the average price of permanent water in the study region is about $500 per ML.

6.2 From Market Share to Demand and Supply Functions

Whilst it is possible to make some assumptions about the extent of the total potential market and current prices, on its own this information provides little guidance about the behaviour of buyers and sellers in the market. Accordingly, we require a vehicle which can depict changes in this potential market that arise from variations in price. Clearly, estimates of the price elasticity of supply and demand would assist. However, the relative paucity of actual permanent trade in NSW and the dearth of empirical analysis in this field requires an alternative approach. In the current context we accomplish this task by employing the concept of 'market share' and the equation offered for its calculation by Blamey *et al.* (1999, p. 342):

$$\text{Market Share} = \underset{I=1,N}{3} P_{ih} \,/\, \underset{j,C}{3} \left[\underset{i=1,N}{3} P_{ij} \right] * 100 \qquad [8]$$

where there are *N* respondents and the *i*th respondent faces *j* alternatives, including the *h*th option. The socio-economic data pertaining to the 'average respondent' is often substituted into the utility function to provide an estimate of market share from the choice data.

The technique employed in this instance estimates the market share that pertains to a particular price scenario and converts this to a volume of water entitlements by multiplying market share by the aforementioned potential market. The price scenarios selected for examination were $500 and $600. The objective is to identify two points on the demand and supply functions in Marshallian space over a range of feasible prices. Given the current price level, and if we accept that the buyer's WTP for enhancing property rights [$103 per ML] represents the extent to which the demand function might be displaced, a range of $500-$600 appears plausible[10].

[10]Clearly, if the demand and supply functions are assumed linear the price points might be considered irrelevant. Nevertheless, maintaining plausible price values is expected to add confidence to the estimation

Again, in line with the *Water Management Bill* we assume that YEARS is set at 15. Market shares for both buyers and sellers have been estimated using equation 8 and are reported in Table 2.

Table 2: Market Shares for Buyers and Sellers Resulting from Different Price Scenarios.

	PRICE = \$500/ML YEARS = 15	PRICE = \$600/ML YEARS = 15
Buyer's Market Share	53.42%	46.58%
Seller's Market Share	47.33%	52.67%

Changes in market share depicted in Table 2 were subsequently used to develop estimates of the variation in the quantity of water offered for sale and sought by buyers at these prices. To the extent that our assumptions about the size of the total market holds, this provides information about two [theoretical] points on the demand and supply functions in a market with a 15 year property right[11]. Assuming that both of these functions are linear, it is then possible to employ this information to estimate the slope and intercept of the demand and supply functions. The resulting demand and supply functions when YEARS is set at 15 are presented in equations 9 and 10.

Demand: $$\text{Price} = 1281.00 - 0.01839\ (\text{Quantity}) \quad [9]$$

Supply: $$\text{Price} = -385.47 + 0.02353\ (\text{Quantity}) \quad [10]$$

Solving for equilibrium reveals a price of \$549.93 per ML and a volume of 39,753 ML being exchanged. Under these conditions the market generates consumer surplus of \$14,531,113. By way of contrast, producer surplus under this scenario is equivalent to \$15,409,078. Thus, under these conditions the market generates a total surplus of about \$29,940,191.

Having established the market surplus under a scenario of a 15 year property right we turn our attention to the performance of the current market. We have already observed that the compensating surplus accruing to buyers by changing the YEARS attribute from 2 to 15 is about \$103. Put differently, this represents the amount buyers are WTP to reduce policy flexibility from 2-yearly 'changes of the rules' to amendments every 15 years. Alternatively, the *status quo* results in individuals discounting their bids by this amount and decreases the demand for each ML of permanent water at each price level. Since transaction costs effectively displace the demand function downwards and to the

procedure. It should also be noted that the buyer's WTP is not equivalent to a change in price but an adjustment to the bids of buyers.

[11]Implicit in this analysis is an assumption that sellers choose to sell all of their entitlement at the prevailing prices. Given our earlier observation of seller behaviour this should not prove unduly restrictive.

left, we can use this estimate of transaction costs to develop a comparative measure of consumer and producer surplus. More specifically, by assuming that transaction costs have moved the demand curve parallel, and by restricting our analysis to a linear demand function, we can describe the new demand function which embodies this level of transaction costs thus:

$$\text{Demand}^1: \quad \text{Price} = 1177.96 - 0.01839\,(\text{Quantity}) \qquad [11]$$

In accordance with our earlier examination of seller behaviour we further assume that the supply function remains fixed.

This new demand function [11] and the supply function described by equation 10 produce 37,295.56 ML of permanent water trade at an equilibrium price of $492.09. Moreover, $12,789,953 of consumer surplus and producer surplus equivalent to $13,308,466 are now generated. Thus, the presence of transaction costs in the form of policy flexibility is estimated to reduce total market surplus by $3,841,772 [to $26,098,419]. This sum represents the welfare foregone by extractive users in the study area as a result of the policy flexibility afforded by the current institutional arrangements. Put differently, this also amounts to the threshold value of environmental benefits that would justify the retention of the institutional *status quo.*

7 Limitations

There are many limitation and caveats that must apply to these findings. Firstly, the assumption pertaining to the extent of the total market plays a pivotal role in the estimated changes to consumer and producer surplus. If the size of the market has been underestimated [or overestimated] the welfare estimates and the changes to welfare will also be underestimated [or overestimated]. However, to the extent that our assumption is tenable, the estimates remain valid. Secondly, the technique employed for developing information about the responsiveness of buyers and sellers to price variations implies that these results should be interpreted with caution. Such estimates are based on contingent behaviour and this may not always accord with the reactions of individual in a ‘real’ market. Thirdly, our analysis has been limited to the consideration of linear demand and supply functions. Alternative functional forms would give rise to different estimates of welfare change. Fourthly, we have employed the most conservative estimate of transaction costs to depict the likely shift in the demand curve. In this instance, assigning different functional forms to the buyers’ choice model would generate markedly different welfare estimates. Fifthly, the extent to which market surplus itself is an adequate proxy for welfare change places caveats on these results.

Two additional issues also remain unresolved. The extent to which these results might be generalised to other irrigators requires further study. More specifically, the results of this study may not easily generalise to other locales. The study region comprises intensively developed irrigation districts with a history of active water trade on a temporary basis. Applying the estimates of transaction costs and welfare change to other irrigation districts that do not share these characteristics could prove problematic.

The time dimension of transaction costs and welfare change also warrants further investigation. In the present context we have argued that the option values that accrue to the environment occur in the current time period. Accordingly, our threshold analysis requires that we compare the currently foregone welfare [observable in the market] with the [unobservable] welfare gain that society accrues by leaving governments with greater policy flexibility. Extending this analysis into subsequent time periods would require an understanding of the appropriate discount rates for environmental benefits and [foregone] market benefits. Moreover, since those rates are likely to differ, as well as change over time, it is important that the results from this study are not carried too far into the future. In addition, Crase *et al.* (2001) observed that ergodicity would result in some transaction costs diminishing over time, further constraining the application of these results in different contexts.

8 Concluding Remarks

Establishing the magnitude of the transaction costs borne by the market as a result of policy flexibility and developing welfare estimates on the basis of these data has raised substantial challenges. However, the choice data assembled by Crase *et al.* (2001) to accomplish this task have provided valuable insights into the behaviour of buyers and sellers in the permanent water market in NSW.

Models developed for buyer behaviour revealed that buyers are more inclined to purchase at lower prices or when property rights are less attenuated. In addition, estimates of compensating surplus indicate that a move to more stable rules, such as that implied in parts of the *Water Management Bill*, would result in significant reductions in the transaction costs of buyers. Accordingly, it can be predicted that a firming of property rights will result in an increase in the demand for permanent water. The behaviour of sellers in the choice experiment also suggests that the supply function in the market for permanent water is unlikely to shift in response to changes in the transaction costs that emanate from policy flexibility.

Nevertheless, the significance of the PRICE attribute in the sell models points to a more active market in the event that policy flexibility is reduced. This issue has been investigated by developing supply and demand functions from the market share estimates of the choice data. Whilst employing many assumptions this technique permits observations to be drawn about the likely welfare impacts of transaction costs on the market. Notwithstanding the limitation embedded in this approach, the estimated changes to market surplus provide some foundation for assessing the threshold values of environmental enhancement that accrue from policy flexibility. Put differently, the environmental benefits of policy flexibility in the study region must be at least equivalent to about $3.8 Million to warrant the attenuation of property rights that presently derives from policy uncertainty.

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