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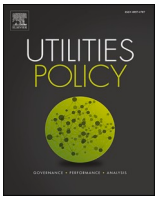

An experimental approach to measuring consumer preferences for water charges

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ABSTRACT

Regulators acting on behalf of the public need to understand the interests of the people they represent. This paper describes a collaboration with the OECD and Scotland's water industry to deploy randomised behavioural experiments to investigate preferences for water charges. In a study conducted online (n = 500) and face-to-face (n = 100), participants rated price trajectories for acceptability, where the temporal pattern, presentation, magnitude of increase and provision of aggregated information were experimentally manipulated across presentations and participants. Results showed that households dislike putting off impending price increases. The study demonstrates how behavioural experiments can support more empirically informed regulation.

1. Introduction

Regulators of monopoly industries must balance multiple priorities. In addition to specific statutory duties and accountability requirements, these generally include monitoring company performance and compliance, setting detailed industry targets to align with broader government policy objectives, and seeking value for money coupled with consumer protection. One common regulatory task is to negotiate prices and service levels in industries that are not subject to market competition. When consumers cannot express preferences for price and service through choice, their representation may become a matter for the regulator, at least within constraints set by policy. However, it may be challenging to ascertain the citizenry's views and represent them accurately.

A contemporary answer to this question is "customer engagement", which aims to understand consumers' needs, preferences and views, then factor these into business decisions. Customer engagement has become a vital aspect of regulatory decision making (Hahn et al., 2020), including in water industries (Annesi et al., 2021). Modern regulators routinely commission qualitative and quantitative research to obtain and exploit insight into what citizens want from the regulated industry, for example, by measuring consumer engagement in, comprehension of, and attitudes towards a regulated market (e.g., Walker, 2018), exploring consumer needs and preferences in relation to new regulatory policy proposals (e.g., Ofgem, 2020), or pre-testing communication materials (e.g., Martins & Moura e Sá, 2020).

The water industry in Scotland, which is the focus of the present study, has championed the role of customer engagement. Scotland's regulatory architecture for water requires that multiple actors consider and represent the preferences of Scottish households regarding their water supply, the infrastructure and systems required to deliver it, and any associated economic, environmental, and social consequences. In 2011 a "Customer Forum" was established to represent customer interests to the regulator, the Water Industry Commission for Scotland (WICS), and the publicly owned monopoly provider, Scottish Water. The Forum aims to understand and represent customer priorities via a constructive and collaborative stakeholder process. In this, it has been judged a success: Littlechild (2014) described the process as "one of the most innovative, successful and encouraging developments in UK utility regulation" (p.207).

Nevertheless, measuring and understanding citizens' preferences is hard. In recent times, behavioural economics has advanced our understanding of the mechanisms behind people's judgements and decisions. This improved understanding has not, however, made the job much

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easier. The findings of behavioural economics have uncovered many inconsistencies and biases in how people express and act on their preferences (Beshears et al., 2008; DellaVigna, 2009), meaning that some methods for measuring preferences might be misleading. This work has led to calls for empirically informed regulation that considers such phenomena (Sunstein, 2011), with behavioural and experimental methods applied directly to regulatory policy problems (Lunn, 2014). The present study contributes to these broader aims.

We report the results of a multi-stage, applied experimental analysis designed in collaboration with WICS and the Organisation for Economic Co-operation and Development (OECD). The study deployed empirical techniques informed by behavioural economics to measure responses of Scottish householders to different possible price trajectories for water charges over the coming years. The method differed from standard stated preference surveys in that it incorporated multiple controlled manipulations in a fully randomised experimental design. While some recent work on price caps in the water industry has deployed randomised presentations of historical data in a choice task (Robak et al., 2021), our view is that there is potential to make greater use of controlled behavioural experiments. The present experiment consisted of a series of within- and between-subject manipulations of how information about possible future price trajectories was presented. The use of randomisation permits strong inferences about the direction of relative preferences. The aim was to get beyond the observation that judgements, decisions and behaviour can be inconsistent or contradictory, to illuminate decision-making mechanisms and improve inferences about underlying household preferences (Beshears et al., 2008).

The following overarching research question constituted the basis for the study: How acceptable do households find different trajectories for water charges over the short to medium term? In a monopolistic context where households have no choice over different trajectories, research must rely on stated (as opposed to revealed) preferences to answer this question. Different hypothetical scenarios are presented to survey participants for them to rate or choose. However, existing behavioural research, briefly reviewed in the next section, indicates that responses can vary depending on how questions are asked. Measures may be sensitive to references to inflation, the range of response options, whether increases are described as percentages or in pounds-and-pence terms, the timing of increases and whether accumulated costs are made explicit. Consequently, the study design sought experimental control over these factors, such that their influence on elicited acceptability could be measured and better understood. The outcome offers greater insight into underlying preferences than is possible with standard survey techniques.

This research aimed not to provide a comprehensive economic welfare analysis by attempting to estimate preference functions for price and service, nor to identify the individual preferences of different consumers. Rather, it was to understand how a representative sample of Scottish water consumers views different realistic future pricing options, given the likely future scenarios for the Scottish water industry. In doing so, the study supplied direct evidence of the likely response to potential policy options. The paper's contribution is ultimately threefold. First, it demonstrates how carefully designed behavioural experiments can be deployed to answer research questions of interest to regulatory policymakers (Eckel and Lutz, 2003; Lunn and Ní Choisdealbha, 2018). Second, it sheds light on the psychological mechanisms individuals use to evaluate price trajectories, with implications for other areas and industries. Third, it provided direct evidence to inform the review of prices in Scotland.

2. Price trajectories and relevant behavioural phenomena

The acceptability of price rises is linked to perceptions of fairness (Kahneman et al., 1986). This understanding may be particularly relevant in the context of a natural monopoly such as water supply, where consumers cannot "opt-out" of consuming the good. In Scotland, citizens are typically content with the standard of their water service and perceive it to provide value for money (Walker, 2018). However, understanding of water charges is reported as low. One-third of survey respondents do not know how water charges are determined (Moyes, 2018), and 20% do not know that charges are tied to local tax bands (Walker, 2018). Thus, some effort is required to ensure that insights into what citizens want from the industry are not contaminated by misconceptions. Accordingly, our experimental design established these initial basic facts for participants.

In judging price changes over time, individuals often consider changes in nominal rather than real terms, failing to account for inflation. This *money illusion* (Shafir et al., 1997) would likely influence responses. Moreover, even when asked explicitly, evidence suggests that individuals misperceive the rate of inflation (Duffy and Lunn, 2009; Arioli et al., 2017). To gauge the influence of these factors on the acceptability of water charges, we manipulated whether price changes were expressed relative to inflation, and we obtained a measure of perceived inflation.

Similarly, framing otherwise equivalent discounts as either an absolute numerical change in price or a percentage change can influence decision-making (e.g., Krishna et al., 2002). Evidence on the direction and cause of this effect is not conclusive. When prices fall, a preference for monetary changes may arise because these are easier to calculate than percentages (DelVecchio et al., 2007). However, evidence on tax rises suggests that what constitutes a "fair" monetary increase is quantitively greater than a comparable "fair" percentage increase (Hite and Roberts, 1991), although the levels of income and tax used in that study were much larger than annual water charges. This finding may matter, as the absolute size of an initial price can alter the relative impact of monetary versus percentage changes (Chen et al., 1998). Given this lack of consensus in existing literature, we directly compared responses to equivalent monetary and percentage changes.

With respect to how prices evolve over several years, multiple competing behavioural phenomena might influence acceptability. Individuals do not evaluate the same objective costs or rewards equally or consistently when faced with intertemporal choices (Frederick et al., 2002; Ericson and Laibson, 2019). With regard to financial gains, this typically manifests as a bias favouring the present (Thaler, 1981; Laibson, 1997; O'Donoghue and Rabin, 2015). Work specific to water charges has demonstrated variation in individual discount rates when faced with trade-offs between upfront costs and future reductions in charges, with acceptance influenced by socio-demographic factors and consumer experiences of the sector (Robak and Bjornlund, 2019). For financial losses, which include price increases, whether there is a desire to delay or overcome them can depend on the size of the loss (Hardisty et al. 2013). General preferences depend on whether the question is framed as an explicit choice or how much monetary compensation is required to undergo the event (Frederick and Loewenstein, 2008). Moreover, for a given overall outcome, people generally prefer good things (such as income) to be increasing over time (Loewenstein and Sicherman, 1991) and bad things (such as pain) to be decreasing (Varey and Kahneman, 1992).

In addition to the differential weighting of costs and benefits over time, evidence suggests that people do not intuitively accumulate regular payments accurately. The granularity of temporal disaggregation alters the attractiveness of prices – the so-called "pennies-a-day" effect (Gourville, 1998). Recent evidence finds that, in general, individuals are inclined to underestimate the accumulation of numbers into a total sum, including when dealing with prices (Scheibehenne, 2019). Where prices increase proportionally, "exponential growth bias" is also relevant. Individuals underestimate accumulation over multiple rounds of exponential growth in mathematical (Wagenaar and Sagaria, 1975) and compound-interest calculations (Stango and Zinman, 2009).

Our primary experimental manipulations underpin our multiple findings regarding the weighting of costs and benefits over time. We varied the timing of price changes and whether accumulated amounts

were made explicit for a given amount of revenue raised. The regulatory cycle in Scotland has previously conducted price determination reviews on a six-year basis in their Strategic Review of Charges (e.g., WICS, 2014). Over a cycle, there are multiple ways to achieve a target level of revenue, including consistent, proportionate increases, one-off price increases, and front-loaded or back-loaded increases. We elicited relative preferences between these price trajectories, first without and then with explicit information on accumulated amounts.

3. Experimental design

Within the overarching research question, three stages addressed the following questions:

1) What are households' prior views (i.e., before being given any information) about what constitutes an acceptable annual price change for water charges? (Stage 1)
2) How is the acceptability of price trajectories affected by their size, shape, and presentation over the medium term? (Stage 2)
3) How is the acceptability of price trajectories affected by explicit information about the accumulated charge and revenue generated? (Stage 3)

The study was a computerised experiment conducted with a larger, representative, online sample (n = 500) and a smaller, representative, face-to-face sample (n = 100) of adults residing in Scotland. As the use of online experiments to capture large representative samples at relatively low cost has expanded, research has sought to confirm that results generalise from conventional face-to-face 'laboratory' to online environments (e.g., Arechar et al., 2018). This present study also adopted this approach.

Stage 1 focused on charges over the coming year. Stages 2 and 3 then presented participants with six-year price trajectories in the form of tables displaying the changes in annual charges (see example in Fig. 1). Annual price changes and price trajectories varied in size, timing, format presentation, and additional information about accumulated changes. As described below, some experimental manipulations were carried out within-subject, others between-subject.

3.1. Stage 1: Short-term price changes

The first stage elicited responses to immediate singular price changes. The aim was to establish participants' views before being exposed to any explanation or information. Participants were shown a range of possible price changes and asked which was the most acceptable over the next year. [1] There was no reference to implications for service quality or any other indication of the purpose of price changes; participants were free to infer the implications of price changes for service as they wished. Participants were randomised to view different versions according to a 2 × 2 between-subject design.[2]

The first manipulation, "Description", tested for an effect of *money illusion*. Half of the participants were assigned to the "Money" condition and saw descriptions framed as *monetary* changes (e.g., "increase by £5.01 - £10.00"). The other half, in the "Inflation" condition, saw descriptions instead framed relative to *inflation* (e.g., "increase at the annual inflation rate"). Given the average annual cost of water (£363.00) and the contemporaneous announced inflation rate (2.50%–2.70%, since the experiment ran over two consecutive months[3]), the approximate cost of each option was almost identical. Despite this, from a technical perspective, the manipulation is arguably not a pure "framing effect" (i.e., the same information framed differently) since the reference to inflation arguably constitutes a form of information provision that might prompt respondents to consider the justification for the price change. However, our concern here is not to demonstrate a pure framing effect but to test alternative conventional descriptions of monetary changes, typical of those made in informational or advertising campaigns about price changes.

The second manipulation, "End Points", varied the scale of responses between participants as a consistency measure to test whether participants' responses were sensitive to the scale used. Participants in the "Small" condition saw responses ranging from statements 2–6 (see Table 1), while those in the "Large" condition saw statements 1–7.

3.2. Stage 2: Price trajectories for six-year periods

The primary study objective was to elicit Scottish citizens' responses to changes in water prices over a six-year period. We manipulated the absolute magnitude of price rises and their pattern and presentation. The most basic presentation was as shown in Fig. 1. Participants rated every trajectory.

In Scotland, most households have unmetered water charges, paying a flat rate depending on the local tax band of their home. "Council tax" bands range from A-H according to historic property valuations, with tax and water charges increasing over the range. At the start of this stage, participants were asked to provide their tax band and could search for it on a website if they did not know it.[4] This approach allowed us to use participants' current water charge as the basis for calculating trajectories and to explain to participants how their charge was set. This procedure helped to make subsequent tasks feel as genuine as possible (as in Robak and Bjornlund (2019) and Robak et al. (2021)).

More generally, in the experimental evaluation of goods and services, the interpretation of findings can be hampered by hypothetical bias, where stated valuations or responses may be greater than those observed in reality (e.g., Murphy et al., 2005). However, the primary aim of the current research was not to measure *absolute* evaluations but to measure the *relative* difference in acceptability when the same price rises were presented to participants with different trajectories, information, or formatting. We see no reason to believe that hypothetical bias would apply differentially across the experimental conditions.

Participants were informed that: "It is anticipated that investment for water in Scotland will need to increase to meet growing demand in the coming years. It is currently not certain by how much this increase will need to be, or what form these price increases will take." They were shown twelve different price trajectories for water charges over the next six years and were asked to rate each for acceptability, on a scale of 1–7 (1 = "totally unacceptable" and 7 = "totally acceptable"). The form of this response scale was considered carefully and piloted in small samples. In one sense, all consumers might prefer lower prices, but measuring this preference would be mostly meaningless. By basing our scale on the concept of what was acceptable, we prompted participants to think of price changes holistically and hence to provide an assessment of overall legitimacy.

[1] Table 1 shows the specific question wording and the range of response options across the different experimental manipulations.

[2] A 2 × 2 design is one that differs across two dimensions. For each dimension there are two alternative conditions, allowing for four unique versions. A between-subject design is one in which participants are randomly assigned to see just one of the four versions.

[3] *July 2018- August 2018 CPI Annual Rate*. Taken from: Office for National Statistics, 2018, *CPI Annual Rate 00: All Items 2015 = 100*, [online] Office for National Statistics, Available at: https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7g7/mm23 [Last accessed 17/01/2022].

[4] 70 participants were randomly assigned to one of two council tax bands (C or F) as they indicated that they still did not know their council tax band.

Now		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
£363.00	**£ Increase**	£5.60	£5.60	£5.60	£5.60	£5.60	£5.60

Fig. 1. Example of a basic price trajectory as presented to participants. The actual starting cost at 'Now' was set to the participant's real annual water charges.

Table 1
Number of participants selecting each statement by presentation type.

"Which of the following options do you believe to be the most acceptable price change for water charges over the next year?"

				Description		End Points	
Money		Inflation	All	Money	Inflation	Small	Large
Decrease by £5.01-£10.00	**1**	Decrease by a lot	4.3%	5.5%	3.1%	0.0%	8.7%
Decrease by £0.01-£5.00	**2**	Decrease by a little	7.8%	6.5%	9.3%	9.3%	6.4%
No change	**3**	No change	46.7%	49.2%	44.0%	46.7%	46.6%
Increase by £0.01-£5.00	**4**	Increase by less than inflation	23.5%	28.2%	18.6%	26.5%	20.5%
Increase by £5.01-£10.00	**5**	Increase at inflation	13.5%	6.5%	21.0%	13.9%	13.1%
Increase by £10.01-£15.00	**6**	Increase a little more than inflation	3.2%	2.9%	3.4%	3.6%	2.7%
Increase by £15.01-£20.00	**7**	Increase a lot more than inflation	1.0%	1.3%	0.7%	0.0%	2.0%
		N	**600**	**309**	**291**	**302**	**298**
		Any increase	41.2%	38.8%	43.6%	44.0%	38.3%
				$\chi^2 = 1.430$, $p = 0.232$		$\chi^2 = 2.072$, $p = 0.150$	
		Increase at or above inflation	17.7%	10.7%	25.1%	17.6%	17.8%
				$\chi^2 = 21.383$, $p < 0.001$		$\chi^2 = 0.006$, $p = 0.940$	

The prices were manipulated according to a 3 × 2 x 2 within-subject design[5] to generate the twelve unique trajectories.[6]

1. **Trajectory Pattern**: How the price rises occur over the six-year period, with equivalent revenue.
   a. **Constant**: A consistent increase for each of the six years.
   b. **Front-Loaded**: Increase for the first three years, no increase in the last three years.
   c. **Back-Loaded**: No increase in the first three years, increase in the last three years.
2. **Format**: How price changes were presented.
   a. **Pound:** Price rises presented as pounds-and-pence increases.
   b. **Percentage:** Price rises presented as percentage increases.
3. **Price Level**: Absolute size of total price increase over the entire price trajectory period.
   a. **Low Cost**: Low price increase (approximately equivalent to 1.5% per annum).
   b. **High Cost**: High price increase (approximately equivalent to 2.5% per annum).

Total additional revenue raised over the six years was held constant within the six Low Cost and, separately, within six High Cost price trajectories.[7] Participants first viewed all twelve price trajectories before rating them. This helped them to calibrate their responses and reduced the possibility of order effects. Each participant saw either all six Pound trajectories followed by all six Percentage trajectories or the reverse. Within these subsets, the order was randomised. Each price trajectory rating task was presented on a separate page.

3.3. Stage 3: Price trajectories for six-year periods with additional information

In this stage, participants repeated the rating tasks for the same twelve price trajectories but were provided with additional information that made the cumulative costs of each price trajectory explicit (Fig. 2). Variations in responses across Stages 2 and 3 would imply that participants initially failed to factor the accumulation of costs into their responses. The two additional pieces of information were:

Annual Cost: The updated annual cost of water in each year.

Accumulated Cost: The total price rise and the total additional amount charged over the entire six-year period (i.e., compared to if prices had remained at current levels).

Half the participants saw Annual Cost only (henceforth Stage 3a), and the other half saw both Annual Cost and Accumulated Cost (henceforth Stage 3b).

4. Method

Participants resided in Scotland and were adults, ranging between 18 and 85 years of age. Online participants were recruited via a market research agency and took part on personal computers or tablets during September 2018. The online study took 15–20 minutes, and participants received an industry-standard participation fee (approximately £2). A different market research agency recruited face-to-face participants to attend sessions in one of two Scottish cities during October 2018. Participants undertook the study on their own using personal computers provided by the experimenters, with approximately 10 participants per session. After completing this study, they undertook an additional unrelated one lasting approximately 10 minutes. They were paid a standard fee for face-to-face studies (£20). Across both platforms, participants were not given details of the exact nature of the study prior to participation.

The study was identical across platforms, although an instructor read instructions aloud in the face-to-face sessions. It was programmed using Gorilla Experiment Builder (Anwyl-Irvine et al., 2019). Participants' socio-demographic characteristics were approximately aligned with official population data for Scotland and across platform types (Appendix A). Across platform types, participants did not differ by tax band,

[5] A within-subject design is one in which all participants see all plausible variations (in this case – 3 × 2 × 2 = 12).

[6] Examples of the twelve unique price trajectories can be found in Appendix B.

[7] It was not possible for pound and percentage rises to match perfectly, since a constant monetary increase in each of the six years would not equate to a constant percentage increase (and vice versa). However, for comparability, the Percentage and Pound trajectories were reported as the same, as the differences were small.

Now		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
£363.00	**£ Increase**	£5.60	£5.60	£5.60	£5.60	£5.60	£5.60	**Price Rise (£)** £33.60
£363.00	**Annual Cost**	£368.60	£374.20	£379.80	£385.40	£391.00	£396.60	**Total Additional Charge (£)** £117.60

Fig. 2. Example of price trajectory presented in Stage 3. The light grey colour denotes the Annual Cost information provided in Stage 3a and 3b; the dark grey colour denotes the Accumulated Cost information provided in Stage 3b.

gender, employment, educational attainment, location, main billpayer, or receipt of a tax and water charge discount. A somewhat greater proportion of face-to-face participants were aged under 40 (42.0% vs. 31.6% online) ($\chi^2 = 4.056$, $p = 0.044$).

5. Results

5.1. Stage 1: Short-term price changes

Results for Stage 1 are presented in Table 1. Overall, 46.7% of participants preferred no price change over the next 12 months. However, participants were generally more supportive of a potential price rise: 41.2% vs. 12.2% who selected a price fall.

We categorise two outcomes of interest for comparison by experimental condition: whether participants chose any price increase as acceptable (i.e., statements 4–7) and whether participants chose an increase at or above inflation (i.e., statements 5–7). There was no statistically significant difference between either manipulation for willingness to select "any increase". However, the description of price changes influenced willingness to select "increase at or above inflation" – selected by 25.1% of participants in Inflation, compared to just 10.7% in Money ($\chi^2 = 21.383$, $p < 0.001$). Inspection of the distributions in

Table 2
Logistic regression models for Stage 1 (log odds). Dependent variable: participant chose "any increase" (Models 1–4) or chose "increase at or above inflation" (Models 5–8).

Acceptable Price Change	Any Increase				Increase at or Above Inflation			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Description (*Ref: Money*)								
Inflation	0.2661	0.1683	0.2233	0.2997	1.1259***	0.9394***	1.2081***	1.3296***
	(0.174)	(0.244)	(0.308)	(0.314)	(0.244)	(0.337)	(0.417)	(0.426)
End Points (*Ref: Small*)								
Large	−0.2555	−0.3590	−0.2598	−0.2709	0.0483	−0.2095	0.0359	0.0394
	(0.174)	(0.249)	(0.175)	(0.176)	(0.226)	(0.402)	(0.232)	(0.234)
Inflation * Large	–	0.2042	–	–	–	0.3846	–	–
	–	(0.348)	–	–	–	(0.485)	–	–
Estimate (*Ref: < 2.01%*)								
2.01%–2.70%	0.2602	0.2624	0.0307	0.1111	0.2164	0.2196	−0.5847	−0.4345
	(0.227)	(0.227)	(0.328)	(0.339)	(0.276)	(0.276)	(0.616)	(0.624)
2.71%–3.10%	−0.1720	−0.1676	−0.1436	−0.0756	−0.0236	−0.0164	0.0614	0.0207
	(0.254)	(0.255)	(0.351)	(0.362)	(0.327)	(0.328)	(0.548)	(0.569)
>3.10%	−0.2813	−0.2779	−0.1367	−0.1155	−0.6091*	−0.6036*	0.3571	0.4104
	(0.241)	(0.241)	(0.332)	(0.337)	(0.356)	(0.356)	(0.493)	(0.485)
Inflation * 2.01%–2.70%	–	–	0.4277	0.3792	–	–	1.0420	0.8862
	–	–	(0.462)	(0.470)	–	–	(0.707)	(0.718)
Inflation * 2.71%–3.10%	–	–	−0.0521	−0.1138	–	–	−0.1210	−0.1595
	–	–	(0.506)	(0.512)	–	–	(0.687)	(0.710)
Inflation * > 3.10%	–	–	−0.2807	−0.3585	–	–	−1.7036**	−1.9122***
	–	–	(0.478)	(0.488)	–	–	(0.699)	(0.719)
Platform (*Ref: Face-to-Face*)								
Online	0.1745	0.1724	0.1413	0.1678	−0.0493	−0.0506	−0.1284	−0.0894
	(0.236)	(0.237)	(0.236)	(0.244)	(0.311)	(0.310)	(0.319)	(0.328)
Gender: Male	–	–	–	−0.0856	–	–	–	0.0739
	–	–	–	(0.185)	–	–	–	(0.246)
Age: 18 - 39	–	–	–	−0.0620	–	–	–	0.1291
	–	–	–	(0.216)	–	–	–	(0.285)
Employed: Yes	–	–	–	0.3190	–	–	–	0.0934
	–	–	–	(0.263)	–	–	–	(0.342)
Retired: Yes	–	–	–	0.0231	–	–	–	−0.1437
	–	–	–	(0.310)	–	–	–	(0.428)
Degree: Yes	–	–	–	0.1412	–	–	–	0.5919**
	–	–	–	(0.183)	–	–	–	(0.243)
Location: Urban	–	–	–	0.1565	–	–	–	−0.0101
	–	–	–	(0.232)	–	–	–	(0.307)
CT Band: A/B/C	–	–	–	0.1266	–	–	–	−0.2802
	–	–	–	(0.192)	–	–	–	(0.257)
Bill Payer: Yes	–	–	–	−0.1912	–	–	–	−0.1885
	–	–	–	(0.259)	–	–	–	(0.341)
Bill Discount: Yes	–	–	–	−0.1882	–	–	–	0.1707
	–	–	–	(0.207)	–	–	–	(0.265)
Constant	−0.4448	−0.3955	−0.3954	−0.6142	−2.0871***	−1.9656***	−2.0704***	−2.3387***
	(0.275)	(0.288)	(0.304)	(0.463)	(0.375)	(0.403)	(0.460)	(0.647)
Participants	557	557	557	557	557	557	557	557

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Robust standard errors in parentheses.

Table 1 shows that this result was driven by the salience of the "increase at the annual inflation rate" option, suggesting a role for *money illusion* - participants did not account for inflation unless explicitly prompted to consider it.

Table 2 reports logistic regression models that estimate the likelihood of selecting "any increase" (Models 1–4) or an "increase at or above inflation" (Models 5–8). Models 1 and 5 confirm the bivariate findings, including the evidence of *money illusion* in Model 5 ($p < 0.001$). Models 2 and 6 find no evidence of an interaction effect between the two manipulations.

Since beliefs about inflation could influence perceptions of the value of price rises in Inflation, we had asked participants to provide their best guess for the UK inflation rate at the end of the study. 95.7% provided a numerical value. Responses were heavily right-skewed, as is common for measures of perceived inflation, e.g., Duffy and Lunn (2009), ranging from 0% to 1000%. Seventeen estimates over 20% were excluded, but results are not sensitive to the exact cut-off. Inflation estimates were transformed into an ordered categorical variable: (1) < 2.01%, (2) 2.01%–2.70%, (3) 2.71%–3.10%, and (4) > 3.10%. Again, results are not sensitive to the exact cut-off. Inflation had remained below 3.10% during the previous five years, so this category captured unambiguously incorrect responses.

Models 3 and 7 test for an interaction between the Description manipulation and inflation estimate. While there was no significant interaction for "any increase" (Model 3), participants who believed inflation to be 3.10% or above in the Inflation condition were significantly less likely to select "increase at or above inflation" than those who overestimated equally in Money (Model 7, $p = 0.015$). Models 4 and 8 include socio-demographic information. Participants with a degree were significantly more likely to choose "increase at or above inflation" ($p = 0.015$).

5.2. Stage 2: Price trajectories for six-year periods

Summary results for Stage 2 are presented in Fig. 3. Participants (n = 42) who reported equal ratings for all twelve trajectories were excluded from the analysis. Results are not sensitive to this exclusion. Consistent with Stage 1, participants were, on average, reasonably accepting of proposed price increases (Median = 3.92, Mean = 3.81, $SD = 1.06$).

There was substantial variation across types of trajectory. Back-Loaded trajectories were rated as much less acceptable than equivalent Constant and Front-Loaded trajectories. Constant trajectories were more acceptable than equivalent Front-Loaded trajectories. Price trajectories framed as Percentage were more acceptable than equivalent trajectories framed as Pound. Unsurprisingly, Low Cost price trajectories were rated more acceptable than High Cost trajectories. Bivariate analyses indicate that these differences are highly statistically significant ($p < 0.001$, Appendix C).

Table 3 reports a generalised ordered logistic regression (GOLR) model that tests for individual effects of the price trajectory manipulations. This partial proportional odds model was fitted in Stata using the 'gologit2' command (Williams, 2006). The equivalent OLR model fails the standard (Brant) test of the proportional odds assumption ($p < 0.001$). We also pool extreme scores to give a five-category ordinal range (1–2, 3, 4, 5, 6–7), which improves model fit.[8] We report only the full GOLR model with relevant interactions and demographic characteristics. Simpler models excluding these generate closely similar results (Appendix D). Given likely non-independence of repeated responses, we report robust standard errors clustered at the participant level.

The model confirms the bivariate findings. Front-Loaded ($p < 0.050$) and Back-Loaded ($p < 0.001$) trajectories were significantly less acceptable than equivalent Constant trajectories, although the dislike of Back-Loaded trajectories was substantially stronger. Percentage trajectories were more acceptable than Pound trajectories ($p < 0.001$). There is evidence of a modest interaction, suggesting that the relative preference for Percentage was reduced when the percentage change varied across the years. High Cost trajectories were less acceptable than Low Cost alternatives ($p < 0.001$).

Participants who receive a discount on their council tax bill ($p = 0.007$), live in urban areas ($p = 0.068$), work ($p = 0.027$), or are retired ($p = 0.052$) generally provided higher acceptability ratings, while those under 40 were less likely to give low ratings. Online participants were less likely to give high ratings.

A control variable for presentation order revealed a small but highly significant effect indicating higher acceptance for price trajectories rated earlier ($p = 0.001$). This effect is commonly observed in experimental evaluations of market (Belton and Sugden, 2018) and non-market (Day et al., 2012) goods and services. The first evaluation can be particularly influential (Flachaire and Holland, 2006). Order was randomised across participants, and this effect does not intrude upon the main findings.

5.3. Stage 3: Price trajectories for six-year periods with additional information

Variation of acceptance for price trajectories in Stage 2 was substantial, including when comparing trajectories that raised equal overall revenues. Participants may have struggled to integrate the annual changes, still less to recognise this equivalence in revenue. Stage 3 made aggregated information explicit. The summary results for Stage 3a (annual cost displayed) and 3b (annual cost and accumulated cost displayed) are presented in Fig. 4. Participants (n = 59) who reported equal ratings were excluded, but results are not sensitive to this exclusion.

By contrast to Stage 2, in both Stages 3a and 3b, Front-Loaded trajectories had higher average ratings than Constant. The preference for price trajectories presented as Percentage, and Low Cost remained. Bivariate analyses indicate that these differences are statistically significant ($p < 0.050$, Appendix E).

Table 4 reports the equivalent GOLR model to that presented in Table 3 for Stage 2. Diagnostic tests again rejected an OLR model (Brant, $p < 0.001$). Simpler models without interactions or demographic controls produce similar results (Appendix F).

The model confirms the bivariate findings, suggesting that participants previously misperceived both the relative and absolute accumulated price increases and revenues. The reversal of preference, such that Front-Loaded trajectories were preferred to equivalent Constant trajectories in Stage 3a ($p < 0.001$), implies that participants failed to realise the accumulated cost of incremental price rises for Constant trajectories until these were made explicit in Stage 3a. The dislike of Back-Loaded ($p < 0.001$) and High Cost trajectories ($p < 0.001$) persisted, as did the preference for Percentage relative to Pound trajectories ($p < 0.005$).

Providing explicit information about the total price rise and additional charge in Stage 3b had no general impact on ratings ($p = 0.528$) but further altered relative preferences for trajectories. Relative to Constant trajectories, the preference for Front-Loaded ($p = 0.034$) and dislike of Back-Loaded trajectories ($p < 0.001$) were reduced. That is, making participants aware of the equivalent yield over the six years caused both differences to narrow relative to Stage 3a. Moreover, the dislike of High Cost trajectories increased ($p = 0.007$), further indicating that participants underestimated the accumulation of costs. Perhaps surprisingly, making explicit that Pound and Percentage were equivalent in revenue terms did not reduce the preference for Percentage trajectories ($p = 0.638$). Overall, demographic effects were more muted than in Stage 2, but the impacts of the online platform and order persisted.

[8] The seven-category GOLR model marginally fails a global Wald test ($\chi^2 = 69.49$, $p = 0.090$), which is rectified by pooling categories ($\chi^2 = 38.55$, $p = 0.233$) – see Williams (2006). Results in any case do not differ appreciably between the two models.

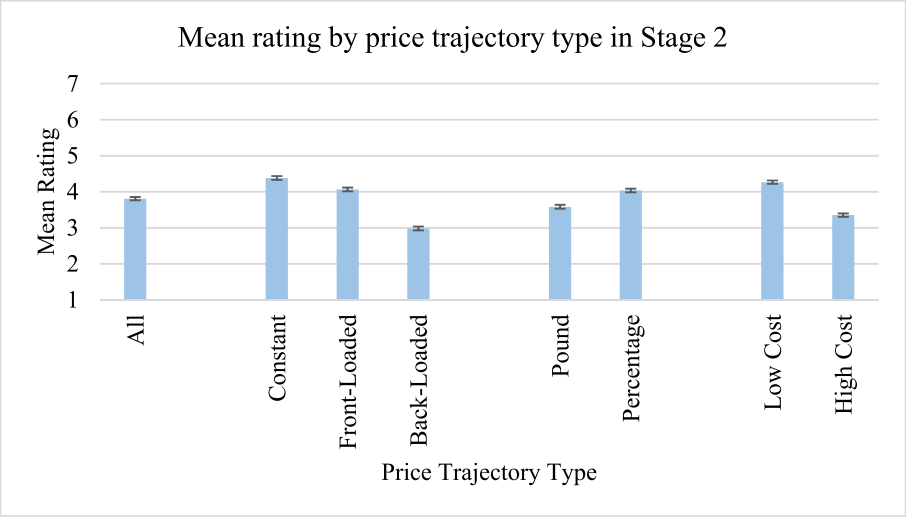

Fig. 3. Mean rating in Stage 2 by type of price trajectory (error bars report standard errors).

Table 3
Generalised ordered logistic regression model for Stage 2 (log odds).

Price Trajectory Rating	1-2 vs. 3-7	1-3 vs. 4-7	1-4 vs. 5-7	1-5 vs. 6-7
Pattern (*Ref: Constant*)				
Front-Loaded†	−0.1304**	−0.2122***	−0.3704***	−0.4625***
	(0.066)	(0.063)	(0.065)	(0.073)
Back-Loaded	−1.4266***	−1.4266***	−1.4266***	−1.4266***
	(0.080)	(0.080)	(0.080)	(0.080)
Format (*Ref: Pound*)				
Percent†	0.6255***	0.6812***	0.6037***	0.4569***
	(0.101)	(0.085)	(0.079)	(0.081)
Front-Loaded * Percent	−0.1112*	−0.1112*	−0.1112*	−0.1112*
	(0.063)	(0.063)	(0.063)	(0.063)
Back-Loaded * Percent†	−0.0333	−0.2092**	−0.3746***	−0.4571***
	(0.111)	(0.099)	(0.099)	(0.118)
Price Level (*Ref: Low Cost*)				
High Cost†	−0.9501***	−0.9475***	−1.0555***	−1.1449***
	(0.051)	(0.047)	(0.052)	(0.065)
Online†	0.0848	−0.0282	−0.3384***	−0.4977***
	(0.153)	(0.130)	(0.124)	(0.130)
Order	−0.0277***	−0.0277***	−0.0277***	−0.0277***
	(0.008)	(0.008)	(0.008)	(0.008)
Gender: Male	−0.0725	−0.0725	−0.0725	−0.0725
	(0.099)	(0.099)	(0.099)	(0.099)
Age: 18–39†	0.4698***	0.4310***	0.2159*	−0.0864
	(0.142)	(0.128)	(0.124)	(0.146)
Employed: Yes	0.3121**	0.3121**	0.3121**	0.3121**
	(0.142)	(0.142)	(0.142)	(0.142)
Retired: Yes	0.3200*	0.3200*	0.3200*	0.3200*
	(0.164)	(0.164)	(0.164)	(0.164)
Degree: Yes	−0.0180	−0.0180	−0.0180	−0.0180
	(0.101)	(0.101)	(0.101)	(0.101)
Location: Urban	0.2207*	0.2207*	0.2207*	0.2207*
	(0.121)	(0.121)	(0.121)	(0.121)
CT Band: A/B/C	−0.0372	−0.0372	−0.0372	−0.0372
	(0.105)	(0.105)	(0.105)	(0.105)
Bill Payer: Yes	0.0170	0.0170	0.0170	0.0170
	(0.137)	(0.137)	(0.137)	(0.137)
Bill Discount: Yes	0.3047***	0.3047***	0.3047***	0.3047***
	(0.113)	(0.113)	(0.113)	(0.113)
Constant	1.3115***	0.5695**	0.1162	−0.4270*
	(0.246)	(0.229)	(0.222)	(0.220)
Observations	6,696	6,696	6,696	6,696
Participants	558	558	558	558

† indicates the variables for which the proportional odds assumption has been relaxed.

6. Discussion and policy implications

This experimental study set out to provide evidence for regulatory policy about households' preferences regarding water charges in Scotland. The study aimed to demonstrate the advantages of an experimental approach that exploits insights from behavioural economics and generates practical, direct measures. In this section, we consider what the overall pattern of results implies for the psychological mechanisms behind responses and the extent to which results might generalise beyond the specific policy context of the study. We also raise a broader issue about the potential exploitation of behavioural research.

Scottish households responded reasonably positively to the prospect of modest increases in charges in the absence of explicit guidance as to how additional revenue would be spent. Indeed, there was no evidence of overwhelming rejection of this set of plausible price rises. While this finding may well be specific to the Scottish context, the study also found that households view price rises as more acceptable when prompted to consider them alongside inflation. As hypothesised, this looks like a manifestation of money illusion (Shafir et al., 1997), although it is also possible that the reference to inflation resulted in participants giving extra weight to inflation as a rationale for price changes. Regardless, the implication is that measures taken following a prompt to consider inflation might be considered more representative of underlying preferences. If so, this conclusion may extend beyond the context of the Scottish water industry to other areas where consumer evaluations of annual charges are at issue.

The consistent difference we recorded between equivalent increases expressed in percentage and monetary terms is more difficult to interpret, with the latter rated as significantly less acceptable. A comparison of coefficients with the Low (1.5%) versus High (2.5%) increase in our statistical models reveals that this effect is equivalent to approximately one half to two-thirds of a percentage point per annum over a six-year price trajectory. It is possible that this and the previous finding are related: expressing increases as percentages may remind people to factor in inflation. If so, then this arguably represents a more informed preference, but other mechanisms are possible. Percentages may be a more straightforward way to provide context, i.e., a simpler indication of the magnitude of the rise in proportion to what is already paid. Alternatively, monetary amounts may garner additional psychological weight. This difference is not easily resolvable; the implied preferences are inconsistent, and it is difficult to determine which are more reflective of underlying preference (Beshears et al., 2008).

Of particular interest for the present study was how households compared differently shaped medium-term price trajectories, given the

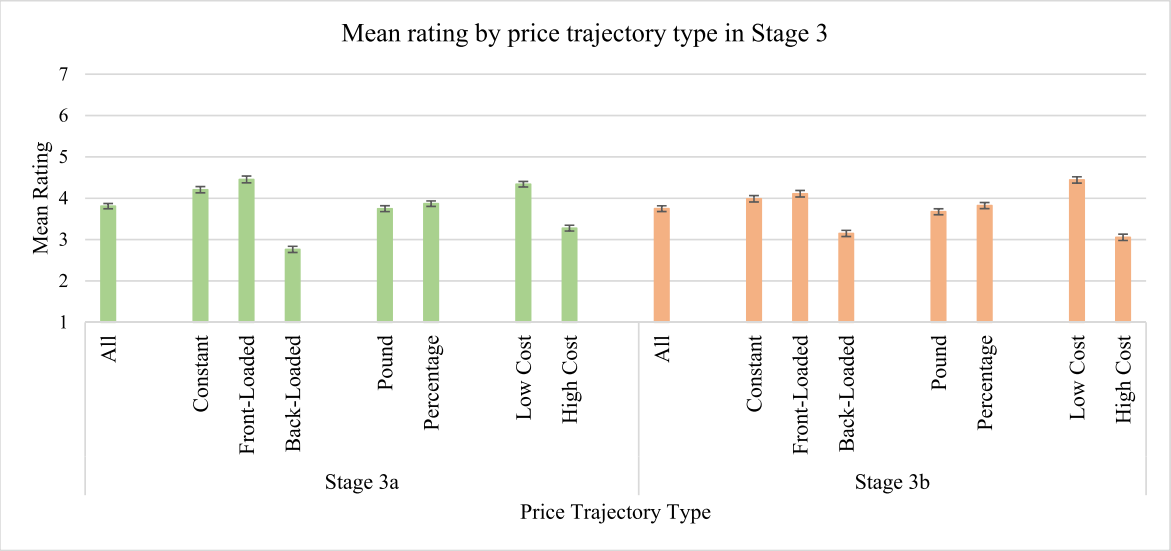

Fig. 4. Mean acceptance rating (1–7) by type of price trajectory in Stage 3a (annual cost displayed) and Stage 3b (annual cost and accumulated cost displayed).

array of established behavioural phenomena that might affect responses. Our findings suggest that the dominant factor was an aversion to putting off price increases. Back-Loaded trajectories were always significantly less acceptable, even when participants were shown that the total revenue was equivalent to the Constant and Front-Loaded trajectories. More than one psychological mechanism may be involved (Frederick and Loewenstein, 2008). One possibility is that people dislike feeling that something negative is "hanging over them"; putting off price rises foreshadows unpleasant year-on-year increases in the future. A second possibility is that people realise and dislike the fact that delaying an increase leads to a higher price at the end of the period, with implications for the size of ongoing bills thereafter. Lastly, an enlightened respondent might reason that the sooner they pay for additional investment, the sooner associated benefits arrive. Although the descriptions of price trajectories did not include explicit statements of the implications for services, participants were free to make such inferences.

Our data offer insights into which of the three mechanisms might be more influential. If assumptions about service levels coupled with a desire for more rapid service improvements drove responses, leading to a dislike of Back-Loaded trajectories, we should have seen a similarly strong preference for Front-Loaded over Constant trajectories, which we did not. Similarly, if the size of the final bill were the key issue, Front-Loaded trajectories would have been equivalently preferred to Constant in both Stages 3a and 3b. Instead, we suggest two conclusions. First, acceptance of price rises depends on more than the implications for service levels; households care about the shape of the price trajectory itself. This finding is consistent with previous work on the trajectories of good and bad outcomes generally (Loewenstein and Sicherman, 1991; Varey and Kahneman, 1992) and is likely to apply beyond the specific policy context. Second, if people know that charges are set to increase over a period, they would rather get on with it. In an industry with a recognised need for investment, the finding that people dislike putting off likely increases in charges, even in the presence of additional information about the cumulative effect, is relevant. Again, if so, this is likely to generalise beyond the Scottish water industry.

Providing explicit information about future bills and accumulated revenue altered responses. Constant trajectories were preferred to Front-Loaded in Stage 2. This result switched when future bills were made explicit in Stage 3a, but that difference narrowed when accumulated charges were also shown in Stage 3b. This pattern is consistent with two competing mechanisms. First, participants failed to fully accumulate smaller price increases in the Constant trajectory until this was made explicit. Second, they did not appreciate the cumulative impact on total revenue of price increases occurring earlier in the period for Front-Loaded trajectories. The pattern of responses to these trajectories relative to the Back-Loaded ones is also consistent with these mechanisms. Arguably, one might consider the situation where participants were shown the greater level of accurate information, i.e., including the accumulated charges (Stage 3b), to be the more informed preference.

It should be borne in mind that our focus was on average preferences rather than individual differences in preferences. In particular, we did not attempt to measure household income, and income may be linked to preferences for putting off price increases. However, variations in responses by educational attainment and council tax band, both of which are likely to be correlated with income, were relatively small.

When considering the degree to which our findings might generalise beyond the specific policy context, one potential limitation is that Scottish water is unmetered, and charges are based on (historic) house value. A metered system might interact with preferences for specific price trajectories, given existing evidence that metered water customers can be less sensitive to price changes (Robak et al., 2021). The impact of price changes may also vary more across households in a metered system and, therefore, raise different equity issues.

In addition, taken as a whole, the findings illuminate an increasingly important debate concerning how to apply behavioural economics to policy. Armed with our results, it would not be difficult for an unscrupulous stakeholder in this industry (or indeed another with a similar annual charging structure) to describe price changes in such a way as to manipulate the public response, either in favour or opposition. Moreover, the findings suggest ways to construct survey measures to increase the likelihood of obtaining a predetermined response. On the other hand, our results provide empirical evidence against which the neutrality or objectivity of survey measures can be judged. As described at the outset, generating accurate and representative evidence about household preferences is not straightforward. Furthermore, for those seeking to act in the interests of citizens, rather than to get things past them, the research demonstrates how behavioural techniques can be used to give more robust insights about household preferences that permit more informed policy judgement. Given these contrasting possibilities, transparency is vital when applying behavioural insights to policy (e.g., Barton and Grüne-Yanoff, 2015; Gold et al., 2020).

Table 4
Generalised ordered logistic regression model for Stage 3 (log odds).

Price Trajectory Rating	1-2 vs. 3-7	1-3 vs. 4-7	1-4 vs. 5-7	1-5 vs. 6-7
Pattern (*Ref: Constant*)				
Front-Loaded	0.4266***	0.4266***	0.4266***	0.4266***
	(0.086)	(0.086)	(0.086)	(0.086)
Back-Loaded	−1.5414***	−1.5414***	−1.5414***	−1.5414***
	(0.108)	(0.108)	(0.108)	(0.108)
Format (*Ref: Pound*)				
Percent†	0.4400***	0.2850***	0.3466***	0.3132***
	(0.094)	(0.088)	(0.085)	(0.086)
Front-Loaded * Percent	−0.2807***	−0.2807***	−0.2807***	−0.2807***
	(0.084)	(0.084)	(0.084)	(0.084)
Back-Loaded * Percent	−0.3322***	−0.3322***	−0.3322***	−0.3322***
	(0.103)	(0.103)	(0.103)	(0.103)
Price Level (*Ref: Low Cost*)				
High Cost	−1.2496***	−1.2496***	−1.2496***	−1.2496***
	(0.073)	(0.073)	(0.073)	(0.073)
Stage 3 Type (*Ref: Stage 3a*)				
Stage 3 b	−0.0889	−0.0889	−0.0889	−0.0889
	(0.141)	(0.141)	(0.141)	(0.141)
Front-Loaded * Stage 3 b	−0.2437**	−0.2437**	−0.2437**	−0.2437**
	(0.115)	(0.115)	(0.115)	(0.115)
Back-Loaded * Stage 3 b	0.6689***	0.6689***	0.6689***	0.6689***
	(0.134)	(0.134)	(0.134)	(0.134)
Percent * Stage 3 b	−0.0499	−0.0499	−0.0499	−0.0499
	(0.106)	(0.106)	(0.106)	(0.106)
Front-Loaded * Percent * Stage 3 b	0.1358	0.1358	0.1358	0.1358
	(0.119)	(0.119)	(0.119)	(0.119)
Back-Loaded * Percent * Stage 3 b	0.0656	0.0656	0.0656	0.0656
	(0.131)	(0.131)	(0.131)	(0.131)
High Cost * Stage 3 b	−0.2893***	−0.2893***	−0.2893***	−0.2893***
	(0.108)	(0.108)	(0.108)	(0.108)
Online†	0.0430	−0.0974	−0.4632***	−0.7418***
	(0.165)	(0.150)	(0.154)	(0.153)
Order	−0.0158***	−0.0158***	−0.0158***	−0.0158***
	(0.006)	(0.006)	(0.006)	(0.006)
Gender: Male	0.1259	0.1259	0.1259	0.1259
	(0.110)	(0.110)	(0.110)	(0.110)
Age: 18 - 39	0.2363*	0.2363*	0.2363*	0.2363*
	(0.132)	(0.132)	(0.132)	(0.132)
Employed: Yes	0.0012	0.0012	0.0012	0.0012
	(0.168)	(0.168)	(0.168)	(0.168)
Retired: Yes†	−0.2562	−0.3699*	−0.0675	0.2462
	(0.201)	(0.192)	(0.195)	(0.199)
Degree: Yes	−0.0403	−0.0403	−0.0403	−0.0403
	(0.113)	(0.113)	(0.113)	(0.113)
Location: Urban†	0.2770*	0.0163	0.0447	0.0268
	(0.166)	(0.149)	(0.145)	(0.155)
CT Band: A/B/C	0.0086	0.0086	0.0086	0.0086
	(0.113)	(0.113)	(0.113)	(0.113)
Bill Payer: Yes	−0.0513	−0.0513	−0.0513	−0.0513
	(0.169)	(0.169)	(0.169)	(0.169)
Bill Discount: Yes	0.1620	0.1620	0.1620	0.1620
	(0.122)	(0.122)	(0.122)	(0.122)
Constant	1.8451***	1.3219***	0.5395*	−0.2150
	(0.301)	(0.287)	(0.280)	(0.283)
Observations	6,492	6,492	6,492	6,492
Participants	541	541	541	541

Declarations

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Conflicts of interest

The authors declare that they have no conflict of interest.

Data and material availability

The data and code for the analyses undertaken are available via the Open Science Framework (https://osf.io/sqk7p/).

Code availability

Not applicable.

Author contributions

All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by **CB**. **CB** and **PL** contributed to the first draft of the manuscript. All authors read and approved the final manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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