Testing heterogeneous anchoring and shift effect in double-bounded models: The case of recreational fishing in Tasmania

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Abstract

This paper explores the extent and nature of anchoring and shift effects in a double-bounded contingent valuation of recreational fishing in Tasmania's inshore saltwater fishery. In particular we model the situation where respondents, when answering the second valuation question, evaluate the bid amount partly with reference to the size of the first bid amount. The estimates of the coefficients and mean WTP for a day of fishing are compared across different contingent valuation models, including a single-bounded model, a conventional double-bounded model and models that control anchoring and exogenous shift effects in both homogeneous and heterogeneous forms. Overall we find consistent evidence of anchoring, but mixed evidence of a shift effect. Results show that both males and females anchor in the same way, but that respondents who have a mainstream view of what recreational fishing represents anchor more strongly than those whose view of fishing is not mainstream. The estimated mean WTP for a day's recreational fishing is consistently higher in all models which account for bias in responses than in either the single-bounded or double-bounded models. We indicate the possibility that anchoring behaviour may be more complex than is captured in our models and suggest that this needs to be addressed if the results of contingent valuations are to reliably inform resource allocation decisions and recreational fishing management.

Keywords: Contingent valuation, anchoring bias, shift effect, heterogeneity, recreational fishing
JEL codes: C35, Q26

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1 Introduction

Increasing pressure on stocks in wild fisheries heightens the need for reliable estimates of the value of the fish resource in different uses. Developing a better understanding of how recreational fishers value the resource is needed to underpin resource allocation decisions and the design of management policies that govern access to, and the quality of, recreational fishing. The non-market nature of recreational fishing implies a continued need for research to be based on stated preference methods, including contingent valuation.

While it is generally accepted that the dichotomous choice contingent valuation format is preferred to the open ended question format (Arrow et al. 1993), debate continues about whether gains in efficiency associated with a multiple bid format (Hanneman 1991) offset the bias that can result from various forms of starting-point bias that may arise (Cameron and Quiggin 1994). For example, respondents may use information provided as part of the valuation exercise to re-evaluate their attitude towards the good or service being valued. They may also modify their willingness to pay (WTP) so as to give responses that they believe are in some sense socially desirable.

A number of studies have developed double-bounded models which incorporate response bias in the form of anchoring and an exogenous shift effect (e.g., Herriges and Shogren 1996, Whitehead 2002, Chien et al. 2005 and Flachaire and Hollard 2006). These studies have consistently found that when these effects are not accounted for, the estimates of the marginal effects and mean WTP are both inconsistent. Generally, however, this work has been based on the assumption that response bias occurs homogeneously across respondents. The possibility that individuals may display differences in the degree to which their responses reflect these behaviours is acknowledged, but less well explored (exceptions are, for example, Aprahamian et al. 2007 and Flachaire and Hollard 2008) .

In this paper we begin exploring the extent and nature of anchoring and shift effect in a double-bounded contingent valuation of recreational fishing in Tasmania. In particular we model the situation where respondents, when answering the valuation question, evaluate the second bid amount partly with reference to the size of the first bid amount. We then test two separate hypotheses regarding heterogeneity in survey respondents' anchoring behaviour by grouping respondents according to gender, and to their social representation of recreational fishing. The estimates of the coefficients and mean WTP for a day of fishing are compared across different contingent valuation models, including a single-bounded model, a conventional double-bounded model and models that control anchoring and exogenous shift effects in both homogeneous and heterogeneous forms.

The rest of this paper proceeds as follows. Section 2 reviews a series of contingent valuation models including those which account for anchoring and a shift effect as both homogeneous and heterogeneous phenomenon among respondents. The estimation method is discussed in Section 3 and the source and characteristics of our data described in Section 4. Section 5 explains how the sample has been partitioned in estimations involving heterogeneity and in Section 6 the results of estimations are presented and discussed. Concluding remarks, which emphasise the future direction this research will take, are in Section 7.

2 The econometric models

Single-bounded model

Assume that respondent *i*'s true willingness to pay (WTP) is specified as:

$$WTP_i^* = x_i^{'}\beta + u_i \, , \; u_i \sim N(0, \sigma^2) \qquad (1)$$

where x_i is a $k \times 1$ vector of independent variables, β is a $k \times 1$ vector of corresponding coefficients and u_i is a normally distributed error term with mean 0 and variance σ^2. In the single-bounded dichotomous choice model, the valuation question is asked only once and respondent i answers *yes* if the bid b_{1i} is less than or equal to his/her WTP, but answers *no* if the bid amount is greater. WTP_{ji} is defined as the willingness to pay used to answer the valuation question *j*, the respondent *i*'s answer is defined as

$$y_{1i} = 1 \text{ if } WTP_{1i} \geq b_{1i} \quad \text{and} \quad y_{1i} = 0 \text{ if } WTP_{1i} \leq b_{1i} \qquad (2)$$

where y_{ji} is an indicator variable such that $y_{ji} = 1$ if the respondent answers *yes*, and $y_{ji} = 0$ if the respondent answers *no*.

Conventional double-bounded model

The single-bounded model can be extended by incorporating additional information from subsequent valuation questions. For the double-bounded model, the first question is followed with a second dichotomous choice valuation question. As in the single-bounded model, the respondent *i* answers *yes* to the follow-up question, if the bid amount b_{2i} is less than or equal to his/her WTP, and answers *no* otherwise. The respondent *i*'s answer to the second valuation question is defined as:

$$y_{2i} = 1 \text{ if } WTP_{2i} \geq b_{2i} \quad \text{and} \quad y_{2i} = 0 \text{ if } WTP_{2i} \leq b_{2i} \qquad (3)$$

One advantage of the conventional double-bounded model over the single-bounded model is that, by incorporating additional information from the follow-up question, the estimates from the double-bounded model are statistically more efficient (Hanemann et al. 1991).

Anchoring and shift effect

Previous studies have shown that estimates from the double-bounded model are unbiased only if respondents answer the first and second valuation questions based on the same WTP, i.e., $WTP_i^* = WTP_{1i} = WTP_{2i}$ (Cameron and Quiggin 1994, Herriges and Schogren 1996, Alberini et al. 1997, DeShazo 2002 and Flachaire and Hollard 2006). It is well established, however, that responses to double-bounded contingent valuation questions may be subject to various forms of response bias, suggesting that this may not always be the case. Herriges and Shogren (1996) propose a framework that explicitly models and estimates the effect of anchoring bias within the double-bounded model, which arises when respondents update their WTP when presented with a second bid amount. The Herriges and Shogren model assumes that respondents' WTP when answering the second valuation question is a weighted average of their true WTP and the first bid amount, such that:

$$WTP_{2i} = \left(1-\gamma\right)WTP_{1i} + \gamma b_{1i} \text{ where } WTP_i^* = WTP_{1i} \tag{4}$$

where $\gamma \in [0,1]$ is the weighting parameter that measures the strength of the degree of anchoring. When $\gamma = 1$, the respondent totally replaces the prior willingness to pay with the initial bid amount, whereas there is no anchoring effect at all when $\gamma = 0$.

Alberini et al. (1997) propose an alternative model which assumes that respondents' WTP when answering the second valuation question is exogenously shifted from the true WTP, such that

$$WTP_{2i} = WTP_{1i} + \delta \text{ where } WTP_i^* = WTP_{1i} \tag{5}$$

where δ is the shift parameter. The economic intuition of the shift parameter is as follows. When the shift parameter is negative ($\delta < 0$), respondents systematically devalue their WTP after the first valuation question, which is referred to as the incentive incompatibility effect. By contrast, a positive shift parameter ($\delta > 0$) represents a form of 'yea-saying' or acquiescence behaviour in which respondents overestimate their WTP for the second valuation question as a result of a tendency for respondents to agree regardless of the bid level. Legget et al. (2003) suggest that this type of bias may be more prevalent in in-person surveys where respondents may be more inclined to respond in ways that they believe will please the interviewer.

Whitehead's (2002) model allows for the possibility that response bias in the double-bounded model might be of a form that involves both anchoring and a shift effect such that:

$$WTP_{2i} = \left(1-\gamma\right)WTP_{1i} + \gamma b_{1i} + \delta \text{ where } WTP_i^* = WTP_{1i} \qquad (6)$$

Heterogeneity in anchoring

Recent studies suggest that anchoring may be a heterogeneous process in that individual respondents may differ in their anchoring behaviour. Using Monte Carlo simulation, Aprahamian et al. (2008) show that if anchoring is mistakenly specified in a homogenous form (as in equations (4) to (6)), when true anchoring behaviour occurs heterogeneously across respondents, the estimates are biased and the shift effect spuriously appears. Limited empirical evidence of heterogeneity in double-bounded contingent valuation studies confirms that failure to correctly account for this in a double-bounded contingent valuation model may result in a biased estimate of WTP.

A common approach has been to explore differences in anchoring behaviour across different groups of individuals, where group membership is based on some observable characteristic (e.g. gender or income) or latent characteristic (e.g. attitude or belief) of the respondent. For example, allowing for only two groups, Flachaire et al. (2007) and Flachaire and Hollard (2008) specify the WTP to the second valuation question as:

$$WTP_{2i} = \left(1-\left(I_i\gamma_1 + (1-I_i)\gamma_2\right)\right)WTP_{1i} + \left(I_i\gamma_1 + (1-I_i)\gamma_2\right)b_{1i} + \delta$$
$$\text{where } WTP_i^* = WTP_{1i} \qquad (7)$$

where I_i is a dummy variable taking value 1 if the respondent *i* belongs to one group, and 0 otherwise, and γ_1 and γ_2 are the corresponding parameters. Employing the theory of social representation to separate their sample into two groups, Flachaire et al. (2007) and Flachaire and Hollard (2008) both find evidence of anchoring among the group whose representation of the good being valued is consistent with a *mainstream* or *conformist* view. [1]

3 Estimation

The single-bounded model is estimated by the method developed by Cameron and James (1987). The model is estimated by maximum likelihood with the log-likelihood function:

$$\log L = \sum_{i=1}^{n}\left(y_{1i}\log\left[\Pr(yes)\right] + \left(1 - y_{1i}\right)\log\left[\Pr(no)\right]\right) \ . \qquad (8)$$

The probabilities can be calculated as:

$$\Pr\left(yes\right) = \Pr(y_{1i} = 1) = 1 - \Phi\left(\left(b_{1i} - x_i^{'}\beta\right)/\sigma\right) \text{ and}$$
$$\Pr\left(no\right) = \Pr(y_{1i} = 0) = \Phi\left(\left(b_{1i} - x_i^{'}\beta\right)/\sigma\right). \qquad (9)$$

where $\Phi\left(\cdot\right)$ is the standard normal density function.

For the models with a follow-up question, there are four possible combinations of answers to the valuation question, i.e., (*yes*, *yes*), (*yes*, *no*), (*no*, *yes*) and (*no*, *no*). If the respondent *i* answers *yes* to the first valuation question, the second bid amount becomes higher ($b_{2i}^{H} > b_{1i}$), while if s/he/she answers *no* the second bid amount becomes lower ($b_{2i}^{L} < b_{1i}$). Thus, the probabilities that respondent *i* answers (*yes*, *yes*), (*yes*, *no*), (*no*, *yes*) and (*no*, *no*) to the first and second valuation questions are:

$$
\begin{aligned}
&\Pr(yes, yes) = \Pr(y_{1i}=1, y_{2i}=1) = \Pr\left(WTP_{2i} > b_{2i}^{H}\right) \\
&\Pr(yes, no) = \Pr(y_{1i}=1, y_{2i}=0) = \Pr\left(b_{2i}^{H} > WTP_{2i} > b_{1i}\right) \\
&\Pr(no, yes) = \Pr(y_{1i}=0, y_{2i}=1) = \Pr\left(b_{1i} > WTP_{2i} > b_{2i}^{L}\right) \\
&\Pr(no, no) = \Pr(y_{1i}=0, y_{2i}=0) = \Pr\left(b_{2i}^{L} > WTP_{2i}\right)
\end{aligned} \tag{10}
$$

and the log-likelihood function is defined as:

$$
\begin{aligned}
\log l = \sum_{i=1}^{n} \Big(& y_{1i} y_{2i} \log\left[\Pr(yes, yes)\right] + y_{1i}(1-y_{2i})\log\left[\Pr(yes, no)\right] \\
& + (1-y_{1i}) y_{2i} \log\left[\Pr(no, yes)\right] + (1-y_{1i})(1-y_{2i})\log\left[\Pr(no, no)\right]\Big).
\end{aligned} \tag{11}
$$

For the model incorporating heterogeneous anchoring and shift effects, the probabilities are computed by

$$
\begin{aligned}
&\Pr\left(WTP_{2i} > b_{2i}\right) = 1 - \Phi\left(\left[\frac{b_{2i} - \gamma_i b_{1i} - \delta}{1-\gamma_i} - x_i^{'}\beta\right]\Big/\sigma\right) \\
&\Pr\left(b_{2i} > WTP_{2i} > b_{1i}\right) = \Phi\left(\left[\frac{b_{2i} - \gamma_i b_{1i} - \delta}{1-\gamma_i} - x_i^{'}\beta\right]\Big/\sigma\right) - \Phi\left(\left(b_{1i} - x_i^{'}\beta\right)\big/\sigma\right) \\
&\Pr\left(b_{1i} > WTP_{2i} > b_{2i}\right) = \Phi\left(\left(b_{1i} - x_i^{'}\beta\right)\big/\sigma\right) - \Phi\left(\left[\frac{b_{2i} - \gamma_i b_{1i} - \delta}{1-\gamma_i} - x_i^{'}\beta\right]\Big/\sigma\right) \\
&\Pr\left(b_{2i} > WTP_{2i}\right) = \Phi\left(\left[\frac{b_{2i} - \gamma_i b_{1i} - \delta}{1-\gamma_i} - x_i^{'}\beta\right]\Big/\sigma\right).
\end{aligned} \tag{12}
$$

where $\gamma_i = I_i\gamma_1 + (1-I_i)\gamma_2$. The probabilities for the conventional dichotomous choice double-bounded model and the model with homogeneous anchoring and a shift effect are computed by imposing restrictions on (12). For the model with homogenous anchoring and shift effects, the restrictions are $\gamma_i = \gamma$ for all i and the restrictions for the conventional double-bounded model are $\gamma_i = 0$ and $\delta = 0$.

4 Survey design and data

Our data came from a series of questions asked of Tasmanian recreational fishers in a survey conducted as a follow-up to the *2007/08 Survey of Recreational Fishing in Tasmania* (Lyle et al. 2009).[2] At the completion of the recreational survey (January 2009), respondents were asked whether they would be willing to participate in a follow-up economic survey. A sample of 604 households was selected for the economic survey which was administered by telephone over a seven week period in June and August 2009 by a team of professional interviewers, all of whom had previously been involved in the fishing survey. Interviewers were briefed on the purpose and design of the survey, as well as being given a broad overview of the contingent valuation method.

Complete responses were received for 480 fishers, representing an overall response rate of 79.4 per cent. Contact could not be established with an active fisher over the age of 18 for 59 households (9.7 per cent) and a further 59 households (9.7 per cent) indicated that no members had fished in the twelve month period between July 2008 and June 2009. These latter households were considered out of scope and excluded from the survey. Six of the eligible fishers who were surveyed, or less than 1 per cent of our original sample, did not provide complete responses.

Our analysis focuses only on the 314 fishers whose last reported day's fishing was in the inshore saltwater fishery (ISF). [3] Eight of these respondents were excluded due to inconsistencies in the daily cost information they provided. On the basis of their answer to the valuation question a further 13 fishers were identified as 'protestors' and their responses were dropped from the final data set (Dziegielewska and Mendelsohn, 2007), which therefore consisted of observations on 293 fishers.

The survey instrument consisted of six parts and generally took 15 - 20 minutes to complete. The survey instrument was pre-tested on ten fishers. Pre-testing resulted in minor changes to the survey and was used to determine the appropriate range of bid amounts used in the valuation question. Part four of the survey asked respondents a series of questions related to their most recent days fishing, including details of the location and nature of the trip, the number and species of fish caught, their motivations for fishing and importantly, the level and types of avoidable costs incurred on the day only. It also included a set of questions designed to establish fisher's economic valuation of their most recent days fishing. Other parts of the survey asked respondents for information about their fishing activity over the past twelve month period, demographic characteristics and what fishing represented to them.

Descriptive statistics for variables derived from the 293 survey responses are reported in Table 1. About 67 percent of respondents indicated that they were targeting a single species on their most recent fishing day, whereas about 23 percent and nearly 10 per cent were either targeting multiple species or nominated no specific target species, respectively. In total, fishers in the ISF reported having caught about 30 different species of fish on the last day's fishing, with a total catch of about 3 884 fish. Flathead (*fam. Platycephalidae*) comprised almost 64 percent of the total personal catch for the sample. About 27 and 38 percent of respondents said that either enjoying the outdoors or spending time with family and friends was their main motivation on that day. Only 19 percent of respondents said that the main reason was to catch fish.

[Table 1 about here]

We use a double-bounded valuation question format that is similar to Wheeler and Damania (2001), in which the payment vehicle is the amount respondents' report having personally spent on avoidable, consumable items for their most recent days' fishing. This format was chosen for its simplicity and because it avoids the need to introduce a license fee or tax, both of which may elicit protest bids from respondents.[4] The first round valuation question consisted of;

“Bearing in mind that you have many calls on your income, if it had cost you an extra $XX on these [consumable] items for this day’s fishing only, would you still have gone fishing on that day?”

This was followed with a second question;

“… and would you have still gone fishing on that day if it had cost you an additional $YY?”

where $YY will be either double or half $XX depending on whether the respondent answers ‘yes’ or ‘no’ to the first question.

The initial bid amounts $XX were set at $10, $20, $30, $40, $50 and $60 and were randomised across respondents according to a uniform probability distribution. Table 2 shows the average bid values for the first and second questions and the joint frequencies of responses (*yes*, *yes*), (*yes*, *no*), (*no*, *yes*) and (*no*, *no*) to the first and second valuation questions.

[Table 2 about here]

Figure 1 shows the distribution of first and second question responses for each initial bid value. The relatively small number of (*no*, *yes*) and (*no*, *no*) responses for respondents receiving an initial bid of $10 suggests that the lower end of the bid range was well chosen.

[Figure 1 about here]

5 Heterogeneous anchoring

In this paper we consider two separate hypotheses regarding the source of heterogeneity in respondents’ anchoring behaviour, these being the respondents’ gender and their social representation of recreational fishing. Previous studies have suggested that differences in anchoring behaviour may reflect the demographic and other socio-economic characteristics of respondents (Aprahamian et al. 2007). The second source of heterogeneity examined follows Flachaire et al. (2007) and Flachaire and Hollard (2008), who hypothesise that a group of people who have unique beliefs (*minority or non-conforming*) about the subject of the valuation exercise are less likely to be influenced by new information. Thus, fishers who have unique beliefs about recreational fishing activity are less prone to anchor to the first bid amount than are people who hold common beliefs.

Flachaire et al. (2007) and Flachaire and Hollard (2008) employ the theory of social representation to separate individuals into two groups, *mainstream* (or *conformist*) and *minority* (or *non-conformist*). In this paper we follow the method proposed by Flachaire and Hollard (2008) to identify the social representation associated with Tasmanian recreational fishing held by respondents in our sample. Identification of this representation and the partitioning of the sample into mainstream and minority groups were based on respondents answer to an open-ended question that preceded the valuation question in our survey. In this question we asked:

> *"What is the first word that comes to mind when I mention recreational fishing?...What is the second word?...What is the third word?"*

The words identified are taken to describe the representation each respondent maintains regarding recreational fishing. This method, known as word association, is commonly applied by psychologists in their investigation of social representation (see for example Farr 1993). Not surprisingly, given the open-ended nature of the question, a large number of words were given by respondents (i.e., about 360 words were obtained).

Words were then sorted into clusters on the basis of their sharing similar meaning. For example, the category *Environment* includes words such as 'beach', 'coast' and 'environment'. A total of eight categories were identified in this way:

Environment, Holiday, Family & Friends, Feeling, Fish & Fishing object, Food & Drink, Restrictions, Weather

Each identified word was then replaced with the corresponding category to obtain an ordered list of categories for each respondent. In developing this ordering, any double or triple citations from the same category are handled by suppressing the lower ranking citations. For example, if a respondent had cited words which were from the categories {*Environment*, *Holiday*, *Environment*} then they would have their representation recorded as {*Environment*, *Holiday*}.

The core of the social representation associated with Tasmanian recreational fishing was identified by calculating the citation rate of each category and ranking them accordingly. Table 3 shows that *Feeling* is the most cited category with 65.2 per cent of respondents listing a word categorised in this way. Any respondent who cited at least one word that belonged to one of the three highest ranked categories (*Feeling; Fish & Fishing object; Family & Friends)* was taken to hold a *mainstream or conformist* representation of recreational fishing.

[Table 3 about here]

6 Results

Single-bounded and conventional double-bounded models

Table 4 presents the estimates of the coefficients and the mean WTP for a day's recreational fishing for the single-bounded model (Model I) and the conventional double-bounded model (Model II). The estimates show that men have a greater WTP for the day of fishing than women. The WTP of respondents who fished from a boat is also higher than that of respondents who fished from either the shore or a jetty. While the number of people in the fishing party is positively related with the WTP, the presence of respondents' children decreases the value of the fishing day. WTP is also positively related to respondents' income.

Interestingly, Table 4 shows that all catch variables are statistically insignificant and thus additional fish caught would not increase the WTP for a days fishing. This result is different from a number of other valuation studies that found a positive relationship between the number of fish caught and the respondents' WTP (Johnston et al. 2006). The potential reason for this is that the number of fish caught in the day's fishing was relatively large (e.g., 2483 flathead were caught in total) and, as a result, the marginal WTP for additional catch is insignificant. In addition, our data suggests that the main motivation for going fishing in the Tasmanian ISF is for reasons other than catching fish for many respondents. In fact, 66 percent of the respondents indicated that the main motivation for going fishing was to either enjoy the outdoors or to spend time with friends/family. In terms of the targeting preference, the estimates from the conventional double-bounded model show that fishers who were targeting flathead and fishers who did not target any species have a significantly lower WTP than fishers who were targeting multiple species.

The estimates of the mean WTP are similar across the single-bounded and conventional double-bounded models. Taking into account that the average total expenditure on consumable goods on the last day of fishing (*Cost*) is A$42.79 (Table 1), the total mean WTP (i.e. $Cost + WTP$) for a day of fishing in the Tasmanian ISF is estimated as A$112.05 in the single-bounded model and A$108.4 in the double-bounded model. It is, however, important to note that since the valuation survey was originally designed to estimate the double-bounded model, the lower and especially higher range of the distribution of bid amounts is truncated. Estimates from the single-bounded model are likely, therefore, to be both inefficient and inconsistent. Further, Table 4 confirms that there are efficiency gains in the estimates of the coefficients from using the double-bounded model.

[Table 4 about here]

Homogenous anchoring and shift effects

Table 5 shows the estimates of the coefficients and mean WTP for a day's fishing from the model controlling anchoring (Model III) and the model controlling both anchoring and shift effects (Model IV). The homogeneous anchoring parameter (γ) is significant for both models and the shift parameter (δ) is also significantly positive in Model IV. The estimates, $\hat{\gamma} = 0.423$ and $\hat{\gamma} = 0.448$ for the two models, suggest that respondents do re-evaluate their WTP in light of the first bid when answering the second valuation question. The positive shift parameter $\hat{\delta} = 3.79$ confirms 'yea-saying' behaviour. This implies that respondents overvalued their WTP when they answered the follow-up valuation question. Given the statistically significant anchoring and shift parameters, the estimated coefficients and mean WTP from the conventional double-bounded model are likely to be biased.

The mean WTP estimated by Models III and IV is considerably higher than that estimated by the single-bounded and conventional double-bounded models. The total mean WTP is estimated as A$126.69 in Model III and A$123.54 in Model IV. Further, while the signs of the estimated coefficients from these models are similar to those from Models I and II, some variables become statistically insignificant after controlling the anchoring and shift effects. This empirical result is consistent with the results illustrated by Herriges and Shogren (1996). The efficiency gains anticipated by incorporating the information from a follow-up question would be diminished or totally lost when anchoring effects are accounted for in the conventional double-bounded model.

[Table 5 about here]

Heterogeneity in anchoring

Tables 6 and 7 present the estimation results of the models incorporating heterogeneous anchoring behaviour. To control the respondents' heterogeneity, the sample is grouped into *men* and *women* in Models V and VI (Table 6) and into *conformists* and *non-conformists* in Models VII and VIII (Table 7). The results of Model V in Table 6 show that both anchoring parameters γ_1 and γ_2 are statistically significant at the 5% level and the estimated values are similar to each other. This confirms that *men* and *women* are both influenced by the first bid amount but the degree to which they anchor is the same between the two groups. By contrast to the results in Model VI, the positive shift effect is lost when the heterogeneous anchoring and exogenous shift effect are both controlled in Model VI.

Where the sample is grouped into *conformists* and *non-conformists*, we confirm heterogeneity in anchoring effects. The estimation result of Model VII in Table 7 shows that the anchoring effect is insignificant for *non-conformist*, whereas the estimate of the anchoring parameter for *conformists* is similar to those obtained in Models III, IV, V and VI (Tables 5 and 6). While the anchoring effect is significant for non-conformists at the 10% level in Model VIII, again the positive shift effect found in Model VI is no longer evident.

The estimated mean WTP from Models IV to VIII, which all control for heterogeneous anchoring, are similar to each other. They are also of a similar magnitude to the estimates obtained from Models III and IV, which treat anchoring as a homogeneous phenomenon. This is expected because our results do not suggest strong differences in anchoring behaviour, between males and females or between fishers whose representation of recreational fishing is consistent with a mainstream belief and those who hold a minority belief.

[Table 6 about here]

[Table 7 about here]

7 Concluding remarks

In this paper we report estimates of a series of models of the WTP of fishers for a day's recreational fishing in the Tasmanian inshore saltwater fishery. These include models that utilise the information contained in the double-bounded format but which adjust for anchoring and a shift effect. Overall we find consistent evidence of anchoring, but mixed evidence of a shift effect. The estimated mean WTP for a days recreational fishing is consistently higher in all models which account for bias in responses than in either the single-bounded or double-bounded models.

We tackle the possibility of heterogeneous anchoring by comparing the anchoring behaviour of distinct groups of respondents. Results show that both males and females anchor in the same way, but respondents who have a mainstream view of what recreational fishing represents anchor more strongly than those whose view of fishing is not mainstream.

As is generally the case in the literature, our treatment of anchoring and shift effects has been limited to the case where respondents' answer to the second question is made by comparing the second bid amount (b_{2i}) with a measure of WTP that reflects both the respondents true WTP (WTP_i^*) and the value of the first bid amount (b_{1i}). Lechner et al. (2003), however, point out that responses to the first valuation question may be anchored to the first bid value, which would mean that WTP_{1i} is a weighted average of WTP_i^* and b_{1i}. Moreover, the particular form of our payment vehicle, namely an increase in the daily cost of consumables, may introduce a further opportunity for anchoring to occur. We conjecture that daily cost may be a particularly strong anchor, as interviewers are often instructed to ensure that respondents are reminded of this amount prior to being presented with the first bid amount. We anticipate that failing to allow for these forms of anchoring in both homogeneous and heterogeneous specifications of the double-bounded model will result in biased coefficients and mean WTP estimates.

Endnote

1. While Flachaire and Hollard (2008) did not explicitly test whether anchoring by the minority group is statistically significant, Flachaire et al. (2007) find that the minority group does not anchor their WTP to the initial bid amount.
2. The *2007/08 Survey of Recreational Fishing in Tasmania* (Lyle et al. 2009) was a phone-diary survey which recorded the fishing activities of participant fishers between December 2007 and November 2008, The selection of the sample for the phone-diary survey was based on a randomly chosen set of Tasmanian listed telephone numbers, and employed some spatial stratification using the Australian Bureau of Statistics (ABS) Statistical Divisions.
3. Respondents were allocated to one of 8 fisheries on the basis of information provided in relation to target species (if defined), catch species composition (if not nil), fishing location (region and water body type) and fishing method used on the most recent days fishing. About 65 percent of most recent days reported occurred in the ISF. Major fish species in the ISF are flathead, Australian salmon, squid, black bream and cod. The freshwater fishery was the next largest fishery in our sample with nearly 20 percent of respondents indicating that their most recent days fishing was in this fishery.
4. Remaining protest bids were identified by including a ‘not willing to answer’ option for the valuation questions, and asking respondents who answered (*no,no*) to explain this response. These measures are consistent with those recommended by the NOAA Panel on Contingent Valuation (Arrow et al. 1993).

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Table 1 Descriptive statistics

Variable	Description	Mean	Std Dev
As_Caught	The number of Australian salmon caught	0.53	1.98
Fh_Caught	The number of flathead caught	7.37	10.95
Oth_Caught	The number of other species caught	1.59	3.98
As_Target	Specifically targeting Australian salmon (yes = 1, no = 0)	0.085	0.085
Fh_Target	Specifically targeting flathead (yes = 1, no = 0)	0.48	0.50
Oth_Target	Specifically targeting other species (yes = 1, no = 0)	0.11	0.11
Non_Target	Not targeting any species	0.10	0.29
Male	Gender (male = 1, female = 0)	0.79	0.41
Age	Age (<20 = 1, 20-29 = 2, …, 60-69 = 6, >70 = 7)	4.47	1.34
Fulltime	Currently working full time (yes = 1, no = 1)	0.60	0.49
Income	Income (<$20k = 1, $20k-40k = 2, …, $80k-100k = 5, >$100K = 6)	2.74	1.33
Days	The number of days spent fishing in the last 12 months	14.67	18.31
PubHoliday	The most recent day of fishing was a public holiday (yes = 1, otherwise 0)	0.28	0.45
DayTrip	The most recent day of fishing was a day-trip (yes = 1, otherwise 0)	0.66	0.48
Hours	The amount of time spent fishing on the most recent day of fishing	3.32	1.59
Importance	How important fishing was on that fishing day (most important = 3,…, less important = 1)	2.46	0.62
OtherPersons	The number of other persons in the fishing party	2.03	1.81
Children	Respondent went fishing with his or her children (yes = 1, no = 0)	0.38	0.49
Boat	Fished from boat (yes = 1, no = 0)	0.65	0.48
Shore	Fished from a shore (yes = 1, no = 0)	0.23	0.42
Jetty	Fished from a jetty (yes = 1, otherwise = 0)	0.12	0.33
MotEating	The main motivation for going fishing was to catch fish for eating (yes = 1, no = 0)	0.19	0.39
MotOut	The main motivation for going fishing was to enjoy the outdoors (yes = 1, no = 0)	0.28	0.45
MotFriends	The main motivation for going fishing was to spend time with friends/family (yes = 1, no = 0)	0.38	0.49
MotSport	The main motivation for going fishing was to fish for sport (yes = 1, no = 0)	0.03	0.18
MotOther	The main motivation for going fishing was other reasons (yes = 1, no = 0)	0.12	0.32
Conditions	Overall fishing condition (excellent = 5,…, terrible = 1)	3.36	1.85
Cost	Total amount spent for the last day of fishing	42.79	41.97

Table 2 Descriptive statistics for valuation questions

Variable	Description	Mean	Std Dev
Valuation questions			
b_1	Bid value for first question	35.8	16.4
b_2	Bid value for second question	55.4	34.7
y_1	Response to first question (yes = 1, no = 0)	0.74	0.44
y_2	Response to second question (yes = 1, no = 0)	0.60	0.49
Joint frequencies of responses			
	$\Pr(y_1 = 1, y_2 = 1)$	0.43	
	$\Pr(y_1 = 1, y_2 = 0)$	0.32	
	$\Pr(y_1 = 0, y_2 = 1)$	0.17	
	$\Pr(y_1 = 0, y_2 = 0)$	0.08	

Table 3 Citation rate of each category

Category	Citation rate
Feeling	65.2%
Fish & Fishing object	37.6%
Family & Friends	32.3%
Food & Drink	29.5%
Environment	22.7%
Holiday	22.0%
Restrictions	11.5%
Weathers	6.2%

Table 4 Estimation results for single-bounded and double-bounded models

Independent variables	Model I (single-bounded)		Model II (double-bounded)	
	Estimates	t-statistics	Estimates	t-statistics
Constant	48.36	(1.69)*	42.31	(2.49)***
As_Caught	-0.28	(-0.13)	-0.49	(-0.34)
Fh_Caught	0.28	(-0.06)	-0.006	(-0.022)
Oth_Caught	0.93	(0.78)	0.49	(0.67)
As_Target	-3.23	(-0.21)	-6.23	(-0.61)
Fh_Target	-18.62	(-1.55)	-11.35	(-1.72)*
Oth_Target	-11.78	(-0.81)	-10.25	(-1.1)
Non_Target	-32.71	(-1.64)	-21.68	(-1.87)*
Non_Target × As_Caught	-3.90	(0.16)	18.64	(0.97)
Non_Target × Fh_Caught	0.93	(0.45)	1.01	(0.8)
Non_Target × Oth_Caught	4.32	(-0.85)	-0.71	(-0.38)
Male	22.46	(2.06)**	13.27	(2.06)**
Age	-6.71	(-1.79)*	-3.51	(-1.76)*
Income	7.24	(2.06)**	4.95	(2.39)***
Days	0.07	(0.33)	0.09	(0.66)
DayTrip	-8.78	(-0.95)	-8.01	(-1.47)
Hours	-0.46	(0.16)	1.15	(0.63)
Importance	5.38	(0.81)	0.89	(0.21)
OtherPersons	5.28	(1.72)***	7.93	(4.13)***
Children	-11.76	(-2.14)**	-11.68	(-2.15)**
boat	17.34	(1.64)	10.55	(1.75)*
MotOther	-30.27	(-2.14)**	-20.98	(-2.73)***
Conditions	0.21	(0.1)	1.25	(0.95)
σ	39.54		33.77	
(p-value)	(0.002)	***	(<0.001)	***
log-likelihood	-127.90		-320.76	
Pseudo-R^2	0.193		0.116	
Prediction success	81.2%		55%	
Observations	293		293	
Mean WTP	69.26		65.61	

*** = 1% level of significance, ** = 5 % level of significance, * = 10 % level of significance

Table 5 Estimation results for homogeneous anchoring models

Independent variables	Model III (homogeneous anchoring)		Model IV (homogeneous anchoring and shift effect)	
	Estimates	t-statistics	Estimates	t-statistics
Constant	45.51	(1.53)	41.63	(1.43)
As_Caught	-1.08	(-0.47)	-1.17	(-0.5)
Fh_Caught	0.01	(0.03)	0.024	(0.05)
Oth_Caught	0.93	(0.76)	0.93	(0.75)
As_Target	-8.20	(-0.5)	-8.63	(-0.51)
Fh_Target	-17.01	(-1.42)	-16.91	(-1.42)
Oth_Target	-12.48	(-0.82)	-12.47	(-0.81)
Non_Target	-33.21	(-1.54)	-33.78	(-1.57)
Non_Target × As_Caught	28.23	(0.95)	28.90	(0.94)
Non_Target × Fh_Caught	1.33	(0.68)	1.38	(0.69)
Non_Target × Oth_Caught	-1.00	(-0.33)	-0.91	(-0.3)
Male	21.40	(1.81)*	21.88	(1.82)*
Age	-5.97	(-1.56)	-6.12	(-1.61)
Income	7.77	(2.01)**	7.92	(2.02)**
Days	0.08	(0.37)	0.08	(0.37)
DayTrip	-13.17	(-1.3)	-13.32	(-1.32)
Hours	0.85	(0.3)	0.91	(0.3)
Importance	3.56	(0.52)	3.57	(0.51)
OtherPersons	12.60	(2.53)**	12.82	(2.58)***
Children	-17.47	(-1.7)*	-17.74	(-1.73)*
boat	19.62	(1.65)*	19.99	(1.68)*
MotOther	-34.73	(-2.07)**	-36.18	(-2.15)**
Conditions	1.65	(0.78)	1.65	(0.95)
σ	54.46		55.62	
(p-value)	(0.005)	***	(0.003)	***
γ	0.423		0.448	
(p-value)	(0.023)	**	(0.0098)	***
δ	-		3.79	
(p-value)	-		(0.0247)	**
log-likelihood	-317.41		-314.97	
Pseudo-R^2	0.125		0.132	
Prediction success rate	55.6%		55.3%	
Observations	293		293	
Mean WTP	83.90		80.75	

*** = 1% level of significance, ** = 5 % level of significance, * = 10 % level of significance

Table 6 Estimation results for heterogeneous anchoring models (*gender*)

Independent variables	Model V (heterogeneous anchoring)		Model VI (heterogeneous anchoring and shift effect)	
	Estimates	t-statistics	Estimates	t-statistics
Constant	45.25	(1.53)	43.02	(1.46)
As_Caught	-1.08	(-0.48)	-1.05	(-0.47)
Fh_Caught	0.01	(0.033)	0.014	(0.031)
Oth_Caught	0.93	(0.76)	0.90	(0.73)
As_Target	-8.20	(-0.5)	-8.16	(-0.5)
Fh_Target	-17.06	(-1.43)	-16.88	(-1.43)
Oth_Target	-12.45	(-0.82)	-12.09	(-0.81)
Non_Target	-33.30	(-1.55)	-32.56	(-1.52)
Non_Target × As_Caught	28.26	(0.95)	27.86	(0.95)
Non_Target × Fh_Caught	1.33	(0.68)	1.31	(0.68)
Non_Target × Oth_Caught	-1.00	(-0.33)	-1.02	(-0.34)
Male	21.68	(1.80)*	24.30	(1.88)*
Age	-6.00	(-1.57)	-5.91	(-1.56)
Income	7.78	(2.02)**	7.70	(1.99)**
Days	0.08	(0.38)	0.08	(0.39)
DayTrip	-13.20	(-1.3)	-13.07	(-1.3)
Hours	0.86	(0.29)	0.88	(0.31)
Importance	3.60	(0.52)	3.60	(0.53)
OtherPersons	12.58	(2.53)**	12.35	(2.40)**
Children	-17.45	(-1.70)*	-17.21	(-1.68)*
boat	19.73	(1.66)*	19.45	(1.64)
MotOther	-34.73	(-2.07)**	-34.00	(-2.00)**
Conditions	1.66	(0.78)	1.66	(0.8)
σ	54.47		53.54	
(p-value)	(0.005)	***	(0.005)	***
γ1	0.43		0.42	
(p-value)	(0.0246)	**	(0.0205)	**
γ2	0.42		0.38	
(p-value)	(0.0458)	**	(0.0825)	*
δ	-		-0.71	
(p-value)	-		(0.286)	
log-likelihood	-317.40		-317.24	
Pseudo-R-squared	0.125		0.126	
Prediction success rate	56%		56%	
Observations	293		293	
Mean WTP	83.96		83.80	

*** = 1% level of significance, ** = 5 % level of significance, * = 10 % level of significance

Table 7 Estimation results for heterogeneous anchoring models (*mainstream*)

Independent variables	Model VII (heterogeneous anchoring)		Model VIII (heterogeneous anchoring and shift effect)	
	Estimates	**t-statistics**	**Estimates**	**t-statistics**
Constant	46.33	(1.53)	42.89	(1.43)
As_Caught	-1.17	(-0.5)	-1.15	(-0.49)
Fh_Caught	0.02	(0.038)	0.014	(0.03)
Oth_Caught	0.94	(0.76)	0.92	(0.74)
As_Target	-8.87	(-0.53)	-8.40	(-0.49)
Fh_Target	-17.07	(-1.42)	-17.51	(-1.43)
Oth_Target	-12.77	(-1.1)	-12.81	(-0.82)
Non_Target	-33.93	(-1.55)	-33.47	(-1.51)
Non_Target × As_Caught	28.78	(0.96)	28.38	(0.93)
Non_Target × Fh_Caught	1.36	(0.69)	1.33	(0.66)
Non_Target × Oth_Caught	-0.96	(-0.32)	-1.01	(-0.33)
Male	21.66	(1.81)*	21.95	(1.79)*
Age	-6.04	(-1.56)	-6.09	(-1.56)
Income	7.74	(2.00)**	7.95	(2.00)**
Days	0.08	(0.37)	0.08	(0.35)
DayTrip	-13.40	(-1.3)	-13.27	(-1.28)
Hours	0.79	(0.27)	0.85	(0.28)
Importance	3.54	(0.51)	3.88	(0.55)
OtherPersons	12.70	(2.52)**	12.89	(2.50)**
Children	-17.65	(-1.70)*	-17.88	(-1.7)*
boat	19.57	(-1.64)	20.19	(1.66)*
MotOther	-35.04	(-2.06)**	-36.56	(-2.10)**
Conditions	1.70	(0.8)	1.64	(0.76)
σ	54.92		55.99	
(p-value)	(0.005)	***	(0.005)	***
$\gamma 1$	0.43		0.45	
(p-value)	(0.0232)	**	(0.0145)	**
$\gamma 2$	0.32		0.39	
(p-value)	(0.3096)		(0.0705)	*
δ	-		2.14	
(p-value)	-		(0.277)	
log-likelihood	-317.27		-316.00	
Pseudo-R-squared	0.126		0.129	
Prediction success rate	56%		55%	
Observations	293		293	
Mean WTP	83.24		82.58	

*** = 1% level of significance, ** = 5 % level of significance, * = 10 % level of significance

Figure 1 Distribution of responses for each initial bid value