Use of Nonrounded Bids Triggers System 2 Full Information Processing in Discrete Choice Experiments

Mark Morrison *Professor, School of Business, Charles Sturt University, Bathurst, Australia; mmorrison@csu.edu.au*

Kevin Boyle *Professor, Blackwood Department of Real Estate, Virginia Tech, Blacksburg; kjboyle@vt.edu*

Downloaded from by guest on October 16, 2026. Copyright 2026

ABSTRACT An aspect of bid vector design in choice experiments that has received limited attention is the effect of using non-rounded (or precise) rather than rounded bids. Insights from the marketing and psychology literatures suggests that there are many factors potentially influencing the effects of using non-rounded bids, including image and level effects, accuracy cues, processing fluency, and stimulating more cognitively-based System 2 thinking. Using a split-sample experimental approach in a choice experiment, we find evidence that non-rounded bids may trigger use of System 2 cognitive processes, thereby increasing the number of significant attribute coefficients as well as reducing model variance.

Key words: Stated preferences, bid vector, heuristics, dual processing, urban rivers

JEL Codes: Q510, Q250

doi:10.3368/le.103.1.102825-0091R

This open access article is distributed under the terms of the CC-BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/4.0) and is freely available online at: https://le.uwpress.org

1. Introduction

Benefit estimation is fundamental to environmental economics, and the use of dichotomous choice and choice experiments are common approaches in the framing of valuation questions. The U.S. EPA Guidelines for Preparing Economic Analyses states that "(t)he aim of a benefits analysis of an environmental policy is to describe the changes resulting from that policy and to estimate the social benefits that ensue" (U.S. EPA 2024, p. 7-1). They further state that "the benefit transfer approach (is) the chief method for monetizing benefits in economic analysis of regulatory actions". Benefit-transfer analyses rely on original valuation studies published in the peer-reviewed environmental and resource economics literature. The price variable plays the central role in economic benefit estimation and if the specification of the price coefficient in experimental designs affects value estimates, this can lead to biased original valuation estimates and biased benefit-transfer estimates that can confound policy recommendations. Thus, the importance of estimating price parameters with the "highest possible precision" is recognised given its central role in determining value estimates (Mariel et al., 2021, p.28).

The effect of bid amounts has been well established in environmental stated-preference applications. The effects have been shown in discrete-choice questions (e.g., Boyle et al. 1985; Boyle et al. 1996; Herriges and Shogren 1996). For choice-experiment applications, the literature provides additional evidence about the consequences of bid-design choices, including the effects of the number of levels and range of levels including the choke price (e.g., Hensher 2004; Rose et al. 2009; Mørkbak et al. 2010; Glenk et al. 2019). However, for other aspects of bid vector design – attribute level range, magnitude of bid levels, and number of levels – there has been mixed findings, which Rose et al. found could be due to cultural differences across countries in how people make choices.

Downloaded from by guest on October 16, 2026. Copyright 2026

An issue that has not been investigated, which we consider here, is the use of what we refer to as rounded versus precise bids in stated-preference questions. While the use of open-ended questions has diminished through time, those studies revealed response spikes at $1, $5, $10, $25, etc., suggesting the use of simplifying heuristics in answering these questions with rounded monetary amounts. From the perspective of the economics literature, using non-rounded bids (e.g., $4, $9, $13, $22, etc.) might be expected to increase task complexity and stimulate the use of heuristics when answering valuation questions with posted bid amounts. One might ask whether respondents would be more or less likely to heuristically respond to a rounded bid.

There is some tangential evidence in the literature. For example, Mariel et al. (2021, p.28) noted that a benefit of not equally spacing cost levels is that it "increase[s] the number of cost differences across the attributes, thereby facilitating the estimation of the cost coefficient, its heterogeneity and WTP measures accordingly". A similar but slightly different point is made by Pearmain et al. (1991) who recommended using non-rounded numbers which create unequal increments between levels for all attributes including price as it leads to "a wider range and larger number of trade-off rates" (p.49). That is, there is likely to be a greater array of implied marginal rates of substitution between price and non-price attributes, and between non-price attributes when non-rounded numbers are used. However, rounded and non-rounded bid amounts can be spaced evenly, and the extent of this increase will depend on how far off the rounded numbers are from the non-rounded and if pairs both increase, both decrease, or move in opposite directions. More generally, bid-level selection has the potential to influence the complexity of choice-experiment questions, stimulating the use of various heuristics including ignoring attributes, elimination by aspects, using a majority of confirming dimensions decision rule (also known as enumeration), lexicographic sequencing, and avoiding choice by increasingly choosing the status quo option

Downloaded from by guest on October 16, 2026. Copyright 2026

(Tversky and Shafir 1992; Mazotta and Opaluch 1995; Swait and Adamowicz 2001; Hensher 2004, 2006; Boxall et al. 2009; Weng et al. 2021).

De Shazo and Fermo (2002, p.141) suggest that "…economists could improve choice consistency by determining which of several possible mechanisms explains how complexity affects choice consistency… Determining whether consumers are using partial information strategies (heuristics) versus full information strategies that exceed their cognitive capacities, could further improve the design of conjoint methods." Here, we investigate the use of rounded versus non-rounded numbers for bid levels (with some non-rounded prices higher than rounded prices and some lower) in estimating environmental values with a choice experiment. In doing so we (1) draw on insights from the marketing and psychology literatures on the use of heuristics in answering complex questions; (2) investigate the effects of using rounded versus non-rounded bids on parameter estimates and marginal willingness to pay; and (3) investigate the effects of using rounded versus non-rounded bids on model variance. Our findings demonstrate that the use of round or non-rounded bids significantly and substantively influences model parameter estimates and variance. We consider two model specifications. Using a random parameters logit model with rounded bids, only the bid amount is significant, not the environmental variable. Whereas, the bid and environmental variable coefficients are significant in the non-rounded bid treatment.

For a scaled multinomial logit model, both the environmental and bid variables are significant in both treatments, but the parameter on the environmental variable is approximately three times larger in the non-rounded bid treatment. In addition, the model variance is 33 percent smaller in the in the non-rounded bid treatment, while marginal willingness to pay is about 140% larger. These results speak to the validity and the reliability of the valuation study outcomes (Bishop and Boyle 2019). They indicate that the use of rounded bid amounts could

Downloaded from by guest on October 16, 2026. Copyright 2026

lead to the potentially erroneous conclusion that environmental conditions are not important or perhaps undervalued.

2. Psychology and Marketing Literatures

The use of round and non-rounded prices in consumer behaviour studies has been of longstanding interest in both the broader marketing and psychology literatures. These literatures can help to understand how people might respond to bid amounts in stated-preference studies. Of particular interest in Marketing has been the use of "just-below" pricing for consumer goods, as well as investigation of a range of other odd and charm prices, which are commonly called precise prices in these literatures. Empirical studies within these literatures have shown that these pricing strategies have differential effects on consumer demand (Linag and Kanetkar 2006; Baumgartner and Steiner 2007; Freling et al. 2010; Kleinsaser and Wagner 2011; Choi et al. 2014), with odd prices generally increasing sales, but the effect depends on purchase motivation (Choi et al. 2014), strength of brand preference (Baumgartner and Steiner 2007) and brand and category type (Ngobo et al. 2010; Mace 2012).

To explain these effects, the early marketing literature articulated the difference between level and image effects. Since then, other marketing and consumer psychology studies have identified that the use of non-rounded prices conveys perceptions of accuracy in pricing. More recently, particularly in the psychology literature, effort has been focused on theorising and demonstrating how the use of non-rounded prices induces different models of mental processing which has particular pertinence for the use of non-rounded pricing as a design tactic in discrete choice experiments.

Downloaded from by guest on October 16, 2026. Copyright 2026

Image and level effects

Image effects are a form of signalling and occur when consumers infer meaning from the right most digits of a price. This includes price-image effects where odd prices (e.g., a 99 cent ending price) are seen to signal a price discount, and quality-image effects where consumers view odd prices as an indicator that a product is of inferior quality (Guido and Peluso 2004; Choi et al. 2014). One potential consequence of price-image effects is that the weighting given to price is increased as consumers give more attention to this attribute, consistent with Green and Srinivasan's (1990) perspective about the influencing of changing attribute ranges. Thus, it would be expected that the absolute value of the coefficient for price is greater for rounded prices than for non-rounded prices:

$|\beta_{\text{Non-Rounded Price}}| < |\beta_{\text{Rounded Price}}|$, where β_{Price} represents the coefficient for price in a consumer's utility function.

Secondly, price-image and quality image effects may lead consumers to make potentially incorrect assumptions about the price and other attributes of a product. In a discrete choice modelling context, such incorrect assumptions would be expected to lead to increases in model variance.

$\sigma^2_{\text{Non-Rounded Price}} > \sigma^2_{\text{Rounded Price}}$, where σ^2 represents model variance.

In contrast, level effects occur when consumers underestimate prices because of the use of non-rounded pricing. This can for several reasons, including memory effects whereby consumers fail to remember rightmost digits due to cognitive limitations, and rounding downward effects from consumers rounding down right most digits during perception before all are recognised (e.g., \$799 becomes \$790 or \$700) (Guido and Peluso 2004). The impact of level effects on a discrete choice modelling experiment would also be an increase in model variance.

Downloaded from by guest on October 16, 2026. Copyright 2026

Downloaded from by guest on October 16, 2026. Copyright 2026

Accuracy cues

As shown in Table 1, a number of studies have provided evidence that non-rounded numbers are considered to be more accurate, factual and concrete, with round numbers considered to be more abstract, general and approximations only (Dehaene and Mehler 1992; Schindler and Yalch 2006; Welsh et al. 2011; Sevilla and Bagchi 2014). Consequently, non-rounded numbers are seen to represent a narrower range of numbers (Dehaene and Mehler 1992). Yan (2016) found that non-rounded numbers are perceived to have more masculine attributes relative to round numbers which are perceived to have more feminine attributes (e.g., flexibility, accommodating, leaving more room for adjustment). Given these features, non-rounded prices have been found to be more persuasive (Schindler and Yalch 2006), are considered more carefully derived (Thomas et al. 2010), are more likely to be agreed to in negotiations (Yan 2016) and can increase attribute weights (Pena Marin and Isaac 2019). The greater persuasiveness of non-rounded prices implies that higher prices are considered more reasonable to pay, and this correspondingly implies a reduction in consumers' price sensitivity, and consequently it would again be expected that the absolute value of the coefficient for price is less for rounded prices than for non-rounded prices:

$|\beta_{\text{Non-Rounded Price}}| < |\beta_{\text{Rounded Price}}|$, where β_{Price} represents the coefficient for price in a consumer's utility function.

<<Table 1 about here>>

Ease of processing

Round numbers have been demonstrated to be more fluently or easily processed than non-rounded numbers, which increase consumer liking of round prices (King and Janiszekwski

2011) and increases demand for products where convenience in purchasing is required. However, ease of processing goes beyond simply influencing consumer liking and purchase frequency and influences the weighting respondents give to round versus non-rounded prices. Thomas and Morwitz (2009) found that computational ease affects the perceived magnitude of price differences, with price differences perceived to be larger when round numbers are used, which implies increased price sensitivity from using round numbers. However, Pena-Marin and Yan (2020) found that the relative weighting from using round or non-rounded prices depends on the decision stage. They found that rounded numbers are weighted more heavily at the consideration stage where processing efficiency is a priority, while at the choice stage where decision accuracy is the priority that non-rounded prices were weighted more heavily. This finding implies that in discrete choice experiments, which involve hypothetical decision making at the choice stage, use of non-rounded prices would be expected to increase price sensitivity. This contrasts with the effect of image and level effects and accuracy cues, and would lead to the expectation that:

$|\beta_{\text{Non-Rounded Price}}| > |\beta_{\text{Rounded Price}}|$, where β_{Price} represents the coefficient for price in a consumer's utility function.

<<Table 2 about here>>

Dual processing theories

The presence of, characteristics, and implications of these two processing systems is the subject of Daniel Kahnemann's 2011 book "Thinking Fast, Thinking Slow", although as Kahnemann acknowledges "Psychologists have been intensely interested for several decades in the two modes of thinking" (p.20). Dual processing theories contend that the brain has two unique processing styles or systems. System 1 or Type 1 processing is intuitive, acts with limited mental effort, makes quick decisions, is gullible and biased to believe; in contrast,

Downloaded from by guest on October 16, 2026. Copyright 2026

System 2 or Type 2 processing is much more cognitive and effortful, slow and deliberative, though it is often lazy and would not be activated unless needed (Alter et al. 2007; Kahnemann 2011). According to Kahnemann (2011), "System 2 is in charge of doubting and unbelieving" (p.81) resulting in one being "more likely to be vigilant and suspicious" (p.59).

A central concept in dual processing models is that System 2 thinking only occurs when a person experiences cognitive strain or disfluency. The presence of cognitive strain is an indicator that System 2 thinking is needed. Atler et al. (2007) supported this perspective by citing neuroscientific evidence that disfluency leads to the activation of that part of the "responsible for deliberative and effortful thought" (p.570). They also added experimental evidence showing that increasing difficulty or disfluency (for example, a more difficulty to read font condition) cues participants to use more cognitive demanding and analytical processing, and to make fewer mistakes.

In the context of round versus non-rounded pricing, Wadwha and Zhang (2015) found that rounded numbers encourage reliance on feelings in decision making (consistent with System 1 thinking), while non-rounded numbers encourage reliance on cognition (which is consistent with System 2 thinking). Consistent with the findings of dual processing theory, they found that fluency acts as a signal suggesting that feelings-based processing is sufficient, while disfluency from the use of non-rounded numbers facilitates a reliance on cognition.

The important implications from dual-processing theories for the setting of bid vectors in discrete choice modelling, is that that by using non-rounded bids System 2 thinking may be induced. If this is the case, full information processing is more likely to occur with less use of heuristic-based decision making. This implies that model variance will be higher with the use of rounded prices than with non-rounded prices.

$$\sigma^2_{\text{Non-Rounded Price}} < \sigma^2_{\text{Rounded Price}}, \text{ where } \sigma^2 \text{ represents model variance.}$$

Downloaded from by guest on October 16, 2026. Copyright 2026

3. Hypotheses

Given that (1) image effects may lead to greater attention and therefore weight being given to non-rounded numbers; (2) that non-rounded numbers are more highly weighted at the choice stage given that processing accuracy is weighted more highly at this stage than processing efficiency; (3) that non-rounded numbers produce marginal rates of substitution that are more difficult to estimate as well being more likely to generate a larger array of marginal rates of substitution within a choice set which will create greater task complexity; and (4) that non-rounded numbers are likely to be less fluently processed, it is expected that use of non-rounded numbers will trigger use of System 2 thinking. As System 2 thinking tends to be more critical and sceptical about the information provided, it is likely to be more cautious about committing to pay increased costs, leading to high cost sensitivity. Thus, our first hypothesis is:

> H1a. Use of non-rounded bids rather than round bids will lead to a significantly larger magnitude in the absolute value of the coefficient for cost

However, given that image and level effects and perceived accuracy potentially decrease the importance placed on cost, our alternative first hypothesis is that:

> H1b. Use of non-rounded bids rather than round bids will lead to a significantly lower magnitude in the absolute value of the coefficient for cost

Our next hypothesis relates to status quo maintenance and status quo biases. As Eidelman and Crandall (2012) have noted, status quo biases can have many causes, including loss aversion, endowment effects, omission bias etc. However, in the current context, these

Downloaded from by guest on October 16, 2026. Copyright 2026

effects would be likely to be present to both treatments to the same extent given that the same status quo alternative is specified, and the alternatives are not materially different apart from minor changes in the prices. Eidelman and Crandall (2012) noted that choosing to maintain the status quo can be rational and need not be caused by bias. One rational basis for choosing status quo maintenance relevant to this study is cognitive limitations, whereby choice difficulty leads decision makers to do nothing or maintain current choices, because the cost is perceived to outweigh the benefit of choosing a different and better option. Eidelman and Crandall (2012, p.217) reported as evidence for their perspective that "preference for the status quo increases as a function of the number of options (Kempf & Ruenzi, 2006; Samuelson & Zechhauser, 1988)". From this perspective, as rounded prices provide an easy yes or no choice, we would expect rounded prices to lead to a lower propensity to choose the status quo option, while complexity arising from non-rounded would be expected to increase the propensity for some respondents to choose the status quo alternative. Indeed, evidence from the economics literature of increased choice of the status quo alternative has been found in a number of previous studies as task complexity increases (as noted by Mazotta and Opaluch 1995; Swait and Adamowicz 2001; Hensher 2004, 2006; Boxall et al. 2009 etc.). However, from the perspective of the psychology literature, by inducing System 2 processing, the use of non-rounded prices is likely to reduce the use of heuristics because greater task difficulty is likely to induce the use of more cognitively-based thinking that relies less on intuition and the use of heuristics. This would reduce the propensity of respondents to choose the status quo option.

Thus, our next hypotheses are:

> H2a. Use of non-rounded bids rather than round bids will lead to an increase in the propensity for respondents to choose the status quo alternative

Downloaded from by guest on October 16, 2026. Copyright 2026

H2b. Use of non-rounded bids rather than round bids will lead to a decrease in the propensity for respondents to choose the status quo alternative

where H2a is based on rational decision making in the presence of cognitive constraints. Here respondents are assumed to compare the costs and benefits of responding, and is based on empirical results from a series of studies from the environmental and resource economics literature (Mazotta and Opaluch 1995; Swait and Adamowicz 2001; Boxall et al. 2009; Hensher 2004, 2006 etc.), and H2b is based on psychology theory and the inducing of System 2 Thinking (full information processing).

Task complexity would also be expected to have effects on attribute choice processes. As noted in our earlier discussion of effects of attribute level design, the use of partial decision strategies is sensitive to bid level design. As has been pointed out by Hensher (2004) within the economics literature, when the number of attribute levels increases, respondents are more likely to use heuristics such as enumeration. Hensher (2006) notes that as complexity increases respondents are more likely to selectively use information, as they do in normal markets, and ignore certain attributes. Thus, in contrast to status quo maintenance, the effect of complexity here is to utilise simplified rules or heuristics to make choices, rather than to simply choose the status quo option for more difficult choices. This use of heuristics would lead to an increase in the number of insignificant attribute coefficients as they are ignored by respondents and less attention is paid to the actual numbers presented, which would also be expected to increase standard errors and reduce the significance of coefficients. This logic and evidence inform Hypothesis 3a. However, again, we note the perspective of the psychology literature, that by inducing System 2 processing the use of more cognitively-based thinking that relies less on intuition and the use of heuristics would be likely to increase, which informs Hypothesis 3b. Thus, our next two hypotheses are as follows:

Downloaded from by guest on October 16, 2026. Copyright 2026

H3a. Use of non-rounded bids rather than round bids will lead to an increase in the number of significant coefficients for attributes

H3b. Use of non-rounded bids rather than round bids will lead to a decrease in the number of significant coefficients for attributes

Based on (1) the findings from the psychology and marketing literatures about cognitive strain from use of non-rounded prices inducing System 2 thinking which is more cognitively oriented and results in fewer errors, and (2) that non-rounded prices produce a richer set of trade-off information (Pearmain et al. 1991; Mariel et al. 2021), we expect that the use of non-rounded prices will reduce model variance (and increase scale, and thus make parameters smaller). However, given the insights from the marketing literature on image and level effects whereby non-rounded prices may lead to the making of incorrect assumptions, and the insights from the economics literature that increased complexity may lead to increased use of heuristics and the ignoring of attributes, it is also possible that the use of non-rounded prices will increase model variance (and reduce scale, and thus make parameters larger). Hence our fourth set of hypotheses are:

H4a. Use of non-rounded bids rather than round bids in a choice experiment will reduce model variance

H4b. Use of non-rounded bids rather than round bids in a choice experiment will increase model variance

4. Methodology

Downloaded from by guest on October 16, 2026. Copyright 2026

Next the methodology for the two experimental treatments is detailed. The experimental treatments are identical in all aspects, including having the same experimental design apart from minor changes to the bid levels in the non-rounded treatment which were made by slightly increasing or decreasing the bids of the rounded treatment.

Case Study

The Cooks River is in the inner south-west of Sydney. Its catchment area covers 100 km^2 and the main stem of the river begins as a stream and flows 23 km where it enters Botany Bay. Most of the streams in the Cooks River catchment area have been substantially modified with most of the native riparian vegetation cleared. In this context there is a need to identify household willingness to pay for habitat remediation, specifically to improve waterway channels and increase native vegetation. The study results can assist in evaluating remediation expenditures against other community needs through cost-benefit analysis, and to enable the prioritising of expenditures given differences in costs, outcomes and expected time frames until restoration outcomes might be achieved.

Questionnaire Design

The questionnaire used for estimating the non-use values was in the second part of a survey completed by respondents, with the first half of the questionnaire designed to collect data for the estimation of a travel cost random utility model.

In the questionnaire an overview was first provided of the Catchments and their location, including a map. This was followed by a definition of what is meant by native vegetation, including its benefits and costs to clarify their functions.

The attributes relating to vegetation and channel condition were introduced next in the questionnaire. Two conditions were defined: (1) modified channels with no native vegetation, and (2) segments with natural channels and native vegetation. Channel condition and

Downloaded from by guest on October 16, 2026. Copyright 2026

vegetation condition were combined to minimise respondent cognitive burden, as more detailed specification of attributes was found to problematic in earlier versions of the questionnaire. Photos were provided as examples for these two conditions, which were used as a basis for defining attributes for vegetation and channel condition in the choice sets.

The current condition of waterways in the Cooks River catchment was then described. The current length of the waterways that have a modified waterway channel and no native vegetation, and the length that has a natural waterway channel and native vegetation were defined and shown on a map of the catchment. Potential management options for improving channels that have been modified and native vegetation were described and photos of examples were then shown**.**

Next, a hypothetical scenario was put to respondents to enable valuation of improvements in channel and native vegetation condition. Households were asked to vote on whether to approve management plans to improve waterway channels and increase native vegetation. A referendum was used as this has been shown to produce value estimates that are closer to the value estimates derived when actual payment is involved (Taylor et al. 2010).

Respondents were told that costs would be experienced through increased land rates, starting in 2016, and that costs would be passed onto renters through additional rental charges. Payments would occur for five years. Respondents were told that the funds raised would go into a trust fund, which would only be used for this purpose.

Respondents were also told that the results will be used by local councils and Sydney Water, an urban water utility organisation, to make decisions, which is consistent with encouraging respondents to believe that the results will be consequential, which has been shown to be important in deriving valid value estimates (Vossler et al., 2009, Vossler et al., 2012). Respondents were also reminded that they could always spend their money on other things and

Downloaded from by guest on October 16, 2026. Copyright 2026

asked to vote as if they were participating in a referendum today, which is consistent with the wording often used in a "short cheap talk" script which are designed to reduce acquiescence bias (List et al., 2006; Morrison and Brown 2009).

After the payment scenario was described, respondents were shown an example choice set and provided with a description of how to answer it. They were then given four choice sets to answer, an example of which is shown in Figure 1. There were three attributes used plus household cost. Two different bid vectors are used for household cost: one with round bids, and one with non-rounded bids (see Table 4).

<<Figure 1 about here>>

Of the remaining three attributes, the first two were related to vegetation and channel condition: "modified channel and no native vegetation" and "natural channel with native vegetation". These were based on the current state of the waterways in the catchment. The levels for these two attributes were varied within the range of possible changes. An increase in the length of "natural channel with native vegetation" implied an equivalent decrement in the length of waterways with "Modified channel and no native vegetation". The third attribute was time until improvement occurs, and its levels were 6, 10 and 20 years.

Experimental Design

The two treatments use the same experimental design apart from minor changes to the bid levels as detailed in Table 4. A Bayesian efficient experimental design was used to derive choice alternatives for the survey. Each experimental design had 24 choice sets. Dominated alternatives were specifically excluded from the design. The design for the non-rounded cost treatment was based on the experimental design generated using Ngene for the rounded cost treatment. As noted, the non-rounded cost treatment different only in that the household costs generated by the Ngene for the rounded cost treatment were slightly increased or decreased

Downloaded from by guest on October 16, 2026. Copyright 2026

from their original value in the rounded treatment. Otherwise, the experimental designs for the two treatments were identical.

Pretesting and Sample

The draft questionnaire was refined using in-depth interviews with residents in the Cooks River Catchment, as well as completion of a pre-test survey. The main survey was conducted in June and July 2016, resulting in a sample of 220 completed surveys for the round-price sub sample and 222 completed surveys for the non-rounded-price sub sample. The data were collected through an internet survey using the Research Now Internet Panel, which is a global provider of internet panels, that also has an Australian internet panel[i]. All respondents available in the panel were included that lived in the Cooks River Catchments that met the criteria that they were above 18 years.

The socio-demographic profiles of the populations and samples from the Cooks catchment is shown in Table A1. While there are some differences to the population, the sub-sample means and proportions for both treatments are fairly similar for the variables in Table S1, and no significant differences were identified using either chi-square tests or independent sample t-tests.

While no significant differences were identified in the variables across the two sub-samples, to test whether there were any effects due to sample and population differences, four variables were used to develop weights: gender, having children, household income, and having a degree. This is important as the power associated with sociodemographic differences is increased in discrete choice experiments because of the use of panel data for each respondent, such that the effect of seemingly minor differences is expanded. Environmental orientation was not included when calculating sample weights as population-level data were not available for this variable, and no significant difference was identified in the comparison across samples, while age was

Downloaded from by guest on October 16, 2026. Copyright 2026

excluded because of difficulties in running the raking algorithm with multiple variables and because of the similarity between the mean age for the samples and their populations. Sample weights were created in R (R Core Team 2013).

Model Estimation

To enable testing of our first three hypotheses, the random parameters error components logit model without correlated errors was initially used to analyze the data (e.g., Campbell et al., 2008; Scarpa et al., 2008). We chose this model because of its ability to account for the pseudo panel nature of many choice data sets (in most stated preference choice modelling applications, individuals typically provide answers to more than one choice question). Failure to account for repeated choices and the panel nature of the data impacts the standard errors and affects parameter estimates. The model also allows the modelling of heterogeneity for variables of interest. A further advantage of this model is that the IID assumption is relaxed, thereby avoiding the IIA (independence of irrelevant alternatives) property that can affect conditional logit models.

Following Kahn et al. (2017), for our dataset we estimate models where time until project outcomes are achieved is included through an interaction with the variable for kilometers of streams with natural channels with native vegetation (NaturalChan&NativeVeg):

$$U_{nsj} = \beta_0 ASC_{nsj} + \beta_1 Household\ Cost_{nsj} + \beta_2 NaturalChan\&NativeVeg_{nsj} + \beta_3 NaturalChan\&NativeVeg_{nsj} \times Time_{nsj} + \varepsilon_{nsj} \quad [1]$$

The utility specification in the random parameters logit model allows for the possibility that different respondents may have different marginal utilities for each attribute being modeled. Such differences are accounted for by allowing one or more parameters to be specified as:

Downloaded from by guest on October 16, 2026. Copyright 2026

$$\beta_{nk} = \overline{\beta}_k + \eta_k z_{nk},$$

where $\overline{\beta}_k$ represents the mean or some other measure of central tendency for the distribution of marginal utilities held by the sampled population and η_k represents a deviation from the mean parameter and z_{nk} is an individual specific (set of) draw(s) from some predefined distribution (e.g., $z_{nk} \sim N(0,1)$. In our modelling approach, the cost variable has a triangular distribution, and all other variables apart from the alternative specific constant are normally distributed.

The data from the rounded and non-rounded samples were jointly estimated so that the estimated parameters for each sample have the same scale and consequently tests of differences of attribute coefficients are not confounded with scale. This was achieved by use of choice sets with varying alternatives, where the rounded and non-rounded samples are assigned different alternatives (i.e., rounded-bid sample – A1, B1, C1; non-rounded bid sample – A2, B2, C2). Sample-specific beta coefficients are estimated for each variable.

Random parameters error component logit models were estimated in preference space given the limitations of the available sample size and difficulty achieving model convergence estimating in WTP space. Further details on the error components random parameters logit model can be found in Hatton-MacDonald et al. (2011).

For testing of hypothesis four related to differences in overall model variance, we estimate a scaled multinomial logit model (Greene 2016). This is a form of the generalized mixed multinomial logit model where no parameters are random. We choose this model because of: (1) its ability to account for heterogeneity across individuals which is needed for modelling treatment effects; (2) it also can account for the panel nature of the data; and (3) it does not

Downloaded from by guest on October 16, 2026. Copyright 2026

include variables (i.e., random parameters) that may confound hypothesis testing of differences in parameters.

Following Greene (2016), the utility function for a scaled multinomial logit model is specified as follows. Let U_{nsj} denote the utility of alternative *j* perceived by respondent *n* in choice situation *s*, V_{nsj} is an observed component of utility, ε_{nsj} an unobserved component the assumption that is IID EV1, and σ_n is scale such that:

$$U_{nsj} = V_{nsj} + (1/\sigma_n)\varepsilon_{nsj} \quad [2]$$

The probability P_{nsj} that respondent *n* chooses alternative *j* in choice situation *s,* shown in equation 2, is similar to the conditional logit model apart from the modelling of the scale parameter (σ_n) which in the conditional logit model is typically normalised to one.

$$P_{nsj} = \frac{exp(\sigma_n V_{nsi})}{\sum_{i \in J_{ns}} exp(\sigma_n V_{nsi})} \quad [3]$$

In the scaled multinomial logit model, the unobserved heterogeneity across individuals is modelled as:

$$\sigma_n = \exp(-\tau^2/2 + \tau w_n) \quad [4]$$

As noted by Greene (2016), in equation 3 the constant $-\tau^2/2$ is chosen so that $E[\sigma_n] = 1$ if $w_n \sim N[0,1]$.

As shown in equation 4, it is also possible to model observed heterogeneity across individuals through addition of $\delta' a_n$. Here a_n represents observed variables which include treatments, panel data (i.e., repeat choices), and sociodemographic characteristics.

$$\sigma_n = \exp(-\tau^2/2 + \tau w_n + \delta' a_n) \quad [5]$$

Downloaded from by guest on October 16, 2026. Copyright 2026

As robustness tests, two additional models are estimated: (1) a nested logit model, (2) a random parameters error components logit model with correlated errors (but no triangular distribution for cost). These models are reported in the Online Appendix.

Variables

The variables included in the models are summarised in Table 3.

<<Table 3 about here>>

Downloaded from by guest on October 16, 2026. Copyright 2026

5. Results

The results for the random parameters logit model with correlated errors is presented in the first and second column of Table 4. As noted in the previous section, the data for the round and non-rounded treatments were estimated jointly using NLOGIT6. This was done to simplify hypothesis testing, as when sub-samples are estimated jointly, they have the same scale.

The results indicate that the coefficients for the alternative specific constants and household cost are all significant at $p<0.05$ in both treatments. The coefficients for natural channels and native vegetation, and the interaction between natural channels and native vegetation and time, are both significant at $p<0.01$ for the non-rounded treatment, while neither coefficient is significant for the round treatment. This provides evidence in support of Hypothesis 3a, that use of the non-rounded treatment will lead to a larger number of significant coefficients.

To test whether the coefficient for household cost (hypothesis 1) differed across treatments, a Wald test was conducted. The Wald test was preferred to a likelihood ratio test because in a random parameters logit model the latter is a test of the equality of both the beta coefficients and the coefficients for the standard deviations, while the Wald test allows for testing of only differences in the beta coefficients. While the mean of the cost coefficient for the non-rounded sample is 36% larger than the mean for the non-rounded sample, no significant difference was found between cost coefficients (Z= -1.20, p=0.23). However, significant differences were found using a nested logit model and a likelihood ratio test (χ^2=5.936, p=0.015) or a Wald test (Z=2.35, p=0.019), and for the random parameters error components logit model where price did not have a triangular distribution using a Wald test (Z=1.92, p=0.055) but not when using a likelihood ratio test (χ^2=9.287, p=0.00). Thus, the robustness of this hypothesis test appears to be sensitive to model specification, which suggests that there is mixed support for hypothesis H1a.

To test whether there was a difference in the propensity to choose the status quo option across treatments (hypothesis 2), a likelihood ratio test was used as this variable was not a random parameter in the model. The test indicated no significant differences between alternative specific constants (χ^2=0.48, p=0.49), and therefore no support for either hypotheses H2a or H2b.

<<Table 4 about here>>

The results for the weighted scaled multinomial logit model presented in Table 5. Of most interest in this model is the results for the delta coefficient. This coefficient shows the effect of the use of the non-rounded treatment on scale. The positive and significant coefficient indicates that scale is higher, and consequently model variance is lower, for the non-rounded treatment. Using equation 4, we find that there is a 33.3% reduction in variance in the non-

Downloaded from by guest on October 16, 2026. Copyright 2026

rounded treatment[ii]. This provides evidence in support of hypothesis 4a and suggests that the reduction in use of heuristics stimulated by triggering System 2 processing and the provision of a richer set of trade-off information from using non-rounded bids outweighs any increases in variance due to incorrect assumptions about prices as implied by the literature related to image and level effects.

<<Table 5 about here>>

A larger number of significant coefficients (Hypothesis 3a) and the magnitude of the cost coefficient (Hypothesis 1) would be expected to influence marginal willingness to pay. Given that the coefficients for NaturalChan&NativeVeg and its interaction with Time were insignificant in the random parameters logit model for the rounded treatment, we use the results from the scaled multinomial logit model to calculate marginal willingness to pay. In the scaled multinomial logit model for the rounded treatment the coefficient for NaturalChan&NativeVeg is positive and significant, while the interaction with Time is negative as expected but insignificant. In contrast, for the non-rounded treatment both the coefficient for NaturalChan&NativeVeg and its interaction with Time have the expected signs and are significant.

In estimating marginal willingness to pay we use the following formula:

$$MWTP = (\beta_2 + \beta_3 \times TIME)/\beta_1 \quad (6)$$

where $MWTP$ is the marginal willingness to pay, β_2 represents the coefficient of NaturalChan&NativeVeg, β_3 represents the coefficient for the interaction of NaturalChan&NativeVeg with Time, and β_1 represents the household cost attribute coefficient. As shown in Table 6, the magnitude of willingness to pay in the non-rounded treatment has increased by approximately 140% across the three scenarios investigated relative to the rounded treatment.

Downloaded from by guest on October 16, 2026. Copyright 2026

<<Table 6 about here>>

6. Discussion

The question of how to design bid vectors for discrete choice experiments has received much consideration in the literature. This has been necessary because of the potential and sizeable effects that design choices can have on results, including effects associated with the magnitude of the bid vector, the range of the bid vector, and the number of attribute levels used. We add to this literature by considering one hitherto neglected aspect of bid design in discrete choice experiments – the usage of round versus non-rounded numbers.

Our first hypothesis focused on the effect of choice or round versus non-round bids on the price coefficient. The various theories that inform the likely effect on price/cost weights suggest different direction of effect. Insights from the literature related to image effects, processing fluency, and dual-processing models infer that an increase in price/cost weights should be expected due to greater attention being given to price at the decision stage (image effects and processing fluency), and increased criticality during purchase (dual-processing models). In contrast, the insight from the research on accuracy cues is the opposite: that price/cost weights should be lower as respondents become more convinced of the appropriateness of higher prices. While our analysis produced a 36% higher price coefficient when non-rounded bids were used, which supports the logic from the literature on image effects, processing fluency, and dual-processing models, we found only mixed evidence in support of this hypothesis with the result sensitive to model type. However, given the current study's sample size, it is possible that increased statistical power would lead to stronger support for Hypothesis 1a.

Downloaded from by guest on October 16, 2026. Copyright 2026

A theme in the choice modelling literature is that increased complexity can lead to increased use of heuristics (e.g., Hensher 2004, 2006). From this perspective we would expect that non-rounded prices that are more difficult to process would lead to the sorts of effects that reflect increased use of heuristics, such as fewer significant attributes and increased choice of the status quo, and increased model variance. In this study, while no difference in the choice of the status quo alternative across treatment was observed, a substantial change in the number of significant coefficients for choice set attributes was observed, as well as reductions in model variance. Thus overall, the evidence from this study suggests the opposite is occurring – use of non-rounded prices appears to be *reducing* the use of heuristic decision rules or partial processing. This suggests that insights from other literatures are needed to explain this phenomenon.

The psychology literature offers a couple of helpful insights to explain the apparent reduced use of heuristics. This includes the growing evidence that non-rounded bids convey to respondents that the numbers presented are more accurate and concrete and represent a smaller range of values (e.g., Dehaene and Mehler 1992). The use of non-rounded prices suggest that they have been more carefully thought through by the researcher and hence should be treated with more confidence. This has the potential to both reduce model variance but also increase the attribute weight for cost (e.g., Pena-Marin and Isaac 2019).

The psychology literature on ease of processing and dual processing theory is also very relevant. There is growing evidence that people have two processing systems: system 1 which is intuitive, fast and acts with limited mental effort, while system 2 is far more cognitively oriented, analytical and makes fewer errors but has to be triggered to operate as it is lazy and avoids engagement unless needed (Kahnemann 2011). We consider that, given previous findings from the psychology literature as well as our own findings, that the use of

Downloaded from by guest on October 16, 2026. Copyright 2026

non-rounded prices triggers use of system 2 thinking when respondents answer discrete choice experiments. We find substantive evidence of the engagement of more cognitive processes in the non-rounded bid treatment, including a larger number of significant attributes and reduced model variance. It is possible and even likely that the reduction in model variance is also due to other factors such as the increase in trade-off information from employing non-rounded rather than round prices (Pearmain et al. 1991), as well as the perception that non-rounded prices are more accurate.

Our findings therefore provide support for the increased use of non-rounded prices in discrete choice experiments, and for reasons beyond simply increasing cost differences or trade-off information (Pearmain et al. 1991; Mariel et al. 2021). Rather, the use of non-rounded prices appears to be a useful mechanism for increasing respondent confidence in the experiment and the accuracy of bid numbers, and for stimulating type 2 full information processing that leads to more careful consideration of choice responses, and fewer errors and reduced model variance which is generally the objective of those designing discrete choice experiments.

Further testing is needed to determine the generalisability of these findings, including across disciplinary contexts (e.g., marketing, transportation and health), and cross-culturally given previous findings of country-specific effects with respect to bid vector design (Rose et al. 2009). Further research could also examine whether the effects identified in this study are moderated by number of levels, and the use of exponential versus even-distribution of levels. We also only considered changes to the cost vector; the effect of using non-rounded prices on other non-cost quantitative attributes could also be examined.

Downloaded from by guest on October 16, 2026. Copyright 2026

Acknowledgments

Greater Sydney Local Land Services, City of Canterbury Council, Fairfield City Council, Sydney Water, Commonwealth Scientific Industrial Research Organisation provided funding for this research.

References

Alter, A.L., Oppenheimer, N.E., Eyre, R.N., 2007. Overcoming Intuition: Metacognitive Difficulty Activates Analytic Reasoning, J. of Exp. Psychol.: Gen., 136(4), 569-576.

Ariely, D., Loewenstein, G., Prelec, D., 2003. Coherent arbitrariness: stable demand curves without stable preferences. Q. J. Econ., 118 (1), 73–105.

Baumgartner, B. and Steiner, W.J., 2007. Are Consumers Heterogeneous in Their Preferences For Odd and Even Prices? Findings from a Choice-Based Conjoint Study, Int. J. Res. Market., 24, 312323.

Bishop, R.C., Boyle, K.J., 2019. Reliability and validity in nonmarket valuation. Envir. and Res. Econ., 72, 559-582.

Boxall, P.C., Adamowicz, W.L. and Moon, A., 2009. Complexity in choice experiments: choice of the status quo alternative and implications for welfare measurement, Aust. J. Agr. Resour. Econ., 53(4), 1-17.

Boyle, K.J., Bishop, R.C., Welsh, M.P., 1985. Starting point bias in contingent valuation bidding games. Land Econ., 61(2), 188-194.

Boyle, K.J., Johnson, F.R., McCollum, D.W., 1997. Anchoring and Adjustment in Single-Bounded, Contingent-Valuation Questions. Am. J. Agr. Econ., 79(5), 1495-1500.

Downloaded from by guest on October 16, 2026. Copyright 2026

Campbell, D., Hutchinson, W., Scarpa, R., 2008. Incorporating discontinuous preferences into the analysis of discrete choice experiments, Env. Res. Econ., 41 (3), 401-417.

Choi, J., Li, Y.J., Rangan, P., Chatterjee, P., Singh, S.N., 2014. The Odd-ending Price Justification Effect: The Influence of Price-Endings on Hedonic and Utilitarian Consumption, J. Acad. Market. Sci., 42, 545-557.

DeShazo, J. R., Fermo, G., 2002. Designing choice sets for stated preference methods: The effects of complexity on choice consistency. J. of Env. Econ. Manag. 44 (1), 123-143.

Dehaene, S. and Mehler, J., 1992. Cross-Linguistic Regularities in the Frequency of Number Words, Cogn., 43,1-29.

Eidelman, S. and Crandall, C.S., 2012. Bias in Favor of the Status Quo: Bias and the Status Quo. Soc. Pers. Psych. Comp., 6(3), 270-281.

Freling, T., Vincent, L., Schindler, R., 2010. A Meta-analytic Review of Just-Below Pricing Effects, Adv. Consum. Res., 37, 618-620.

Glenk, K., Meyerhoff, J., Akaichi, F. and Martin-Ortega, J., 2019. Revisiting Cost Vector Effects in Discrete Choice Experiments, Resour. Energy Econ., 57, 135-155.

Green, P.E., Srinivasan, V., 1990. Conjoint Analysis in Marketing: New Developments With Implications for Research and Practice. J. Market., 54(4), 3-19.

Greene, W.H., 2016. NLOGIT Version 6 Reference Guide. Econometric Software Inc, New York.

Guido, G. and Peluso, P., 2004. Consumers' Perceptions of Odd-Ending Prices with the Introduction of the Euro. J. Prod. Brand Manag., 13(2/3), 200-210.

Downloaded from by guest on October 16, 2026. Copyright 2026

Hatton MacDonald, D., Morrison, M., Boyle, K.J., Rose, J., 2011. Valuing a Multi-state River: The Case of the River Murray. Aust. J. Agr. Resour. Econ., 55: 374-392.

Hensher, D.A., 2004. Identifying the Influence of Stated Choice Design Dimensionality on Willingness to Pay for Travel Time Savings, J. Transport. Econ. Policy., 38(3), 425-446.

Hensher, D.A., 2006. How do Respondents Process Stated Choice Experiments? Attribute Consideration Varying Information Load. J. App. Economet., 21, 861-878.

Herriges, J.A., Shogren, J.F., 1996. Starting point bias in dichotomous choice valuation with follow-up questioning. J. Env. Econ. and Man., 30(1), 112-131.

Kahn, J.R., Vásquez, W.F. and De Rezende, C.E. 2017. Choice modeling of system-wide or large scale Env. change in a developing country context: Lessons from the Paraiba do Sul River. Sci. Tot. Environ., 635, 315-322.

Kahnemann, D., 2011. Thinking, Fast and Slow. Penguin Books, Melbourne.

King, D., Janiszekwski, C., 2011.The Sources and Consequences of the Fluent Processing of Numbers. J. Market. Res., 48(2), 327-341.

Kleinsaser, S. Wagner, U., 2011. Price Endings and Tourism Consumers' Price Perceptions, J. Retailing Consum. Serv., 18, 58-63.

Linag, J., Kanetkar, V., 2006. Price Endings: Magic and Math, J. Prod. Br. Manag., 15(6), 377-385.

List, J., Sinha, P., Taylor, M., 2006. Using Choice Experiments to Value Non-Market Goods and Services: Evidence from Field Experiments. BE J Econ. Anal. Policy. 5(2):1-39. https://doi.org/10.2202/1538-0637.1132

Downloaded from by guest on October 16, 2026. Copyright 2026

Mace, S., 2012, The Impact and Determination of Nine-Ending Pricing in Grocery Retailing. J. Retail., 88(1), 115-130.

Mariel, P., Hoyos, D., Meyerhoff, J., Czajkowski, M., Dekker, T., Glenk, K., Jacobsen, J., Liebe, U., Olsen, S., Sagebiel, J., Thiene, M. (2021). Environmental Valuation with Discrete Choice Experiments: Guidance on Design, Implementation and Data Analysis, Springer, Cham, Switzerland.

Mazzotta, M.J., Opaluch, J.J., 1995. Decision making when choices are complex: A test of Heiner's hypothesis. Land Econ. 71 (4) November, 500-515.

Mellers, B. A., Cooke, A.D. J., 1994. Trade-offs depend on attribute range. J. Exp Psych.: Human Perception and Performance, 20(5), 1055–1067. https://doi.org/10.1037/0096-1523.20.5.1055

Mørkbak, R.M., Christensen, T., Gyrd-Hansen, D., 2010. Choke price Bias in choice experiments. Env. Resour. Econ. 45, 537–551.

Ngobo, P., Legohérel, P., Guéguen, N., 2010. A Cross-category Investigation in the Effects of Nine-ending Pricing on Brand Choice. J. Retail. Consum. Serv., 17, 374-385.

Pearmain, D., Swanson, J., Kroes, E., Bradley, M., 1991. Stated Preference Techniques: A Guide to Practice. Second Edition. Report prepared by Steer Davies Gleave and Hague Consulting Group.

Pena Marin, J., Isaac, M.S., 2019., Placing Value on Place Value: Numerical Precision Influences the Weighting of Ascending Versus Descending Attributes, Adv. Consum. Resear., 47, 222-226.

Downloaded from by guest on October 16, 2026. Copyright 2026

Pena-Marin, J., Yan, D., (2020). Reliance on Numerical Precision: Compatibility between Accuracy versus Efficiency Goals and Numerical Precision Level Influence Attribute Weighting in Two-Stage Decisions. J. Cons. Psych., 31(1), 22-36. DOI:10.1002/jcpy.1178

Petty, R.E., Caccioppo, J.T., 1986. The elaboration likelihood model of persuasion. Adv. Exp. Soc. Psychol., 19, 123-204.

R Core Team., 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Rose, J.M., Hensher, D.A., Caussade, S., Ortúzar, J. Jou, R., 2009. Identifying Differences in Willingness to Pay Due to Dimensionality in Stated Choice Experiments: A Cross-Country Analysis, J. Transport. Geog., 17, 21-29.

Schindler, R.M., Yalch, R.F., 2006. It Seems Factual, But Is It? Effects of Using Sharp Versus Round Numbers in Advertising Claims. Adv. Consum. Res., 33(1).

Sevilla, J., Bagchi, R., 2014. The Effect of Numeric Roundness on Probability Perceptions and Choice. Adv. Consum. Res., 42, 672-676.

Su, L., Adam, B.D., Lusk, J.L., Arthur, F., 2017. Anchoring, information, and fragility of choice experiments: an application to consumer willingness to pay for rice with improved storage management. J. Agr. Resour. Econ., 42, 255–274.

Swait, J., Adamowicz, W., 2001. The Influence of Task Complexity on Consumer Choice: A Latent Class Model of Decision Strategy Switching, J. Consum. Res., 28, 135-148.

Swait, J., Louivere, J.J., 1993. The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models. J. Mark. Res., XXX, 305-314.

Taylor, L.O., Morrison, M., Boyle, K.J., 2010. Exchange Rules and the Incentive Compatibility of Choice Experiments. Env. Resour. Econ., 47(2): 197-220.

Downloaded from by guest on October 16, 2026. Copyright 2026

Thomas, M., Morwitz, V.G., 2009. The Ease-of-Computation Effect: The Interplay of Metacognitive Experiences and Naïve Theories in Judgements of Price Differences. J. Market. Res., 46(1), 81-91.

Thomas, M., Simon, D.H., Kadiyali, V., 2010. The Price Precision Effect: Evidence from Laboratory and Market Data. Market. Sci., 29(1), 175-190.

Tversky, A., Kahnemann, D., 1974. Judgement Under Uncertainty: Heuristics and Biases, Sci., 185, 1124-1131.

Tversky, A., Shafir, E., 1992. Choice under conflict: The dynamics of deferred decision. Psychol. Sci., 3 (6) November, 358-361.

U.S. EPA. (2024). Guidelines for Preparing Economic Analyses. Third Edition. Office of Policy, National Centre for Environmental Economics. epa.gov/system/files/documents/2024-12/guidelines-for-preparing-economic-analyses_final_508-compliant_compressed.pdf . Downloaded 05/19/2025.

Vossler, C.A., Evans, M.F., 2009. Bridging the Gap between the Field and the Lab: Env. Goods, Policy Maker Input, and Consequentiality. J. Env. Econ. Manag., **58**(3): 338-345.

Vossler, C.A., Doyon, M., Rondeau, D., 2012. Truth in Consequentiality: Theory and Field Evidence on Discrete Choice Experiments. Am. Econ. J.: Micro Econ., 4(4), 145-171.

Wadwha, M., Zhang, K., 2015. This Number Just Feels Right: The Impact of Roundness of Price Numbers on Product Evaluations, J. Consum. Res., 41(5), 1172-1185.

Welsh, M.B., Navarro, D.J., Begg, S., 2011. Number Preferences, Precision and Implicit Confidence. Annual Meeting of the Cognitive Science Society, Boston, USA.

Downloaded from by guest on October 16, 2026. Copyright 2026

Weng, W., Morrison, M., Boyle, K., Boxall, P., Rose, J., 2021. Effects of Number of Alternatives in Public Good Discrete Choice Experiments, Ecol. Econ., 182, https://doi.org/10.1016/j.ecolecon.2020.106904

Wieseke, J., Kolberg, A., Schons, L.M., 2016. Life Could Be So Easy: The Convenience Effect of Round Price Endings, J. Acad. Market. Sci., 44, 474-494.

Yan, D., 2016. Numbers are Gendered: The Role of Numerical Precision. J. Consum. Res., 43, 303-315. DOI: 10.1093/jcr/ucw020

Downloaded from by guest on October 16, 2026. Copyright 2026

Table 1. Summary of Studies on Non-rounded Numbers and Perceived Accuracy

Study	Findings
Dehaene and Mehler (1992)	Round numbers are perceived to be approximations; that is, they represent the number itself and numbers close to the round number. Round numbers are more likely to be inaccurate, while non-rounded numbers represent a smaller range of values.
Schindler and Yalch (2006)	Advertising claims made using non-rounded numbers are perceived to be more likely to be based on empirical evidence and more credible, and the effect was the same regardless of whether the non-rounded number was higher or lower than the round number. The difference appears to be primarily to be driven by respondents who have higher ad scepticism, as defined by a median split.
Thomas et al. (2010)	Find in a real estate context that buyers underestimate the magnitude of non-rounded prices, and that they are judged to be smaller than round numbers of a similar magnitude, even when non-rounded numbers are larger. Thomas et al. provide several potential explanations, including expectations that non-rounded prices have smaller magnitudes (a level effect) and buyers inferring that sellers have set the price carefully and therefore it must be a more fair or accurate price.
Welsh et al. (2011)	Precision is an indicator of the level of accuracy and confidence of an estimate
Sevilla and Bagchi (2014)	Round numbers are more abstract or general, while non-rounded (odd) numbers are perceived to be more concrete or realistic

Downloaded from by guest on October 16, 2026. Copyright 2026

Yan (2016)	People project gendered meanings to non-rounded versus round numbers, with non-rounded numbers seen as more masculine relative to round ones. Non-rounded offers are considered to possess more masculine attributes (e.g. aggressive, competitive) than female attributes (e.g., flexible, accommodating, leave more room for adjustment). Communications about product attributes using non-rounded (round) numbers result in more favourable evaluations when the products or attributes are positioned as masculine (feminine).
Pena-Marin and Issac (2019)	Demonstrated that attribute weights are influenced by the level of precision, and that consumers will weight descending attributes (like price where smaller is better) more (less) heavily in their decision making if attribute information is more (less) precise.

Downloaded from by guest on October 16, 2026. Copyright 2026

Table 2. Summary of Studies on Effects of Ease of Processing

Study	Findings
Thomas and Morwitz (2009)	Ease of computation affects judgements of the magnitude of price differentials. Computationally easier differences (e.g., 5.00 – 4.00) will be judged to be larger than computationally difficult differences (e.g., 4.97-3.96) though the differences are similar. Found in experiments that participants were less likely to choose higher price brands when the computations of price differences were easier, implying higher price sensitivity from using round prices.
King and Janiszewski (2011)	Processing fluency contributes to number liking, and round numbers are more fluently processed, therefore round numbers are more liked than non-rounded numbers
Wadwha and Zhang (2015)	Rounded numbers encourage reliance on feelings in decision making, while non-rounded numbers encourage reliance on cognition. Rounded prices intensify evaluative judgements when purchases are driven by feelings (hedonic good), while non-rounded prices intensify evaluation judgements when the purchase decision is driven by cognition (utilitarian good). Fluency acts as a signal suggesting that feelings-based processing is sufficient, while disfluency from the use of non-rounded numbers facilitates a reliance on cognition.
Wieseke et al. (2016)	Consumers perceive round prices as more convenient because their high cognitive accessibility saves time and effort during transactions, consequently round prices increase sales when purchase situations are characterised by a high importance of convenience. Increasing use of round prices fulfills consumers need for convenience.

Downloaded from by guest on October 16, 2026. Copyright 2026

Pena-Marin and Yan (2020)	Found that non-rounded attributes are weighted more heavily when people create consideration sets where decision efficiency is prioritised as non-rounded (rounded) numbers are more easily processed; while more non-rounded attributes are weighted more heavily when making choices where decision accuracy is the priority

Downloaded from by guest on October 16, 2026. Copyright 2026

Table 3. Variable Definitions

Variable	Definition
ASC	Alternative Specific Constant which equals 1 when a status quo alternative is chosen and 0 otherwise
NaturalChan&NativeVeg	Kilometres of streams with natural channels and native vegetation: 4, 10, 16 and 25 km
NaturalChan&NativeVeg * Time	Interaction between Natural Channels and Native Vegetation and Time (where time until improvement occurs is 6, 12, 20 years)
Household cost	Cost to households from improving river health, an annual payment over five years starting in 2016:

Round bid vector	***Non-rounded bid vector***	***Difference in bid amounts***
$10	$9	-$1
$25	$24	-$1
$50	$52	+$2
$100	$93	-$7
$150	$147	-$3
$250	$256	+$6

Downloaded from by guest on October 16, 2026. Copyright 2026

Table 4. Random Parameters Logit Error Components Models with Correlated Errors

	Rounded Sample	**Non-rounded Sample**
NaturalChan&NativeVeg		
B	0.00989	0.09379***
	(0.03277)	(0.02333)
σ	0.43458	0.028579
	(1.15538)	(1.35567)
NaturalChan&NativeVeg × Time		
B	-0.00092	-0.00248***
	(0.00099)	(0.00094)
σ	0.00501	0.00380
	(0.00615)	(0.04920)
Household cost		
B	0.00721***	0.00984***
	(0.00148)	(0.00161)
σ	0.02698***	0.02644***
	(0.00643)	(0.00653)
Non-random Parameters		
ASC	-3.10187***	-3.43178***
	(0.65377)	(0.87032)

Downloaded from by guest on October 16, 2026. Copyright 2026

Summary statistics	
LL(0)	-3110.37013
LL(β)	-1458.74852
Adj. $\rho(0)$	0.53100
No. of respondents	442
No. of observations	1768

Notes: the data from both treatments were estimated jointly in a single model

* p<0.1; ** p<0.0; *** p<0.01

Standard errors are in brackets

Downloaded from by guest on October 16, 2026. Copyright 2026

Table 5. Scaled multinomial model showing results for both the round and non-rounded treatments

	Round Treatment	Non-rounded Treatment
Design parameters		
NaturalChan&NativeVeg	0.03033**	0.09142**
	(0.01416)	(0.03606)
NaturalChan&NativeVeg * Time	-0.00060	-0.00155**
	(0.00049)	(0.0004)
Household cost	-0.00620***	-0.00809***
	(0.00203)	(0.0052)
ASC	-2.08815***	-1.50029**
	(0.66799)	(0.60394)
Variance parameters		
τ	1.59368***	
	(0.22129)	
$\delta_{bid\ design}$	0.59567***	
	(0.02523)	
σ_n (sample mean)	1.33777	
	(3.49162)	
Summary statistics		
Initial log likelihood	-3110.37013	
Final log likelihood	-1723.91374	
ρ^2	0.44575	

Downloaded from by guest on October 16, 2026. Copyright 2026

N	1768

Notes: both treatments were estimated jointly in a single model

* p<0.1; ** p<0.0; *** p<0.01

Standard errors are in brackets

Downloaded from by guest on October 16, 2026. Copyright 2026

Table 6. Marginal Willingness to Pay Across Time

Time Until Restoration	Round Treatment	Non-rounded Treatment	Percentage Difference in MWTP
5 years	$4.41	$10.34	134.6%
10 years	$3.92	$9.38	139.1%
15 years	$3.44	$8.43	144.9%

Notes:

1. MWTP amounts are for an additional kilometer of NaturalChan&NativeVeg
2. The percentage difference in MWTP is the increase from the Round Treatment to the Non-rounded Treatment

Downloaded from by guest on October 16, 2026. Copyright 2026

Figure 1. Example Choice Set for the Cooks River Survey

Endnotes

[i] Further information about the Research Now Internet Panel is available here:

http://marc.researchnow.com/wp-content/uploads/2016/09/Panel-Book-10-16-WEB.pdf

[ii] As a robustness check we used a grid search approach (Swait and Louviere 1993) to deterministically identify the scale differences between treatments. This produced a scale ratio of 1.5 (where 1 is the rounded treatment), indicating that the non-rounded treatment had a larger scale, and therefore lower variance.

Downloaded from by guest on October 16, 2026. Copyright 2026

Suppose a referendum was held today to improve waterway channels and increase native vegetation along waterways in the Cooks River Catchment and the following options are the ONLY alternatives available. Which one would you vote for? *Tick one box only.*

		Maintain the current situation	**Option 1**: Improve waterway channels and increase native vegetation	**Option 2**: Improve waterway channels and increase native vegetation
Modified channel and no native vegetation		Currently 34 kilometres	**Now** 28 kilometres	**Now** 22 kilometres
Natural channel with native vegetation		Currently 4 kilometres	**Improve** to 10 kilometres	**Improve** to 16 kilometres
Time until improvement			6 years	20 years
Household cost	**$**	$0	$9 per year for 5 years	$52 per year for 5 years

- I would vote to maintain the current situation
- I would vote for Option 1 to improve waterway channels and increase native vegetation
- I would vote for Option 2 to improve waterway channels and increase native vegetation

Downloaded from by guest on October 16, 2026. Copyright 2026