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Matching customers' preferences for tariff reform with managers' appetite for change: The case of volumetric-only tariffs in Australia*

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At the height of the Millennium Drought in Australia, there was unprecedented interest in the role of demand-side management in the urban water sector. Conservation tariffs, where water users pay significantly less by reducing consumption, were mooted in some policy circles, although they were never seriously trialled. The easing of the drought was also accompanied by a new era of economic regulation, where monopoly water suppliers are increasingly encouraged to deliver services valued by customers. This trend has been embraced in Victoria, where the Essential Services Commission effectively rewards water businesses that match their services against customer expectations. This article explores whether customers and business managers hold similar priorities for water services by using a Best-Worst Scaling experiment. The experiment includes a conservation tariff, and findings suggest that customers enjoy relatively higher utility from these tariffs, sustainability, water restrictions and small-scale projects compared to the services emphasised by managers. The study exposes the general difficulty of water businesses matching their customers' preferences, especially if there is heterogeneity in preferences and given businesses must simultaneously deliver on many other fronts.

Key words: best-worst scaling, customers, latent class analysis, preferences, regulation, tariff reform, water pricing.

1. Introduction

Water pricing remains a contentious topic worldwide, especially as prices are often used to achieve competing ends like efficiency, affordability, equity, cost recovery, utility sustainability and resource conservation. Much of the water

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pricing literature has centred on the design criteria water utilities should use to achieve a given outcome (e.g. Griffin 2006) or the different options for addressing regulatory objectives. Whether end users agree with the tariff design they ultimately confront is another matter entirely and one which has received relatively little attention.

At a practical level, the limited understanding of water users' preferences for different tariffs is also at odds with the direction of regulatory thinking, at least in parts of Europe and Australia where water users are increasingly regarded as customers with unique preferences that should be met by suppliers (Littlechild and Mountain, 2015; Essential Services Commission 2019). In an environment where customers' preferences matter, questions arise about how the water utilities enumerate and forecast customers' preferences. This is especially challenging in a sector where governments' and regulators' preferences have been at the fore – relatively little historical data are on hand where customers faced a real choice, especially around charging regimes. Moreover, questions arise about the extent to which managers of water utilities might be able to now align the ambitions of water businesses with the preferences of customers.

In this paper, we investigate the capacity of managers within water utilities in Victoria, Australia, to meet the preferences of customers. We give specific attention to the preferences for a water tariff that rewards conservation behaviour on the part of customers (henceforth referred to as a conservation tariff or a volumetric-only tariff). The motivation for the research is twofold. First, the recent trend in the economic regulation of water utilities sets out to reward water businesses for matching customer preferences and we thus seek to expose potential challenges with this approach. Second, we explore how segments of customers might hold preferences that vary around a conservation tariff, given that earlier efforts to gain support for this pricing arrangement in Melbourne proved problematic.[1] Here we draw attention to the difficulties of meeting heterogenous preferences for urban water use. Our overall aim is to encourage discussion about the need to balance the desire to meet water customers' preferences with the numerous other expectations placed on water utilities.

The paper itself comprises five additional parts. In part two we provide a synopsis of the context by briefly reviewing water pricing principles and current trends in economic regulation of the urban water sector. Part three provides a short description of the theoretical and methodological considerations, and part four outlines the data gathering approach and offers a broad description of the assembled data. In section five, results are presented

[1] Initial enthusiasm for a conservation tariff witnessed at the height of the Millennium drought rapidly dissipated when the drought broke, even though this should have coincided with greater enthusiasm on the part of customers given wet periods would realise the greatest monetary saving to customers.

using count data and latent class clustering and in section six key findings and brief concluding remarks are offered.

2. Water pricing and the regulatory context

2.1 Pricing water

The cost structure of water businesses means that most are natural monopolies with large up-front capital costs and network effects, making it difficult for new entrants to gain market share. There is extensive literature on the appropriate way to recover costs for regulated water monopolies, with two-part tariffs featuring prominently in that discourse (Griffin 2001; Spang 2014). One interpretation of two-part tariffs is that the volumetric charge is set to return the marginal cost of supply and the fixed charge is then calculated as the residual revenues required to cover the shortfall that is needed to meet the costs of the business remaining viable, while providing incremental augmentation. In practice, the ratio of the portion of revenue collected as a variable charge versus a fixed charge is subject to a range of factors. In some cases, the split between variable and fixed revenues is arbitrarily assigned or chosen on the basis of the risk appetite of the firm – the greater the reliance on volumetric revenues, the more variable the firm's total revenue, given this component is heavily weather dependent. The extent to which a government-owned business wishes to send a 'conservation signal' more generally can also influence this ratio, as can instances where customers express a desire to have more 'control' over their water bills. Obviously, a 100 per cent volumetric tariff provides greatest reward to conservative water use and maximises the customers' control of bills but can also represent a serious risk to water businesses.

2.2 Regulation of water prices in Victoria, Australia

The data for this study were collected in Melbourne, the capital city in the state of Victoria in Australia. The framework for economic regulation of water businesses in Victoria, including price regulation, is set by a Water Industry Regulatory Order, which is made under the Water Industry Act 1994. The Water Industry Regulatory Order enables the Essential Services Commission to specify standards and conditions in relation to water services and supply. The Essential Services Commission has historically performed this role by reviewing and approving retailers' five-year water plans and monitoring water businesses' performance (Consumer Action Law Centre 2007). In 2015, following adjustments to the Water Industry Regulatory Order, the Essential Services Commission commenced a discussion with the sector in Victoria about modifying its regulatory approach (Essential Services Commission 2016).

Particularly influential in this context was Stephen Littlechild, a noted regulatory expert based in the UK. Littlechild (2014) and Littlechild and Mountain (2015) had raised concerns about the relative costs and benefits of the traditional regulatory approach (i.e. building block[2]). Littlechild argued that the costs of regulation had grown and the adversarial approach that had developed between regulators and businesses was not always in the best interest of customers. Moreover, customers' preferences were supplanted by the regulator's and this was adding unnecessary costs and inefficiencies. Littlechild favoured a move away from regulators setting a revenue requirement based solely on long run marginal cost, and a shift to putting customers and their preferences at the centre of the process (Littlechild and Mountain, 2015). This broad trend resonated with the Essential Services Commission, and over the period 2016–2017, a new regulatory approach emerged that was subsequently deployed to shape Victorian water business plans commencing in 2018 (Essential Services commissions 2019).

Under the new arrangement, it is impossible for businesses to prepare price submissions without having meaningful engagement with customers. Customer engagement goes beyond just having a chat with end users. As stated by the Chair of the Essential Services Commission, the principle of the new approach is based on the assumption that 'only customers know their preferences. Just as occurs in other markets, service providers in the water industry must also endeavour to discover those preferences, and then, they must seek to align their outputs with those preferences in order to achieve the most socially efficient outcome possible' (Essential Services Commission 2016).[3]

The new approach allows businesses to decide on the services to be delivered to customers and the price configuration to be paid, but only in consultation with customers. In order to encourage water businesses to adopt this approach, the rate-of-return is linked to the ambition evident in the pricing proposal; for example, higher rates of return are afforded to novel and customer-oriented services. The revenue requirement for businesses continues to be calculated using the building-block methodology; however, water businesses that produce a water plan that specifically appeals to the Commission's Performance, Risk, Engagement, Management and Outcomes (PREMO) framework are rewarded inasmuch as those plans that are adjudged 'better' permit the business to apply a higher rate of return. This approach was first used in the 2018 water price submissions. Accordingly, a single Weighted Average Cost of Capital was not applied to every water business. Rather, the return to equity for each business was linked to the

[2] The building block approach involves calculating the maximum allowable revenue to be collected by a regulated entity by summing the cost of capital, depreciation, other efficient operating expenditures, financial incentive mechanisms (positive or negative) and taxation.

[3] In addition to encouragement from the ESC, water retailers arguably have a range of other incentives for offering the preferred services of customers, such as reductions in payment default and enhanced customer satisfaction that flows over to a preparedness to pay for other services (e.g. Donkar 2013; Homburg *et al*., 2005).

Water business self-assessment

ESC assessment of submission	Leading	Advanced	Standard	Basic
Leading	5.3			
Advanced	4.7	4.9		
Standard	4.1	4.3	4.5	
Basic			3.9	4.1

Figure 1 Indicative regulated return on equity (real).

outcome they sought to deliver to their customers, as illustrated in Figure 1. At the conclusion of the review of water plans in 2018, only three metropolitan water retailers of the fourteen eligible were awarded 'advanced' standing through the PREMO rankings (Essential Services Commission 2019). In some instances, these 'advanced' businesses made a commitment to introduce conservation tariffs but the extent to which this was based on empirical assessment of customer preferences cannot be adjudged.

3. A method and analytical approach for contemplating how managers' and customers' preferences might coalesce or differ

Given the complexity of individual decision-making and the new interest in water users as customers with unique preferences, some form of multi-variate method can assist in the analysis. Discrete choice analysis has been widely used to study preferences in education (Soutar and Turner 2002), transport, health (Louviere and Flynn 2010), environmental issues (Alriksson and Öberg 2008) and food industry (Erdem *et al.*, 2012).

3.1 Best-Worst Scaling

Best-Worst Scaling (BWS) is a form of discrete choice analysis that was introduced by Louviere and Woodworth (1990) and Finn and Louviere (1992) to overcome some of the limitations of scaling techniques and to also elicit additional preference information per choice task. This method is a special type of discrete choice analysis in which respondents are asked to choose their most and least preferred alternative. In this instance, we sought to use the BWS technique to identify the services most sought by customers of a water utility, including the relative importance of a specific tariff. Simultaneously, we sought to compare the rating of different services by managers from the overall perspective of the water businesses that employed them.

Researchers use the ‘Case one’ BWS when they are interested in eliciting the relative weight or importance that respondents allocate to items in a set. The objects can be brands, products or policy goals (Hess and Daly 2014). In this case, researchers are interested in finding the degree of concern for each object relative to others and this approach is suitable for this analysis.[4]

Another step in conducting a BWS is to decide on the experimental design and determine how many choice sets are required. Although Balanced Incomplete Block Designs (BIBD) are available, there is no guarantee that, given the number of items in the design, that one can be generated with a small enough number of choice sets that can be answered by a respondent. The merits of different designs are discussed in detail by (Flynn and Marley 2014). In this instance, a programming-based algorithm developed within Sawtooth was used to generate the optimal design. The system developed in Sawtooth uses a cyclical algorithm that repeats the process 1,000 separate times to choose an efficient fraction of the total possible combination of items. This programming-based algorithm chooses a design that satisfies the criteria of frequency balance, orthogonality, connectivity and positional balance (Sawtooth Software Inc, 2013).

Several areas of concern exist in the application of BWS and some are briefly identified by (Louviere *et al.*, 2013). Giergiczny *et al.* (2014) specifically argue that the ‘best’ is unlikely to be the inverse of the ‘worst’; however, Louviere *et al.* (2015) offer a test to verify this assumption. The usual caveats to any stated preference approach also apply (see, for instance, Hensher *et al.* 2005).

3.2 Analytical approaches and model specifications

Prior research suggests that there are alternative, but acceptable, methods for analysing BWS data. At the more straight-forward end of the spectrum, Louviere *et al.* (2015) argue that simple frequency counts can offer useful insight into the processes used to make choices. At the more sophisticated end of the spectrum, logistic models can be used to measure the probability of choosing each item.[5] There are also methods for accommodating individual unobserved heterogeneity, like the latent class clustering approach.

The primary and most frequent way of analysing BWS choice data merely involves counting the number of instances in which a best and worst choice aligns with each choice object (see, Umberger *et al.*, 2010; Flynn *et al.*, 2015; Lockshin and Cohen 2015; Louviere *et al.*, 2015). A simple ranking of the relative importance of each item can be obtained by subtracting the ‘least preferred’ count from the ‘most preferred’ count for each object and ordering

[4] See McIntosh and Louviere in (2002) for a description of case two and Flynn and Marley (2014) for a description of case three.

[5] For completeness, a mixed logit comparison of customer and manager preferences is included in Appendix S1.

the objects accordingly. The average score is calculated by dividing the most and least preferred choice M-L count (M-L score) by the number of respondents. The number is then normalised by dividing the average score by the total availability of each item. The larger the M-L score, the more preferred the service item.

Latent class clustering approaches are particularly useful for shedding light on heterogeneity. Previously, the cluster approach used traditional techniques such as K-Means and two-step clustering to identify segments by minimising cluster variances within each segment and maximising the variation across clusters. However, latent class analysis is a model-based clustering approach, which assumes that each respondent is a member of a latent class that has an unknown size, a priori, and it involves estimating the probability of class membership using model parameters and observed individual measures (Vermunt and Magidson 2008). The probabilities can be used for predicting and explaining differences in preferences or utilities which cannot be directly observed (Meghani *et al.*, 2009). When using the maximum likelihood method for parameter estimation, the clustering problem involves maximising a log-likelihood function. This technique minimises the within-cluster variation and/or maximising the between-cluster variation.

The latent class clustering approach allows for simultaneous examination of several indicator (dependent) variables, such as utilities for several service items, as well as allowing for the inclusion of covariates to identify predictors of class membership. Covariates not only influence class membership but also have direct effects on the cluster-specific mean. This technique is referred to as the 'active covariate' technique in the latent class clustering approach. Haughton *et al.* (2009) note that an active covariate will help to explain classes and improve classification. For example, in this study, we cannot directly observe an individual customer's utility for a specific service item, but by using BWS we can measure the importance of each service item to individual respondents. If respondents are heterogeneous in their ratings of different service items, then unique latent classes should exist (Meghani *et al.*, 2009).

4. Overview of data gathering and descriptive analysis

4.1 Item development

Iterative steps were employed to manage the inherent trade-offs with an experiment of this form. Customers were initially interviewed to generate a list of services sought by water users and the nomenclature describing these services was progressively refined through follow-up group sessions. A total of sixteen hour-long sessions were conducted across customers with participants recruited from community groups in metropolitan Melbourne. The discussion in these sessions was open-ended but structured around questions designed to elicit 'ideal' services provided by a water supplier. The latter of these sessions yielded very little new information and the process was thus paused. Simultaneously, fifteen managers within the water retail businesses were interviewed, with participants recruited through industry contacts involved in water planning and pricing. Group sessions were not arranged for managers, but the list of service items suggested by them was reviewed for completeness by a small group of managers at SA Water.

All items were also checked against existing research in the refereed and sector-relevant grey literature. For instance, 'delivering uninterrupted and high-quality water and sewerage service' is noted as a service expectation in corporate documentation by SA Water (2014) and City West Water (2017), and it is similarly cited in peer reviewed outlets (Zhang & Brown, 2005). This provided some surety that the items were pertinent to the case at hand and were comprehensive. Surveys were subsequently piloted using a paper-based format to gain feedback; an initial online pilot was run to generate prior estimates of parameters and a final design was then developed.

Table 1 shows the list of twelve items ultimately presented to participants in a BWS format. The second column offers an indicative domain for each service, as categorised using the results of qualitative research conducted among customers living in Melbourne and also using reports published by water retailers on customer objectives (see, Essential Service Commission, 2017). These domains show the spread of interests held by customers. Each attribute can be traced to one of the five broad domains, but our main focus was on the items and specifically how a conservation tariff was ranked relative to others. It needs to be conceded that this approach could potentially result in some cognitive weighting by respondents; for example, assigning a large number of items to a given domain might dilute the weight assigned to a specific item. Nonetheless, in the interests of parsimony a decision was made to rely on those items most consistently described by customers rather than add or delete items to achieve balance against domains. The study was also premised on the notion that managers seek to prioritise the functioning of water businesses to deliver the items most preferred by customers.

A BIBD for 12 items is available, but has 22 choice sets, each with 6 items. As 22 was deemed too large, the alternative approach of producing a design with smaller set size, but multiple blocks, outlined in Sawtooth Software Inc (2013), was used. Ten versions (blocks) were generated with the intention that each version would be sequentially assigned to survey participants. The algorithm, in this case, generated a balanced design, all items showing four times to each participant within their block of 12 questions, each question containing 4 items and all items equally paired. Although presentation of items was not specifically randomised within each set, the fact that a large number of blocks was used, accompanied by the requirement to achieve pairing across all items meant that the item order necessarily varied for respondents. An example of these BWS questions is presented below in Figure 2.

Table 1 List of service expectations placed on water retailers

Service items	Domain
Delivering uninterrupted and high-quality water and sewerage service (e.g. ensuring delivery of the core service despite population growth and climate change)	Conventional service
Being proactive and not reactive with large scale projects (e.g. having a long-term perspective with minimum political intervention for large assets such as desalination and recycled water)	Conventional service
Focusing on small scale and decentralised solutions (e.g. more regular maintenance to prevent burst pipes and leaks, harvesting storm water)	Conventional service
Dealing with customer enquiries and complaints, resolving them to the satisfaction of customers (e.g. providing swifter responses with friendly personnel)	Communication and customer service
Providing personalised support tailored to customers' needs (e.g. offering an instalment option and payment options, providing customised advice on saving water)	Communication and customer service
Having more interactive communication with customers (e.g. engaging in community events, having a help desk at local shopping centres, etc.)	Communication and customer service
Keeping the price affordable and stable (e.g. ensuring water bills do not rise faster than inflation)	Charging
Offering an alternative breakdown of water charges with a smaller fixed charge and larger usage charge (e.g. providing zero fixed charge with the bill based only on water consumption)	Charging
Continuing mandatory water saving programs (e.g. water restrictions)	Mandatory demand management strategies
Investing in renewable energy and carbon emission reductions (e.g. being environmentally conscious, using renewable energy in water supply systems)	Sustainability
Being innovative and offering contemporary services (e.g. installing digital meters, setting up a mobile app to check daily usage)	Other
Collaboration with external authorities to deliver a liveable city (e.g. working with other retailers, Councils, Park Victoria, cultural representatives)	Other

Source: Interview of customers and managers.

4.2 Survey structure, deployment and administration

The survey of customers was administered online using the Qualtrics survey system in June 2018, and participants were offered a small financial inducement to complete the survey. The survey was sent to 1260 customers living in the Melbourne metropolitan area. To qualify for the survey, participants had to be 18 or above and (co)-responsible for paying water bills. A total of 469 recipients who did not qualify for the survey were automatically screened out. The completion rate was 35.7 per cent of those that were eligible, and a small number of duplicate responses were subsequently deleted resulting in 267 usable responses. We exploited the capability of the online environment by placing interactive tools including videos and images throughout the survey. Attention-check questions were also employed to test the accuracy of responses.

1. Please choose your most preferred and least preferred service from your water provider

Least Preferred		Most Preferred
○	Dealing with customers enquiries and complaints, resolving satisfaction of customers (e.g. swifter response with friendly personnel)	○
○	Delivering uninterrupted and high-quality water and sewerage service (e.g. ensure delivery of the core service despite population growth and climate change)	○
○	Focusing on small and decentralized solutions (e.g. more regular maintenance to prevent burst and leaks, harvesting storm water)	○
○	Be proactive and not reactive with large scale projects (e.g. having long-term perspective with minimum political intervention on large assets such as desalination and recycled water)	○

Figure 2 Example of BWS questions.

The customer survey comprised three parts. In Part A, questions were framed to elicit socio-demographic information including age, education level, gender, dwelling type, number of persons in the household, tenure, whether the participants had a garden and whether they maintained it, whether they owned an outdoor pool and whether they used any non-mains sources of water. Part B investigated how customers ranked the various expectations they have of their ideal service providers. This comprised a BWS exercise of 12 questions. Part C of the survey contained questions evaluating opinions on environmental issues, the seriousness of droughts, water prices and water rate structures. Questions in this part of the survey used a five-point Likert scale format. To measure respondents' attitude towards the environment, the New Environmental Paradigm (NEP) scale and to measure attitude towards switching, the scale adopted by Bansal *et al*. (2005) was applied. A scale to measure attitude towards conservation was taken from Gilbertson *et al*. (2011). Other attitudinal statements in the survey were drawn from interviews and focus group analysis.

The sample frame comprised respondents from four urban water retailers, and the customer data is representative in terms of corresponding water retailer and gender. However, there are significant differences between the age, highest education level, income and rate of housing ownership of the sampled population versus the population of Melbourne. Some response bias was expected considering the online platform adopted for the survey delivery, as research shows that people with lower incomes and lower education levels, and older age groups, are underrepresented on online panels (Fleming and Cook 2007).

The comparison survey of managers involved personnel from all four of the Melbourne water retailers. To be eligible, participants needed to hold a senior management role. In Part A of the managers' survey, respondents were asked questions about their age, education, area of expertise and number of years' experience in the water industry. In Part B, respondents were presented with a BWS experiment similar to that presented in the customers' survey. The only change was the replacement of the phrase 'most and least preferred' with 'least and most important', as we sought managers' opinions regarding business interests and not their individual preferences. Care was taken to stress that the survey was not seeking managers' perception of the preferences of customers, but business priorities. Also, to test the tendency of water retailers to accommodate the preferences of the economic regulator, an additional question was added to the managers' survey. In this question, the managers were asked to choose the three most important and three least important service expectations of the economic regulator. The survey finished with some questions asking for general feedback.

The managers' survey was conducted using snowball sampling where a survey invitation was sent out to key managers at the four water retailers in Melbourne, who subsequently distributed the survey link within their organisations to those who were adjudged as meeting the selection criteria. There is some disadvantage associated with this technique. For instance, the researcher has little control over the sampling and representativeness of the sample is not guaranteed. However, snowball sampling is popular and pragmatic when conducting surveys with experts in a certain field such as medicine, health studies (Weng *et al.*, 2008) and water management research (see, Cooper *et al.*, 2017).

The exact participation rate is therefore not clear, as the survey link was sent out by multiple sources. A reminder was distributed every two weeks to improve participation rates. The survey link was open for 2 months and 31 responses were received. What stands out from the participants in the managers' survey is that the majority of respondents are male and engineering was the most common disciplinary background. In addition, about 65 per cent of managers were aged between 25 and 49 and the majority of respondents have more than five years of experience in the water industry.

5. Results

5.1 Differences between customers and managers

One key assumption underpinning BWS analysis is regarding the decision rule that individuals use to select the most preferred and least preferred items. In this study, we assumed that individuals will consider all possible pairs simultaneously to select their most preferred and least preferred items and

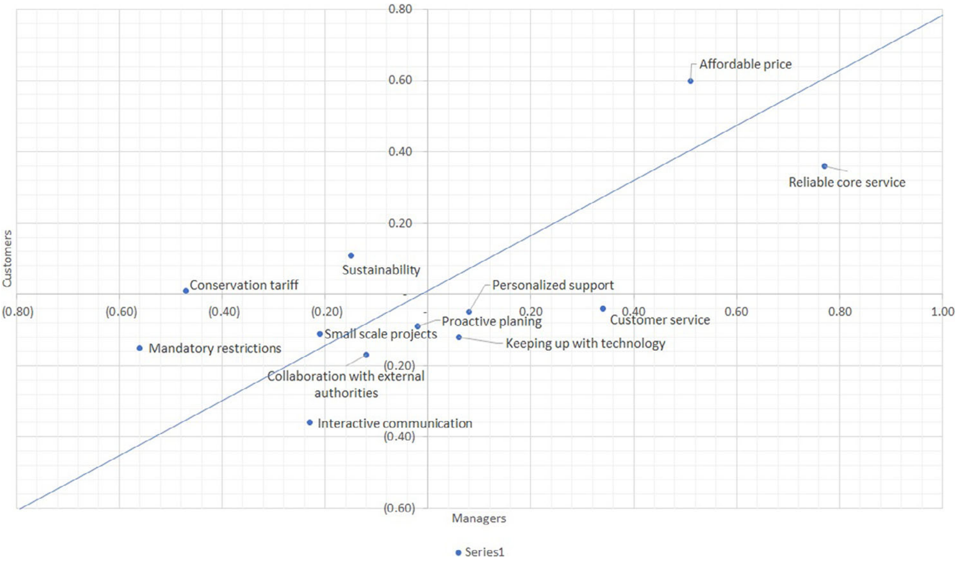

Figure 3 Comparison between customers and managers preferences. [Colour figure can be viewed at wileyonlinelibrary.com]

thus make deterministic choices.[6] Louviere *et al*. (2015) suggest a test to verify this MaxDiff assumption. This begins by displaying the most and least preferred choices at sample level, and then calculating the square root of the M-L score and the natural log of the ratio. If most count = 1/least counts, then the M-L score should be proportional to the log of square root ratio[7] of Most/Least, which is represented by Ln(SQRT) (Louviere *et al*., 2015). The results generated for both customer and manager samples support the view that both groups behaved deterministically. This result is presented in Appendix S2.

Data were subsequently analysed using a range of methods, but we report results using count data and latent class clustering here.[8] Researchers have suggested different techniques to estimate individual-level scores and produce high-quality results, including counting M-L scores, individual-level logits and Hierarchical Bayes scores. However, previous studies reveal that replacing a simple count with a more sophisticated technique such as Conditional logit, Mixed logit, Hierarchical Bayes only improves the model slightly, and that the correlation between these three measures is almost linear (Marley and Louviere 2005; Orme 2009). In the interests of parsimony, we thus opt to use the individual count scores in the remainder of the paper. Figure 3 provides a comparison of the normalised counts for customers and managers.

[6] This assumption referred to MaxDiff assumption.
[7] Ln(SQRT).
[8] To reiterate, mixed logit analysis is provided in Appendix S1.

The difference in relative importance allocated to each service item was explored further by testing the hypothesis that customers and managers have the same allocation of importance for different service items. The null hypothesis here is that the mean of each group's preferences for each service item will be similar. In order to test the hypothesis, the individual-level score was required.

In order to choose the appropriate test for a comparison between the two groups of stakeholders, we conducted a normality test on the sample. The results of the test are presented in Table 2. According to the Kolmogorov–Smirnov and Shapiro–Wilk tests, only managers' responses for items 10 and 12

Table 2 Test of normality

	Kolmogorov-Smirnov†			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
BWS 1						
Customer	0.145	267	0.000	.939	267	.000
Manager	0.281	31	0.000	.800	31	.000
BWS 2						
Customer	0.136	267	0.000	.956	267	.000
Manager	0.229	31	0.000	.873	31	.002
BWS 3						
Customer	0.236	267	0.000	.828	267	.000
Manager	0.204	31	0.002	.846	31	.000
BWS 4						
Customer	0.128	267	0.000	.967	267	.000
Manager	0.227	31	0.000	.844	31	.000
BWS 5						
Customer	0.129	267	0.000	.964	267	.000
Manager	0.165	31	0.031	.959	31	.280
BWS 6						
Customer	0.168	267	0.000	.951	267	.000
Manager	0.229	31	0.000	.891	31	.004
BWS 7						
Customer	0.105	267	0.000	.962	267	.000
Manager	0.222	31	0.000	.825	31	.000
BWS 8						
Customer	0.128	267	0.000	.965	267	.000
Manager	0.189	31	0.006	.941	31	.087
BWS 9						
Customer	0.131	267	0.000	.960	267	.000
Manager	0.203	31	0.002	.926	31	.033
BWS 10						
Customer	0.126	267	0.000	.947	267	.000
Manager	0.102	31	0.200	.958	31	.259
BWS 11						
Customer	0.126	267	0.000	.961	267	.000
Manager	0.169	31	0.024	.955	31	.214
BWS 12						
Customer	0.129	267	0.000	.961	267	.000
Manager	0.137	31	0.147	.966	31	.424

Note: BWS refers to Best-Worst Scale for each item in the survey.
†Lilliefors Significance Correction.

Table 3 Wilcoxon–Mann–Whitney *U*-test statistics to compare means of two groups

	BWS 1	BWS 2	BWS 3	BWS 4	BWS 5	BWS 6	BWS 7	BWS 8	BWS 9	BWS 10	BWS 11	BWS 12
Mann–Whitney *U*-test	1901	1817	3777	1747	3872	3450	2110	3331	2835	3509	3266	3950
Wilcoxon W	37679	37595	4273	2243	39650	3946	2606	39109	3331	39287	39044	39728
Z	−5.00	−5.22	−0.83	−5.33	−0.60	−1.56	−4.52	−1.81	−2.91	−1.41	−1.95	−0.42
Asymp. Sig	0.00***	0.00***	0.41	0.00***	0.55	0.12	0.00***	0.07*	0.00***	0.16	0.05**	0.67

***Indicates significance at the 1 per cent level.
**Indicates significance at the 5 per cent level.
*Indicates significance at the 10 per cent level.

were normally distributed and we opt to use the Wilcoxon–Mann–Whitney U-test, which is a distribution-free test (Bruin 2011; Neuhäuser 2011).

The results of the Wilcoxon–Mann–Whitney U-test are reported in Table 3. The table illustrates that customers and managers differ significantly in their views regarding seven of the twelve service items. These items are *reliable core service*; *customer service*; *conservation tariff*; *mandatory restrictions*; *personalised support*; *sustainability*; and *keeping up with technology*. However, both groups of stakeholders allocated the same level of importance to *affordable price*, *proactive planning*, investing in *small-scale projects*, *interactive communication* and *collaboration with external authorities*.

In terms of offering a conservation tariff (volumetric tariff), customers show more enthusiasm than managers, although heterogeneity within customers would likely restrict universal acceptance of a tariff change where it offered.

5.2 Latent class clustering analysis of customer heterogeneity

One of the objectives of this research is to determine whether customers are heterogeneous in their preferences, particularly conservation tariffs, and identify factors explaining different customer groups with diverse preferences. A latent class clustering analysis[9] was used to determine the number of customer clusters and their form. This technique has been previously adopted for similar purposes in water irrigation research (Cooper *et al.*, 2018), food studies (for instance, Umberger *et al.*, 2010) and wine industry analysis (Lockshin and Cohen 2015).

The twelve M-L scores generated for 267 respondents were used as the indicators of clusters. M-L scores are used as dependent variables to predict an individual's unique membership in a specific latent class. It is assumed that observed preferences are homogenous within clusters and heterogeneous across clusters. The first step was to identify the number of clusters by assessing the degree of improvement in explanatory power, adjusted by degrees of freedom. The most common criteria used to determine this are the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). We estimated the model using one, two, three and four clusters to evaluate which model had the best overall fit. Based on the information criteria and particularly the BIC numbers, Model 3 (with three clusters, in Table 4) had the lowest BIC, and lower Npar which represents the number of parameters in the model compared to Model 4 (see Table 4). Therefore, Model 3 was considered to have the best fit with the sample. A summary of the model statistics is presented in Table 4.

Parameter estimates using Model 3 appear in Table 5. For cluster models, the most important betas are those ones that indicate the strength of the effects of the clusters on the indicators (Vermunt and Magidson, 2008).

[9] *Latent GOLD 5.1 program is used.*

Table 4 Comparisons of latent class analysis models

		LL	BIC (LL)	AIC (LL)	Npar
Model 1	1 Cluster	−6085.80	12696.80	12359.61	94
Model 2	2 Clusters	−6033.88	12665.59	12281.76	107
Model 3	3 Clusters	−5991.22	**12652.92**	**12222.45**	120
Model 4	4 Clusters	−5962.72	12668.55	12191.44	133

Note: N_{par}, Number of parameters.
Significant at 5 per cent level.

Table 5 Parameter estimation of indicators for each cluster (3-cluster solution)

Service items	Cluster 1	Cluster 2	Cluster 3	Wald	*P*-value	R^2
	Parameter estimations					
Reliable core service***	0.15	0.34	−0.49	36.17	0.00	22%
Customer service***	−0.26	0.18	0.08	15.23	0.00	8%
Affordable price***	−0.02	0.55	−0.53	43.46	0.00	28%
Conservation tariff***	−0.11	0.22	−0.12	12.60	0.00	7%
Proactive planning***	0.18	−0.18	−0.00	12.51	0.00	6%
Small-scale projects*	−0.13	0.11	0.02	4.34	0.11	2%
Mandatory restrictions***	0.00	−0.32	0.31	31.36	0.00	16%
Personalised support***	−0.19	0.06	0.13	11.29	0.00	5%
Sustainability***	0.52	−0.38	−0.15	45.41	0.00	32%
Interactive communication***	−0.35	−0.15	0.50	33.49	0.00	21%
Keeping up with technology*	−0.11	0.02	0.09	4.37	0.11	2%
Collaboration with external authorities***	0.10	−0.28	0.18	15.13	0.00	8%

***Indicates significance at the 1 per cent level.
**Indicates significance at the 5 per cent level.
*Indicates significance at the 10 per cent level.

For most indicators, the *P*-value is shown to be less than 0.05, indicating that the null hypothesis (which states that all effects associated with that indicator are zero) is rejected. Thus, for most indicators, knowledge of the response for that indicator contributes in a statistically significant way to the ability to discriminate between the clusters. Ten indicators had significant values, suggesting that those indicators were able to discriminate between clusters. Investing in small-scale projects and using technical solutions were insignificant indicators in this model.

The latent class cluster analysis revealed three distinct clusters of customers, each with different demographic characteristics, attitudes and preferences. The profile of each cluster, containing the mean score for each item, is presented in Table 6. Latent Gold reports the conditional probabilities for each indicator as well as the mean score for each item. Comparing the mean score for each service item within the clusters will help to describe the clusters and possibly name them. One property that all clusters had in common was their relative preferences for *affordable price*. This item appeared to be the most preferred item across all three clusters. However, the extent of its importance varied between clusters.

Table 6 Clusters profile (mean scores)

	Cluster 1	Cluster 2	Cluster 3
Cluster Size	44%	34%	22%
Service items	Cluster 1	Cluster 2	Cluster 3
Reliable core service	1.71	2.14	−0.10
Customer service	−0.62	0.27	0.07
Affordable price	2.48	3.41	0.83
Conservation tariff	−0.27	0.77	−0.30
Proactive planning	0.07	−0.87	−0.41
Small-scale projects	−0.69	−0.23	−0.41
Mandatory restrictions	−0.50	−1.54	0.63
Personalised support	−0.61	0.09	0.27
Sustainability	1.69	−0.81	−0.15
Interactive communication	−2.04	−1.57	−0.03
Keeping up with technology	−0.77	−0.39	−0.15
Collaboration with external authorities	−0.41	−1.25	−0.24

Cluster 1, which is the largest cluster, contained 44 per cent of participants. This cluster was very similar to the sample average with respect to ranking of preferences for different service items. It placed the highest priority on *affordable price*, rather than on receiving a reliable water supply. The next most preferred items for members of this cluster were *sustainability* and *proactive planning* for large scale projects.

Cluster 2 contained approximately 34 per cent of participants. Like Cluster 1, this group's most preferred items were *affordable price* and *reliable water supply*. However, this group placed a higher priority on *conservation tariffs* and *customer service*. It had the highest score for *affordable price* and *reliable service*, suggesting that members of this group expect water businesses to focus more on delivering their core business at an affordable price with good customer service.

Given the parameter estimates in Table 6, conservation tariffs, which are a focus of this study, are most likely to be supported by members of Cluster 2 (0.22) and least likely to be supported by Cluster 1 (−0.10). However, using technological solutions, such as digital meters, was not significant in terms of identifying distinct clusters. This item appeared to be the second least important item for Cluster 1; however, respondents in Clusters 2 and 3 did not express a strong preference regarding this item.

A comparison of responses in the 3-cluster model is presented in Figure 4.

5.3 Interactions of respondents' socio-demographic and psychographic characteristics

Respondents' characteristics were included as an active covariate to test the hypothesis that groups with different characteristics have the same probabilities of being in each class. These covariates represented the differences between the clusters, helping to explain the latent classes and improve the clustering (Haughton *et al.*, 2009). As indicated earlier, the survey also

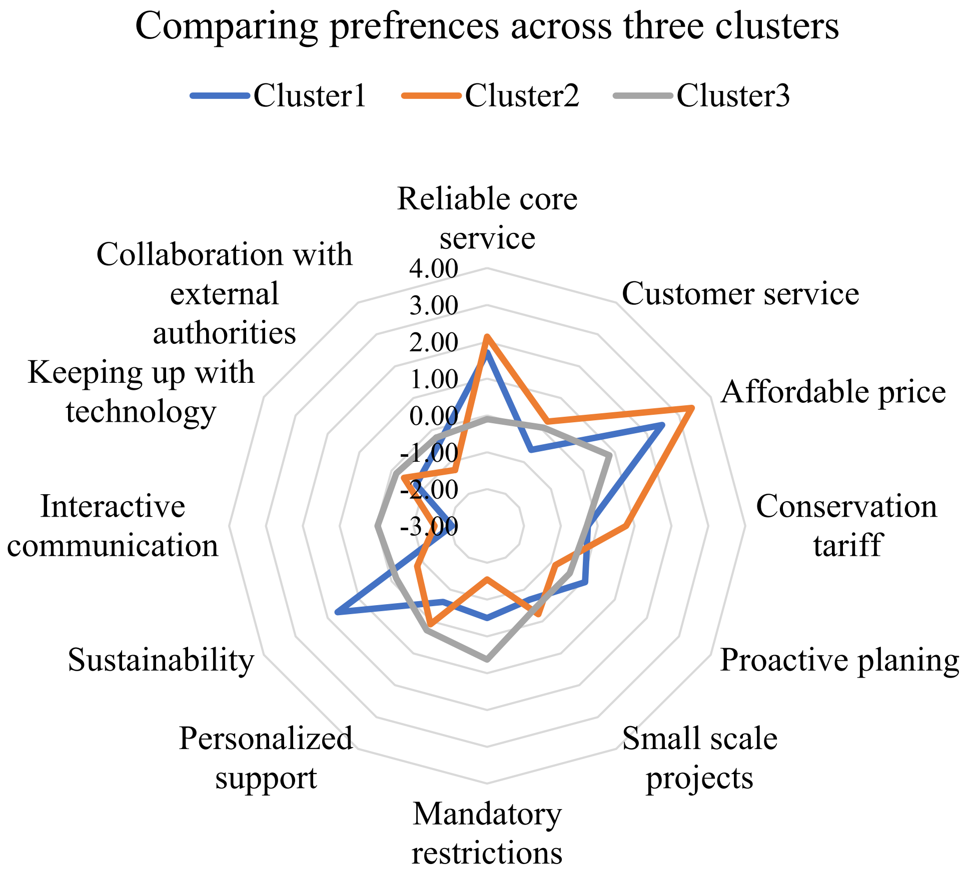

Figure 4 Relative importance of preferences across three clusters. [Colour figure can be viewed at wileyonlinelibrary.com]

contained 34 attitudinal items adopted from previous studies and from the earlier interviews. After conducting an exploratory factor analysis five factors emerged comprising perception of water charges breakdown, (Cronbach Alpha = 0.87); attitude towards conservation, (0.78); understanding of the bill, (0.73); attitude towards switching tariffs, (0.77); attitude towards the environment generally, (0.61). The model including socio-economic and attitudinal variables is presented in Appendix S3.

Cluster 1 is characterised by individuals with a higher education and more positive attitudes towards the environment in general, relative to those in the other clusters. In contrast, cluster 2 comprises customers who are significantly older, are lower in income than the other clusters and are leasing rather than owning houses but also enjoy more access to rainwater tanks than other clusters. This group also expressed greater disquiet about the current charging regimes, but scored lowest in terms of their engagement with water issues and had relatively less understanding of water bills. Cluster 2 consumers are also significantly less enthused about switching, despite their negative perceptions about the current breakdown of charges that makes up the water bill. Finally, customers within cluster 3 are characterised by higher home ownership rates, higher incomes, more ownership of pools and gardens, greater familiarity with water issues (including charging regimes/bills) and had most access to recycled water.

Given this information, it is then possible to contemplate the plausible links between the preferences for the different services and the characteristics of cluster groups. Of particular interest is the likely uptake of the conservation tariff, given it forms part of the commitment of some of the so-called 'advanced' water plans in Victoria. An interesting conundrum emerges. What is clear is that customers having a positive attitude towards water conservation and the environment does not necessarily translate to strong support of conservation tariffs; rather, socio-demographic characteristics and attitudes towards switching can contribute to individual choices. People with higher engagement with water related topics are more likely to fall into the category that prefers command and control solutions, such as mandatory water usage restrictions. In contrast, people in cluster 1, who had relatively low utility for water restriction policies, placed a higher value on conservation tariffs.

Cluster 2 customers had greatest enthusiasm for a conservation tariff but, ironically, this group is also the least engaged and less disposed to take on switching behaviours. Thus, while a water business might offer a tariff of this form and potentially appeal to some, it may not manifest in noticeable change. Accordingly, this raises broader questions about the regulatory framework being promoted.

6. Key findings and concluding remarks

The divergence between customers' preferences and retailers' priorities for those service items might be attributed to numerous factors including the history of attempting to engender change in tariffs. This study has occurred against a backdrop of change. It commenced when water utilities in Australia were intensely interested in the utilisation of tariffs as a means of reining in water use during drought. That interest was also spurred by utilities being able to simultaneously reward customers for their water stewardship and thus potentially bolster customer satisfaction. However, the end of the drought shifted priorities and there is at least some evidence that the factors needed to encourage switching were no longer as prominent in the minds of consumers once the drought eased.

Subsequently, the economic regulator has placed a stronger emphasis on water businesses matching their service deliverables to the preferences of customers, as witnessed in the PREMO approach now in place in Victoria. This has raised the stakes for water utilities inasmuch as historically the focus has been on managing supply, and demand-side management has only been considered in the context of how it might be used to defer expensive capital upgrades or rein in consumption during drought.

The rationale for the economic regulator shifting to this new approach is probably not especially controversial. The building-block approach, where the revenue requirement for each water business is set at long run marginal cost, has likely constrained the growth of water prices and a semblance of economic efficiency has also been delivered. Its prominence in the National Water Initiative also means that the long run marginal cost approach has gained national support, with most states at least endeavouring to keep price-setting at arm's length from politics, even if this has not always been achieved. On the down side, the building-block approach has tended to stifle innovation and shield businesses from taking appropriate risks and left the regulator an unenviable but prominent role as the sole representative of customer preferences. In that context, the PREMO approach seeks to stimulate and promote innovation and potentially lower the cost of regulation while shifting the focus onto customers' real preferences.

Notwithstanding those perceived benefits, this study raises doubts about the long-term effectiveness of this new regime of regulation. This study clearly shows that customers are not homogenous and that there are likely to be very different preferences between groups – what is highly rated by some customers received a very low rating from others. How is a water business to respond to these differences?

In some industries, having customers with different preferences is not especially challenging. Even in network businesses like electricity and telecommunication, firms have managed to cater for heterogeneity. By and large, this has required firms to develop plans or bundles and then allow (or persuade) customers to adopt those that best fit their needs. In a theoretical sense, this type of product discrimination is welfare enhancing, but in a practical sense the political consequences of charging different customers different prices must be managed.

What is not clear is the extent to which these examples from other utilities can now be applied to the water industry, and several conundrums remain. First, water is still viewed as 'different' in the minds of many customers and having access to reasonable water services at an affordable price remains a focus for most. Differentiating services and offering more (less) costly options has yet to be tested, and there is at least some evidence from earlier studies that water users are loath to have differing levels of reliability across the community (Cooper *et al.*, 2014).

Second, the methods used by water businesses to understand customers' preferences are themselves under development. To the knowledge of the authors, no water business has yet sought to use a rigorous approach like BWS to shed light on preferences. Rather, most businesses have used qualitative insights gained from citizen juries and generalist surveys to inform the structure of water plans. Arguably, this leaves ample room for error on the part of water businesses, even if they have a highly rated plan endorsed by the regulator. Exploring the data presented here by using additional techniques, like latent class modelling, might offer additional insights.

Third, the supply of water remains rainfall-dependent in most parts of Australia, and this is a major point of difference with other utilities.[10] Importantly, this variability in the resource does not only influence the supply capability of water businesses, but can also influence public awareness of water scarcity. There is also at least anecdotal evidence that it has a bearing on customers' preferences and their willingness to adopt the conservation tariff. This variance raises the stakes further for water businesses.

Put simply, the regulator is effectively asking water businesses to match their current service offering to multiple customer groups, and yet the size and makeup of those groups can change with the weather. The impact on water business revenues and the long-term sustainability of utilities might be sorely tested in this environment, and this in turn could undermine political support for the new approach.

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[10] Desalination plants can decrease rainfall dependency of water supply; however, it remains only a partial source of water supply in Australia. The capacity of desalination plants ranges from 15 percent of water supply in NSW to 50 percent in SA. Moreover, it is not always the most cost-effective alternative. Design, construction and maintenance costs tend to be high and plants have often sat idle for extended periods.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. A mixed logit analysis of customer and manager preferences.
Appendix S2. Testing for participants' deterministic decision-making.
Appendix S3. Latent class clustering model.