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Consumer preferences for water billing structures: A choice modelling approach

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I Introduction

The design of water/wastewater tariffs and the potential role for economic regulators to establish 'efficient' prices in this context continues to trouble policy makers in Australia. Of particular concern is the efficacy of the present pricing arrangements and whether the purported 'signals' to customers adequately reflect economic parameters (see, for example, Edwards 2007, Dwyer 2006). However, closer scrutiny by scholars and general agreement on the need for robust economic regulation has failed to transform into genuine consensus. Identifying the 'most appropriate' approach to setting prices for water and wastewater services is no simple task and significant discrepancies have emerged on several fronts. First, the dichotomy between fixed (service or connection) charges and usage (volumetric) charges varies markedly between and within states. Second, the methodology employed to determine a price for un-metered wastewater services differs between jurisdictions. Third, the approved mechanics for funding extensions to the water and sewer networks is inconsistent. And fourth, the acceptance and implementation of inclining block tariffs (IBT) is far from uniform. In light of these discrepancies and the apparent absence of a universally and theoretically preferred price-setting technique, there would appear to be merit in at least understanding the consumers' preferences for different pricing regimes. And yet there is also a relative paucity of information of this type and bureaucrats and regulators run the risk of imposing their own values on the structure and level of prices in the absence of an objective rationale.

This paper attempts to make some progress to addressing these deficiencies by considering consumers' preferences for a particular water price regime. In light of the myriad of structural considerations that underpin a pricing regime for a product as complex as water, the data presented here focus on only two components of water tariffs: Namely, the relative weight of volumetric and fixed charges and the impacts of 'pseudo-volumetric' wastewater charges. The paper reports the findings of a recent study that developed empirical models of consumers' preferences for billing structures for urban water services in regional Victoria.

The paper itself comprises eight main parts. Section two provides a synoptic overview of the current status of water and wastewater charges applied in different Australian jurisdictions, honing in on the two components of interest. Some theoretical considerations for the establishment of fixed and volumetric water/wastewater charges are also briefly reviewed in this section along with a précis of the arguments for a composite water/wastewater charge when the consumption of wastewater services cannot be feasibly monitored. The fourth section briefly outlines the rationale for employing a choice modelling approach to reveal the preferences of consumers, whilst section five offers a summary of the choice modelling methodology as it applies to the current context. The sixth section presents the results of the choice models, before discussing them from a policy perspective in section seven. Finally, some brief concluding remarks are presented in section eight.

II Approaches to Urban Water and Wastewater Pricing

In 2004 the Council of Australian Governments (CoAG) announced that it had reached agreement on a new round of water reforms, known as the National Water Initiative (NWI). An important ingredient of the NWI was a call for the implementation of "best practice water pricing" accompanied by "improved pricing for Metropolitan water" (NWC 2004). Notwithstanding the nobility of these ambitions and their purported links to enhanced resource allocation, reaching consensus on these principles has proven problematic. More specifically, there is an emerging and, at times, acrimonious debate about what constitutes sound water and wastewater pricing for urban communities (see, for instance, Sibly 2006; Dwyer 2006). Arguably, this discord is also reflected in current practice which varies markedly throughout Australia. In an effort to illustrate the extent of the problem and to make the analysis manageable we consider only two elements here: The use of access (fixed) charges versus volumetric prices, and; alternative wastewater pricing regimes.

(i) Fixed versus volumetric water tariffs in Australia

All Australian jurisdictions currently structure water tariffs around fixed (or access) charges accompanied by a volumetric (or use) component. The economic rationale for this approach is dealt with shortly, but it is worth noting that the magnitude and relative importance of these charges varies markedly between cities. In some instances these data are complicated by the use of

IBT pricing regimes that also differ in their makeup and complexity[1]. An IBT purportedly targets 'discretionary water use' by increasing the unit price of water once a threshold limit is exceeded (WSAA 2005).

Edwards (2007) surveyed the relative size of access and volumetric charges across several Australian cities and found that for households consuming a 'typical' 250 kilolitres in 2006-07, the use component varied between 80% (in Sydney and Newcastle) to a low of 49% (in Perth). Where the household consumed 400 kilolitres, the volumetric component of the total water bill exceeded 80% in Newcastle, Sydney, Melbourne and Canberra but still fell short of 70% of the total water charge for households in Perth. Households using a modest 100 kilolitres face an access charge which can constitute as much as 78% of their water bill in Perth and as little as 21% in Newcastle.

It is important to realise at the outset that the relative magnitude of fixed charges plays a critical role in determining the effectiveness of potential price signals that are purportedly designed to modify consumption behaviour. Put simply, 'excessive' fixed charges blunt the incentive to curb household water use, since the household's average water charge falls only slightly when they refrain from using water. Accordingly, large access charges would appear to be at odds with the supposed targeting of profligate water use by invoking IBT regimes.

[1] IBT are themselves the subject of considerable debate amongst economists. For an excellent critique of the problems that attend this approach see Edwards 2007 and Sibly 2006.

One way to enhance the ‘signalling effect’ of water prices would be to reduce the access charge and increase the per unit volumetric charge. Moreover, this could be achieved in a revenue neutral manner from the perspective of the water utility, although this would likely increase revenue variability between years.

(ii) The rationale for separate access and volumetric charges

The justification for applying a separate access charge for household water consumption is that household should be forced to confront the true fixed cost of providing the water infrastructure associated with water service delivery. This will purportedly encourage households (and water utilities) to make optimum investment decisions that equate marginal benefits and costs in the long run. This line of argument contends that a household will rationally consider the access charge when deciding whether to avail themselves of the services of the water utility. Similarly, this reasoning leads to the conclusions that the returns from access charges provide the optimal incentives for water utilities to extend their infrastructure.

In reality, neither of these arguments holds for Australian water utilities and their customers. Urban households have no choice other than to connect to the water network if they are fortunate enough to reside in an area declared as a ‘water district’. Thus, the access charge has no meaningful signalling role in the decisions of households (unless they live in a mobile home or caravan).

Similarly, the argument that water utilities are both sending and receiving appropriate economic signals via access charges is fallacious. Much of the existing infrastructure of a water utility is sunk and, in many instances, has already been recovered in one form or another. In this context Dwyer (2006: 11-12) notes the case of the Burdekin Dam, which was initially funded by the Federal taxpayer, and the Queensland Government's subsequent decision to charge a rate of return on the dam infrastructure. In this regard Walker (1993 - cited in Dwyer 2006) observes that there are few businesses where the assets are gifted by the taxpayer or consumers who are then asked to make a payment to cover a rate of return on money that was never spent. Moreover, even if the infrastructure cost has not yet been recouped, the real beneficiaries are the long term owners of land who enjoy access, not just the immediate water users. It was this line of thinking that led public works to be funded by rates on land values prior to the current exuberance for 'user pay' in its present form (Dwyer 2006). It might also be argued that the true opportunity cost of water infrastructure is zero. Once in place water infrastructure has virtually no alternative use and is a sunk investment. The extensive efforts of regulators and water utilities to strike an economically-meaningful access charge for water is thus a ruse, shrouded in the mystique of accounting standards that mask the true profitability and costs of water utilities (Walker and Walker 2000).

In practical terms fixed access charges are more about "protect[ing] the supplier from demand fluctuations and reduc[ing] financial risk" (Rogers et al. 2002: 4) than they are about sending appropriate price signals to water

consumers. Thus, whilst the economic rationale for any access charges in this setting is weak, the likelihood of their complete abandonment is remote. In any case, excessive access charges are difficult to justify on economic grounds.

The economic debate for the establishment of volumetric charges largely hinges on the appropriateness of Short-Run Marginal Cost (SRMC) pricing and Long-Run Marginal Cost (LRMC) pricing. SRMC refers to the cost of meeting an additional unit increase in demand within an existing supply system. Clearly, if the system has excess capacity, because consumption is low relative to capacity, this will manifest in a low water price. LRMC is favoured by state regulators and is implicit in the NWI (Edwards 2007). This approach considers the cost of augmenting supply infrastructure as capacity is progressively exhausted.

There are two main concerns with this approach and its present implementation. First, LRMC is an appropriate mechanism for setting prices only insomuch as the mechanisms for augmenting supply are adopted in order of their economic merit. Political intervention that sets mandatory urban recycling targets or constrains water trade between low value agricultural users and urban water authorities stands to undermine the validity of LRMC calculations. Second, the current approach of some regulators (eg ESC in Victoria) involves the use of a 'building block' approach to estimate the revenue requirements for water businesses. Given the earlier reservations

about the (shaky) foundations of access charges, it is difficult to see how a volumetric charge will adequately encapsulate true LRMC.

In sum, the notion of an access charge paid by current water users has only weak economic grounding at best and, whilst volumetric charges would ideally encapsulate LRMC, there is no guarantee that this will occur under present arrangements. The (second) best an economist could hope for is that access charges are minimised and a single volumetric charge at least approximated LRMC.

(iii) Wastewater tariffs in Australia

The water sector's penchant for two-part tariffs (i.e. access charges supplemented by a volumetric usage charge) is not restricted to water services. Wastewater services also attract two part tariffs in many jurisdictions, although the structure of wastewater tariffs is more varied than is the case of water. In South Australia residential customers are charged only a fixed rate based on the value of their property (SA Water 2006) whilst in Western Australia a two-part tariff applies; the fixed component representing the amortised cost of providing sewage services in each town with the variable component being based on the Gross Rental Value (GRV) of the property. The wastewater pricing regime is Western Australia is currently being amended to excise the GRV component (ERA 2004). In Queensland, all category two water authorities are required to impose fixed wastewater tariffs (NRM 2005) as occurs with some utilities in New South Wales, like Sydney Water. However, several water utilities in New South Wales apply a

two-part tariff for wastewater (e.g. Gosford, Hunter Water), although the recently released *Best Practice in Pricing Principles* favours a move towards fixed tariffs for wastewater services. Like New South Wales, wastewater tariff structures vary within Victoria with about half of the water utilities applying fixed access charges only and the others applying a combination of fixed and variable charges, based loosely on water usage.

One of the attractions of the study area was that it comprised residents in Victoria who faced different charging regimes for wastewater. More specifically, about half of the customers of the North East Water Authority currently pay a fixed wastewater charge whilst the remainder are charged a fixed and volumetric component for wastewater services.

(iv) The economic rationale of imposing volumetric wastewater charges

The practicality of a volumetric charge for household wastewater services is complicated by the fact that wastewater volumes and composition are not metered at the household level. Nor is it likely to prove feasible to install devices of the kind needed to achieve this level of monitoring for the foreseeable future. Thus, in order to apply a volumetric charge for wastewater services, the regulator/water utility applies an assumption about the volume of water which is consumed by the household that will ultimately require treatment as wastewater. For instance, in that part of the study area where a volumetric tariff applies, half of all water that is metered entering the property is assumed to return as sewage and the cost of treating that volume of sewage is then applied to the bill.

Clearly, this embeds inefficiencies insomuch as the household which, by virtue of its desire (or necessity) to have a large garden, swimming pool or other outdoor water-using features, must simultaneously assume greater responsibilities for the treatment of urban sewerage. In this context the National Competition Council (NCC 2003) observed that "charging on a consumption basis for wastewater services provided to households and small commercial customers is generally not efficient". In reality, this amounts to little more than a *defacto* increase in the volumetric price of water with no guaranteed correlation to the costs associated with sewage-generating activities.

However, at odds with this are observations about the strength of the nexus between water consumption and wastewater. For instance, Houston et al. (2001: 25) contend that customers "rarely if ever decide to use the sewer, or not use the sewer, once a decision is made to turn on the tap. This suggests that water and sewerage could usefully be considered one consumer decision". Moreover, if this is truly the case the efficiency losses that attend an increased volumetric charge on water to accommodate the cost of wastewater treatment might not be too severe.

Supporting this view are recent calls for a 'more holistic' approach to water pricing to ensure that adequate signals are received by households about the benefits of water recycling (see, for instance, Khan 2007). In essence, this argument contends that the real cost of water usage is deflated insomuch as

the cost of disposing of wastewater (which is a subset of water use) does no adequately reflect the environmental degradation that attends ocean outfalls or in-stream wastewater pollution. A Coasian solution would see the rights to environmental amenity in the receiving environment more clearly defined so that an optimal level of degradation could be established via trade (Crase 2007). The Pigovian alternative is to increase taxes on wastewater to encapsulate the social cost of wastewater disposal. Both of these measures should *a priori* make the benefits of urban water recycling more apparent, although it also presumes that the outcomes of the Coasian trade or the Pigovian taxes ultimately resonate in the form of efficient price signals to consumers. Thus, on the one hand a wastewater volumetric charge coupled to water usage has some appeal insomuch as it could provide a vehicle for signalling the broader costs of urban water use. However, as we have already observed, this only holds insomuch as there is a relatively stable and homogenous relationship between households' water consumption and their use of wastewater services.

In sum, wastewater and water pricing in Australia is characterised by efficiency 'compromises'. In the case of water supplies the economic rationale for access charges is weak and there is a case for considering higher volumetric charges that reflect LRMC. However, this needs to be considered against the increased revenue variability and risk borne by the water utility.

In the context of wastewater pricing the nature of the service and the limits on metering technology make the deliver of an efficient outcome implausible – it is more a question of minimising efficiency losses. Volumetric wastewater charges coupled to water use have some merit, which may explain why the Victorian ESC foreshadows that in future regulatory periods "sewerage charges for residential and non-residential customers … should include both fixed and volumetric components" (ESC 2005: 88). However, there is also a danger that perverse cross-subsidies between water and wastewater services could arise from this approach.

These 'compromises' are reflected in the variation in water and wastewater pricing regimes across Australian jurisdictions. Even within single jurisdictions there is considerable variability, as witnessed by the current differences in wastewater pricing regimes in Victoria. By and large, what is missing from this debate is an understanding of consumers' preferences and tastes in this context. This information would assist policy makers in choosing between 'sub-optimal' alternatives which arguably are presently selected on the basis of bureaucratic preferences. The following sections detail a methodology for eliciting such preferences before returning to the policy choices at hand.

III Methodology and Rationale

A way to examine the preferences of consumers for a range of water billing options involves conceptualising the bill itself as a 'product' that comprises of a number of attributes that, in combination, give the bill its form and utility (Kaul & Rao 1995). Accordingly, a sample of consumers could be offered the

choice between a bill that allows different levels of individual control (via smaller access charges) along with a range of other features, like the option of paying environmental premiums via the water account. Participant's repeated choices between these hypothetical billing systems ultimately reveal their preferences and the magnitude of the trade-offs that they make. This technique is termed experimental choice analysis, and has been extensively used in environmental evaluation (see, for instance, Morrison, Blamey, Bennett & Louviere 1996; Morrison, Bennett & Blamey 1998), and more recently, in determining preferences for guaranteed service delivery in water utilities (Hensher, Shore and Train, 2005).

Choice modelling draws upon the concept of rational economic actors pursuing utility maximising outcomes that forms the foundation of neo-classical economics. It does however, simultaneously recognise the constrained nature of the individual decision process as conceptualised by Simon (1959). Notwithstanding the criticisms of stated preference techniques[2], a compelling advantage of this technique is that it affords the researcher the opportunity to gather *ex ante* data on consumer preferences, rather than relying on revealed preference data. In the current context, changing a billing structure represents a non-trivial investment of financial and human resources that is arguably better informed with the type of ex-ante information furnished by a choice experiment such as this.

[2]Several areas of concern exist in the application of any stated preference technique. Firstly, all stated preference techniques can be criticised due to the poor correlation between intent and behaviour. For instance, Ajzen and Peterson (1988: 58) observe that '…social psychological research has revealed poor relations between attitudes and overt action'. Similarly, Diamond and Hausman (1994) found that there were large and significant differences between willingness to pay in stated preference experiments on one hand and actual payment on the other. In addition, a number of biases associated with all stated preference techniques have been identified (see, for instance, Morrison et al. 1996).

Choice modelling also allows for the incorporation of socio-economic and demographic data in the form of interaction terms within the models, enabling an expanded understanding of the likely characteristics of consumers favouring particular combinations of attributes of the billing system. In the present context, the bifurcation of the study area into two groups – those who presently pay only a fixed wastewater charge and those who pay a combined fixed and volumetric wastewater charge – may provide useful insights.

IV Experimental Procedure

Appropriate experimental design is crucial to the success of a conjoint experiment like choice modelling (Hair et al. 1998: 99). The aim in this phase is to identify those variables or attributes that affect consumer preferences, to assign realistic levels to these and to establish a suitable model for consumer preferences. Since, in this case, the realistic choice context does not include a brand, the use of an unlabelled choice set was deemed appropriate. This necessitates the estimation of generic parameters regardless of the number of choice alternatives (Hensher, Rose and Greene 2005: 151)[3]. In keeping with the nature of utilities, and following Hensher, Shore and Train (2005: 10) a 'no choice' option was not included. This means that respondents were not given the alternative of 'choosing neither' in each choice set. In the context of water bills this appears a reasonable approach given that all consumers must have water – as we noted earlier, consumers are obliged by law to connect to the water and wastewater network I most urban environments. The only realistic

[3] Hensher et al. 2005 provide a comprehensive discussion of the theoretical and practical implications of the choice to employ an unlabelled or a labelled choice set.

choice is between alternative billing systems, since consumers cannot choose not to have any bill. An additive or main effects model was specified as these type of models generally account for 80-90% of the variation in preference in most cases, according to Hair et al. (1998: 408).

(i) Identifying and specifying attributes and levels

The identification and specification of attributes reflected the present research question along with other dimensions of interest from the funding body (Consumer Utilities Advocacy Centre). Input was also sought from a range of industry 'experts' to ascertain those attributes that would be of most benefit in formulating tariff structures. The attributes that emerged from this process were then discussed at length in interviews and focus groups, with the particular aim of ensuring that the attributes and their levels were able to be communicated in a meaningful way. Following Lockwood and Carberry (1998), this phase was followed by survey pre-testing. In-depth semi-structured focus interviews of around 30 to 40 minutes' duration were conducted with volunteers in their homes. Subsequently, focus groups comprising between 4 and 14 volunteers were then conducted to confirm the attributes and levels. Importantly each of these components covered both small and large towns, and communities with differing water/wastewater bill structures. The resulting attributes and levels emanating from this process are summarised in Table 1. For convenience, the Table also includes the definition of other variables that ultimately proved significant in the statistical models.

Table 1: Coding of attributes and variables

Attribute/Variable	Definition	Levels identified	Coding
Household control over total water bill (CONTROL)	The extent to which the household can reduce their bill by reducing consumption.	Maximum, medium	1,0
Method of payment to extend the network (DEVELOPERS)	The extent to which the cost of extending the network is shifted to land developers.	Developers pay more or included in water charges	1,0
Guaranteed service level (GSL)	An unplanned disruption to a household's water or wastewater service, which was not corrected within 5 hours, would result in a $25 discount on that household's next water bill.	Yes, no	1,0
Optional environmental premium (GREEN)	The option of paying a premium so that the water authority can undertake environmental offsets	Yes, no	1,0
Water saving tips and comparisons (TIPS)	Bill to include comparisons with other households and advice on reducing water consumption.	Yes, no	1,0
Cost per quarter for average household (75kl.) (PRICE)	Actual figures based on the average bill in each regimen.	No change, +$5, +$10, +$15	0,5,10,15
RATE	The respondent's self-rating of his/her knowledge about water issues.	Scale of 1-7 where 1 = 'no idea' and 7 = 'completely informed'	1-7
FIXED	Whether respondent was currently connected to the fixed or volumetric system	Fixed, volumetric	1, 0
PEOPLE	The number of people in the household.	1-2, 3-4, 5-6, > 6	1,2,3,4

There was general agreement across the interviews and focus groups that there were six attributes which represented the key aspects of a billing system on which they would base their choice: Namely, the amount of control they could exercise over the bill (CONTROL); whether their on-going bill funded expansion of infrastructure (DEVELOPERS); if a guaranteed service level was on offer (GSL); the possibility of purchasing green energy as part of the billing

process (GREEN); if the bill contai9ned useful information to assist in saving water (TIPS), and; the quarterly cost (PRICE) . Of particular interest in the present context is the 'split' between fixed and volumetric charging, and a review of the discussion in the focus groups revealed that many participants conceptualised this as 'the extent of control' an individual could exert over their bill. As one participant observed:

The service (access) charge represents most of my water bill. I have no real control over the account.

Another participant noted that:

I am a low water user. We don't use much water and this is a choice we have made. We replaced all our lawn because we thought that it was the right thing to do, but at the end of the day our bill is much the same. I would like to think that I could drive my bill down by using less water.

An information booklet was circulated with the choice experiment which detailed the level of 'control' that households would have by varying the weight of the fixed (access) charge. The information booklet informed participants that any reduction in service charges would have to be accompanied by increases in the per unit price of water to ensure that it remained revenue neutral. It also suggested that wastewater charges would be tied to the amount of water consumed. Currently, half of the residents in the study area pay access charges which constitute about 70% of the average

customer's water bill, whilst in the other half of the study area access charges represent about 49% of the total water/wastewater bill.

Two different revenue-neutral water charge scenarios were developed for each of the regions within the study area using data from North East Water. One involved a single access charge to water and wastewater equal to $50 per quarter coupled with a single volumetric water charge of $1.36 whilst the other comprised a $25 access charge and a volumetric rate of $1.72 per kilolitre. The former was referred to as a 'medium control' scenario whilst the latter was given the description as a 'maximum control' scenario.

For the average household located in the region where a relatively high access charge currently applies, this represents a 112% and 170% increase in the volumetric rate for the respective scenarios, although the access charge would simultaneously fall by 55% and 77%. In the region where a relatively low access charge currently applies, similar scenarios were developed. However, in this case the percentage increase in the volumetric rate[4] was less pronounced, corresponding to a 29% increase when the higher access charge is applied and 62% for the lower access charge. The proportionate reduction in the access charges is also less for this region representing a 34% and 67% fall respectively.

[4] In this region the volumetric rate for water use was about $0.64 per kilolitre. The wastewater volumetric charge is based on the assumption that 50% of all water returns to the sewer and attracts a treatment cost of $0.84 per kilolitres. As we observed earlier this reduced to a *defacto* water price of $1.06 per kilolitre.

Given the complexity of the topic and on the basis of the discussion in the focus groups the decision was taken to detail these scenarios by providing data on a range of indicative households. In essence, this would show the impact of altering the weight of the access charge on an 'average' household (using 300 kilolitres per year) a 'high-water-using' household (440 kilolitres) and a low-water household (160 kilolitres). An example of these data is provided in Table 2. Since the sample comprised two main groups with slightly different billing structures two sets of surveys and information brochures were produced to make the survey reflective of the respondent's current billing arrangements. The PRICE attribute remained common across both samples insomuch as the variations to the average water bill in each region was used to define the attribute levels (see, Table 1).

Table 2: Water Account 'Control' Scenarios – Version 2

Household Water Use (per quarter)	Present Cost	Scenario 1 Medium Control	Scenario 2 Maximum Control
Low Water Use Household: 40 kl per quarter	$117	$104	$94
Average Water Use Household: 75 kl per quarter	$154	$152	$154
High Water Use Household: 110 kl per quarter	$191	$200	$214

The other attributes included in the choice experiment included the different approaches to funding network extensions, the existence of a Guaranteed Service Level (GSL) and whether there was an option to pay a premium that would enable the water utility to undertake environmental offsets. In addition,

the qualitative data collected earlier supported the inclusion of water saving tips as a relevant attribute of a water account. Finally, the cost (price) was described as the change in cost per quarter for the average household, although, as we have already observed respondents were made aware of the impact of their choice on low-water and high-water using households.

The focus group discussions had shown the potential for payment vehicle bias, with numerous participants expressing their objection to paying anything extra to the water utility. With this in mind, each choice set was carefully constructed and the price increase was justified in terms of the minimum costs borne by the water utility to bring forth the features of the tariff. For example, the GSL was described as comprising a $25 rebate to customers that suffered an unplanned service disruption of more than 5 hours. Moreover, the overall cost of this was estimated as being about 10 cents per household and this information was included.

The survey was pre-tested by 30 volunteers to ascertain whether the choice sets were communicable and whether the payment vehicle bias was likely to be problematic. Most respondents indicated that the choice tasks had been challenging but manageable if kept to a modest number. None of those who participated in the pilot survey expressed concern about the changes in tariffs being unrealistic or unreasonable.

(ii) Design of the choice sets

A main effects fractional factorial design was generated using SPSS Conjoint which yielded 16 choice options. A fold-over design was then used to generate alternative choice options which were paired to provide the choice sets. These choice sets were put to respondents in terms of which option they would prefer as a billing structure for an average household in North East Victoria. This approach, where the respondent 'votes' for an option for people in North East Victoria, varies from applications of experimental choice analysis where individuals are asked which product they would purchase, or which travel option they would choose. In effect, respondents are asked to choose as citizens, rather than as consumers *per se* although this is not inconsistent with other applications of similar techniques (see, Blamey, Common and Quiggin 1995).

An example of a choice set appears below in Table 3.

Table 3: Example of a choice set for a water bill

Choice 1 (one tick in bottom box):

Features	*Option 1*	*Option 2*
Household control over total water bill	Maximum	Medium
Paying for extending the network	Included in water charges	Developers pay more
Guaranteed service level	Yes	No
Optional environmental premium	No	Yes
Water-saving tips and comparisons	No	Yes
Cost per quarter for average household (75kl)	$159	$164
Tick one option in this table ➔		

Each respondent was faced with four separate choice sets, given concern about the extent of cognitive burden visited on respondents[5]. Blamey et. al (1997) suggest that reducing the number of choice sets may assist in this regard, as well as the inclusion of attitudinal questions and 'debriefing' questions since these may then allow individuals to express their views more freely.

[5] Recent empirical work by Hensher , for example, maintains that it is not the number of choices and attributes *per se* that make an experiment burdensome, but rather the selection of inappropriate attributes, levels and alternatives that complicates the respondent's decision task. Brazell and Louviere subjected respondents to up to 96 choice situations without any appreciative 'cognitive burden' being detected.

(iii) Administration of the survey

The sample was a stratified random sample of 1686 water customers serviced by North East Water. More specifically, in September 2006, a total of 800 surveys were distributed to customers on the fixed system, and 886 to those volumetric. Each potential participant was sent a survey, information booklet, information sheet and a stamped self-addressed envelope in which to return the survey. A thankyou and reminder letter was posted after 10 days. Relatively few minor changes were effected as a result of this process. Each survey was accompanied by an information booklet that calibrated attributes against the customer's current billing system, to enable meaningful interpretation of the status quo.

(iv) Overview of survey respondents

After two weeks had elapsed 338 of the total 1686 surveys were returned, representing a response rate of approximately 20%. Some respondents (12) failed to complete any of the choice sets, and so these surveys were discarded from the data set for estimating the models. Details of the 'average' respondent are summarised in Table 4.

Table 4: Characteristics of average survey respondent

Age (years)	No. people in household	Household income	Estimate of last water bill	Rating of knowledge about water use (0-7)
48.4	2.4	$46052.29	$98.75	4.5

V Estimation of Choice Models

In the first instance, basic multinomial logit models were computed using Equation 1. A specialised computer program, *LIMDEP*, designed to analyse models employing limited dependent variables, was used to conduct the analysis. The indirect utility functions specified for the basic models were as follows:

$$V_1 = C_1 + \beta_1 \text{ Control} + \beta_2 \text{ Developers} + \beta_3 \text{ GSL} + \beta_4 \text{Green} + \beta_5 \text{Tips} + \beta_6 \text{Price}$$

$$V_2 = \beta_1 \text{ Control} + \beta_2 \text{ Developers} + \beta_3 \text{ GSL} + \beta_4 \text{Green} + \beta_5 \text{Tips} + \beta_6 \text{Price} \qquad [1]$$

Parameter estimates were generic, and since a non-labelled design was employed, a single constant was employed across the model. The results of the model estimation process pertinent to the CONTROL attribute are contained in Table 5. In addition, alternative functional forms for each of the attributes were trialled but did not improve the performance of the models. For the sake of clarity, only those attributes and other variables that were significant are included.

Table 5: Choice Models

	Model 1:	Model 2: Control interactions
C1	0.2506*** (3.989)	0.2522*** (4.006)
CONTROL	0.3831*** (6.175)	
DEVELOPER	0.4662*** (7.420)	0.45546*** (7.205)
GSL	0.2932*** 4.697	0.2986*** (4.778)
GREEN	0.2596*** (4.160)	0.26119*** (4.176)
TIPS	0.2560*** (4.552)	0.2858*** (4.547)
PRICE	-0.05432*** (-9.437)	-0.05475*** (-9.494)
CONTROL*RATE		0.05105** (2.849)
CONTROL*FIXED		0.2615* (.2.219)*
Rho 2 (ρ^2)	0.15029	0.15089
Adjusted Rho 2 (ρ^2_{adj})	0.14570	0.14563
Observations	1304	1304
Chi-Square	1669.8854	1664.2169

t- ratios in parentheses

***Significant at the 1% level

**Significant at the 5% level

*Significant at the 10% level

The resulting linear model is referred to as Model 1. The coefficients for the six attributes in this model are significant at the 1% level or better and have

signs which meet *a priori* expectations. More specifically, all attributes are positively signed with the exception of PRICE which attracts a negative sign indicating that respondents were less likely to choose an option with a higher price.

The adjusted Rho 2 indicates adequate explanatory power. Rho 2 values of between 0.2 and 0.4 are usually regarded as a good fit of the data in choice analysis (see, for example Hensher & Johnson 1981). However, Wooldridge (2000: 563) notes that "goodness-of-fit is not usually as important as statistical and economical significance of the explanatory variables". Model significance was estimated using an approach employed by Lockwood and Carberry (1998: 6-7) and Morrison (2000: 23). In this instance the chi-square statistic exceeds the critical value of 16.8119[6] and the null hypothesis that the model is insignificant is rejected. That is, the chi-square is supports the view that the model is statistically significant.

Choice modelling allows for socio-economic and demographic variables to be included in the models, however since these variables do not differ across the choice sets, they cannot be used to predict the option chosen (Blamey, Gordon & Chapman 1999: 350). They can, however, be used to explain some of the preference heterogeneity through interaction with attributes in the choice sets. The aim in doing so is to facilitate increased understanding of the behavioural effect of each attribute. Here we report only those interactions that relate to the CONTROL attribute and this is referred to as Model 2.

7 The critical value used here was χ^2 α=0.01. The degrees of freedom are equal to the number of restrictions on the model.

Tellingly, Model 2 shows two important trends which are dealt with in the following section.

The choice modelling technique also allows for the calculation of implicit prices or marginal rates of substitution that put a dollar value on the trade-offs individuals make between attributes of a billing regime. For example, we can estimate how much an individual is, on average, willing to pay to have increased control over their bill. Confidence intervals for implicit price estimates can be calculated using a technique attributed to Krinsky and Robb (1986) using the coefficients generated by Model 1. Results for implicit prices and related confidence intervals are reported in Table 6.

Table 6: Estimated Marginal Rates of Substitution for Attributes (Based on Model 1)

Attribute	Mean	95% confidence interval	
		Lower bound	Upper bound
CONTROL	$7.06	$4.68	$10.08
DEVELOPERS	$8.61	$6.06	$11.84
TIPS	$5.27	$2.97	$8.06
GREEN	$4.81	$2.45	$7.58
GSL	$5.44	$2.99	$8.25

Marginal rates of substitution give an estimate of the trade-offs between the PRICE attribute, and another attribute of interest. The result is that these calculations reveal the magnitude of respondents' willingness to pay to have the various aspects of a billing regime included.

VI Discussion and Interpretation of Findings

Scrutiny of these models and implicit price estimates reveals some important insight into the preferences of North East Water customers in relation to various components of a hypothetical billing structure. Attributes of PRICE, DEVELOPERS, CONTROL, TIPS, GSL and GREEN were important determinants of the level of utility associated with a particular billing structure, although in the present context the CONTROL attribute has important implications.

Recall that the CONTROL attribute represents the extent to which the household could amend their water account by adjusting water use. The data suggest that the CONTROL attribute is central to the choice decision and invokes a mean WTP estimate of $ 7.06 per quarter. Put differently, not only do households appear to favour a tariff structure that affords them greater choice, they are willing to pay to see this structure implemented.

Prima facie it might be expected that households using less water, on average, would opt for this attribute, or at least more so than those with average or above average consumption patterns. To test this hypothesis data on the participants' estimate of their most recent water account was introduced as an interaction term but failed to be statistically significant. Similarly, household size was introduced into the choice models but, again, proved to be insignificant. This lends some support to the view that all households would prefer that access charges constituted a smaller proportion

of their water charges, including those whose accounts would seem likely to increase as a result.

Additional interaction variables were also trialled in the choice models to further investigate the choice context (see, model 2). A variable which represented the respondents' assessment of their own knowledge (RATE) proved significant when interacted with CONTROL. Moreover, the positive sign that attends this term (CONTROL*RATE) suggests that those who rated their knowledge of water use higher were more inclined to choose an option that embodied maximum household control. Presumably, this reflects the additional salience of the CONTROL variable to those households with a greater understanding of their own water-use behaviour.

In addition, a dummy variable that represents the current wastewater tariff structure was interacted and proved significant. In this instance, the variable (FIXED) was coded '1' for that portion of the sample that presently pay only a fixed access wastewater tariff and '0' for those currently faced with a composite volumetric/fixed tariff. Tellingly, the sign for this interaction term (CONTROL*FIXED) was positive. This suggests that those residents who presently have a fixed wastewater tariff were significantly more predisposed to selecting an option with maximum control than others. Arguably, this is explained by the status quo of these residents, who currently have less influence over their total water account than those with a tariff that includes a volumetric wastewater component.

Other demographic and socio-economic variables were trialled as interaction variables but were not statistically significant. One explanation for this could reside in the nature of the choice experiment and the context in which the choice was made. More specifically, the choice attributes were designed around the 'average household' and respondents were asked to choose on behalf of that household. Notwithstanding that respondents were given sufficient information to deduce the likely impact of that choice on their own household, this setting encourages respondents to view the choice problem more as 'citizens' than as 'consumers'. If respondents made choices strictly as 'price conscious consumers' we would reasonably expect strategic behaviour, particularly from those who were heavy water users. The fact that variables like income, age and the cost of the previous water bill were not significant lends some support to the view that respondents considered the problem from a 'citizen's' perspective.

Regardless of the mode by which respondents made a choice, the data provide unequivocal evidence that urban water customers in North-East Victoria would prefer tariff structures that embody a lower access charge and a higher volumetric charge. In addition, the data indicate that this preference is strongest within those communities that presently face fixed wastewater tariffs. On the basis of this information it could be argued that consumers see merit in moving towards a volumetric wastewater charge, since this provides a *defacto* mechanism for increasing household control/choice.

The fact that the interaction term that encapsulated the households rating of their water knowledge proved significant when interacted with a number of attributes in the models should not be overlooked from a policy perspective. These results suggest that any move towards greater volumetric tariffs and smaller access charges is likely to be more willingly received by customers if they are simultaneously given the capacity to enhance their water knowledge.

VII Concluding Remarks

The current structure of water and wastewater tariffs embody many inconsistencies and trade-offs. We have argued that the present emphasis on access or fixed charges is inconsistent with economic theory and provides little incentive for households to adopt strategies that limit their use of water. Arguably, it might come as no surprise that water utilities are forced to revert to mandated water restrictions, in part, because of the inability of tariff structures to send appropriate behavioural signals to water consumers. Nevertheless, access charges do provide revenue stability for water utilities and it is this argument that appears to have held sway with regulators.

A confounding problem is the manner in which wastewater tariffs are structured. Volumetric tariffs in this context provide increased incentives to reduce water use, although they also embody inefficiencies insomuch as they must be assumed on the basis of water consumption because of the lack of metering technology.

In the absence of any compelling theoretical arguments to resolve these matters the preferences of consumers were investigated using a choice modelling technique. The results from the choice models show a clear preference from consumers to switch to higher volumetric charges and lower access charges. These preferences were strongest for respondents who reside in communities that presently face a fixed wastewater tariff and amongst those who rated their own knowledge of water use highly. Accordingly, these data provide support for policies that amend tariffs in line with consumer preferences.

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