A General Model of Starting Point Bias in Double-Bounded Dichotomous Contingent Valuation Surveys

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Abstract

This paper develops a general model that addresses the starting point bias in the dichotomous choice evaluation data by incorporating both the anchoring effect and yea-saying bias. The model is applied to a contingent valuation study that evaluated the health benefits of air quality improvement in three major metropolitan areas in Taiwan. The empirical evidence shows a strong anchoring effect but an insignificant yea-saying bias. The results show a serious understated willingness to pay if the biases in anchoring and yea-saying are not controlled.

Introduction

The contingent valuation (CV) method obtains evaluation data on non-market goods and services by inquiring into people's willingness to pay (WTP) or their response to certain hypothetical market scenarios. In order to elicit more reliable answers from respondents, researchers have developed several different methods of asking evaluative questions. Among them, the dichotomous choice (DC) dominates in the contingent valuation surveys of non-market goods and services. However, empirical evidence has shown that DC is subject to starting point bias, which DC questions were supposedly developed to avoid.

Several methods have recently been developed in an effort to address the problem of starting point bias in DC questions. In the Bayesian approach of the Herriges and Shogren model, respondents provide the interviewer with information on their posterior WTP that represents a weighted average of their prior WTP and the initial bid value introduced by the interviewer. The anchoring weight, that is the weight of the initial bid, measures

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the extent of the anchoring effect on posterior WTP. Herriges and Shogren’s innovative model is useful in estimating the magnitude of anchoring weight and hence the starting point bias. However, the model does not take into consideration of the second starting point bias, namely the ‘yea-saying bias’.

The presence of yea-saying bias is well-documented in the sequential DC valuation questions. The yea-saying bias is defined as “the tendency of respondents to agree with questions regardless of the content”. The presence of yea-saying bias may be motivated by ‘warm glow’, moral satisfaction of contributing to public goods and social pressure. Thus, in addition to the anchoring effect of bid values that leads to biased responses to DC questions, the yea-saying bias also leads to a biased-upward response.

In this paper, we develop a general model incorporating both the anchoring effect and yea-saying bias, and an econometric model and its estimation method.

An Econometric Model with Stochastic Yea-Saying Bias

While using the CV method to value public goods, researchers assume implicitly that a rational respondent knows his/her latent value for these public goods. In the absence of yea-saying bias, the respondent’s latent WTP, denoted as \( W^* \), is assumed to be determined by a vector of the respondent’s characteristics \( X \) as

\[
W^* = X \beta + V
\]

where \( \beta \) is the correspondent coefficient vector, and \( V \) represents the statistical noise and is symmetric with \( E(V) = 0 \).

Since yea-saying bias is defined as the tendency of respondents to agree regardless of the content of the DC questions, we assume that the bias is a self-induced upward shifting of the WTP. Given the respondent’s characteristics \( X \), the distribution of WTP is no longer centered at \( X \beta \) in (1). The prior WTP, \( W_1 \), includes a stochastic element of the propensity towards saying ‘yes’ and is specified as follows:

\[
W_1 = W^* + U = X \beta + \varepsilon
\]

where yea-saying bias, \( U \), is a one-sided, non-negative random error. The composite error \( \varepsilon = V + U \) does not have a zero mean. The nonnegative error component \( U \) reflects the fact that yea-saying propensity will raise a respondent’s prior WTP.

Thus, respondent’s answers to the first bid question of whether they would be willing to pay \( b_1 \) for an improvement of air quality, would be ‘yes’ if the prior willingness to pay, \( W_1 \) was greater than \( b_1 \), and the response would be ‘no’ otherwise. That is:

\[
d_1 = \begin{cases} 
1 & \text{if } W_1 \geq b_1 \text{ or } \varepsilon = V + U \geq b_1 - X \beta \\
0 & \text{if } W_1 < b_1 \text{ or } \varepsilon = V + U < b_1 - X \beta
\end{cases}
\]

where \( d_1 \) is an indicator variable.

According to Herriges and Shogren model, the presence of an anchoring effect in the follow-up question implies a weighted average of the prior willingness to pay \( W_1 \) and the initial bid amount \( b_1 \) to form the posterior willingness to pay \( W_2 \). That is,

\[
W_2 = (1 - \gamma) W_1 + \gamma b_1
\]

where \( \gamma \) is the anchoring weight and \( 0 \leq \gamma \leq 1 \). The respondent’s answer to the follow-up question of whether he is willing to pay the bid amount \( b_2 \) will be “yes” if \( W_2 \) was greater than \( b_2 \); otherwise, the response would be ‘no’. That is:

\[
d_2 = \begin{cases} 
1 & \text{if } W_2 \geq b_2 \text{ or } \varepsilon = V + U \geq \frac{b_2 - \gamma b_1}{1 - \gamma} X \beta \\
0 & \text{if } W_2 < b_2 \text{ or } \varepsilon = V + U < \frac{b_2 - \gamma b_1}{1 - \gamma} X \beta
\end{cases}
\]

It is obvious that the probability of a “yes”
response in each valuation question depends on the probability distribution of the composite error $\varepsilon$. Since the stochastic "yea-saying" bias is nonnegative, the distribution of the composite error is positively skewed. Under the normality assumption for the symmetric random noise $V$, the probability is not likely to be estimated by, for example, a probit or logit model.4

Assume that the symmetric random error $V$ is normally distributed with zero mean and constant variance $\sigma^2_V$, i.e., $N(0, \sigma^2_V)$, and the nonnegative error $U$ is distributed half-normal, i.e., $\mathcal{N}(0, \sigma^2_U)$. The assumption of nonnegative half normal on the "yea-saying" bias $U$ is based on the plausible proposition that the modal value of the bias is zero, with increasing value of the bias becoming increasingly less likely. It is also based on tractability, since it is relatively easy to derive the distribution of the composite error $\xi = (V+U)$. Under the independent assumption of $V$ and $U$, Aigner, et al. [2] derived the density function of the error term $\xi$ as

$$f(\xi) = \frac{2}{\sigma} \phi\left(\frac{\xi}{\sigma}\right)\Phi\left(\frac{\lambda\xi}{\sigma}\right),$$

where $\lambda = \sigma_u / \sigma_V$, $\sigma^2 = \sigma^2_U + \sigma^2_V$, and $\phi(.)$ and $\Phi(.)$ are the standard normal density and distribution functions, respectively. The parameter $\lambda$ provides a useful indication of the relative contributions of $V$ and $U$ to $\xi$. As $\lambda \rightarrow 0$, it implies either $\sigma^2_U \rightarrow 0$ or $\sigma^2_V \rightarrow \infty$, and the symmetric error component of random variation dominates the "yea-saying" bias in the determination of the prior willingness to pay, $W_1$. In this case, the model is reduced to the model of Herriges and Shogren if $U=0$. Similarly, when $\lambda \rightarrow \infty$, it implies either $\sigma^2_U \rightarrow \infty$ or $\sigma^2_V \rightarrow 0$, and the "yea-saying" bias becomes the dominant source of random variation in the determination of the prior willingness to pay, $W_1$.

This density function (6) is asymmetrically distributed, with mean and variance. The mean 'yea-saying' bias and the variance of the error term $\varepsilon$ are given by:

$$E(\varepsilon) = E(U) = \sqrt{\frac{2}{\lambda}} \sigma_u = \sqrt{\frac{2}{\lambda}} \frac{\lambda}{\sqrt{1 + \lambda^2}} \sigma$$

$$\text{Var}(\varepsilon) = \left(\frac{\pi - 2}{\lambda}\right) \sigma^2_U + \sigma^2_V = \frac{1 + ((\pi - 2) \lambda^2)}{1 + \lambda^2} \sigma^2_U$$

Using the density function (6), the log likelihood function of the model for a sample of $n$ respondents is:

$$\ln L = \sum_{d=1}^{d=1} \ln P_{11} + \sum_{d=1}^{d=0} \ln P_{10} + \sum_{d=0}^{d=0} \ln P_{01} + \sum_{d=0}^{d=0} \ln P_{00},$$

where $P_{11}$ is the probability for the first bit value $b_1$ and the response to the first bit value $b_1$ is "yes". In this case, the second bit value $b_2$ is raised and $b_1 > b_2$. Thus the probabilities, $P_{11}$ and $P_{10}$, are evaluated only for observations that $b_2 > b_1$. Similarly, for $d_1=0$, it means that $W_1 < b_1$ and with the response "no" to the first bit value $b_1$. The second bit value $b_2$ is lower. Thus the probabilities, $P_{01}$ and $P_{00}$, are evaluated only for observations that $b_2 < b_1$.

**Empirical Analysis**

An econometric model with stochastic yea-saying bias is illustrated with a CVM study that estimates the willingness to pay on health benefits of air quality improvement from three major metropolitan areas in Taiwan. These areas comprise the cities and counties of Taipei, Taichung, and Kaohsiung (TTK). In early 1996, we conducted an in-person interview survey of 938 residents age 20...
years and over within the TTK areas. The survey was undertaken by the Center for Survey Research at Academia Sinica, and all respondents in the formal survey were randomly sampled.

Each respondent is asked to value two CVM questions: the willingness to pay for air quality improvement from ‘unhealthy’ to ‘moderate’; and similarly, from ‘moderate’ to ‘good’. The specific CVM question is as follows:

“In order to improve the air quality of your city such that all of the unhealthy (moderate) air quality days in 1995 become moderate (good), are you willing to pay NT$______ annually for the government and firms to control air pollution?”

The respondents were randomly assigned a set of three bid values from a list of ten. The first bid value in each set is the starting WTP bid for the first question. In the follow-up question, the respondents are offered a second bid value twice the first starting value if the answer to the first question is a ‘yes’. If the first answer is a ‘no’, the second bid value is half the first bid value.

Four different model specifications are estimated using the maximum likelihood estimation method. The estimates first show that the responses to DC questions are clearly influenced by the first bid values introduced by interviewers. Then, we find a strong anchoring effect on the valuation of the air quality that is consistent with other empirical studies. We also surprisingly find an insignificant yea-saying bias in this first empirical estimation of the bias. It shows that the estimates of the mean and median of the latent WTP controlling for the biases in anchoring and yea-saying are two to five times greater than the estimates without controlling for the biases. Thus, it is very important to make sure that the starting point bias has been well taken care of in future CV studies.


**Reference:**