Resource and Energy Economics 35 (2013) 396–411

Contents lists available at SciVerse ScienceDirect

Resource and Energy Economics

journal homepage: www.elsevier.com/locate/ree

# Identifying inconsistent responses in dichotomous choice contingent valuation with follow-up questions

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ARTICLE INFO

*Article history:*
Received 26 April 2012
Received in revised form 24 April 2013
Accepted 30 April 2013
Available online 7 May 2013

*Keywords:*
Contingent valuation
Double-bounded format
Inconsistent responses

ABSTRACT

We develop a new but simple non-parametric method to diagnose inconsistency in double-bounded contingent valuation questions in the presence of both perfect and imperfect correlation between initial and follow-up response distributions. The proposed method can identify inconsistency in iterative responses at each bid interval. We apply this method to data from five well-known double-bounded contingent valuation surveys. The predictions of our model match closely with parametric outcomes. Further, we find that the inconsistency patterns generally vary for different data sets and different bid intervals within data sets. Therefore no single behavioral model can explain all latent inconsistency patterns either within or across data sets. In addition, we examine the impact of inconsistency in responses on bias and efficiency of the double-bounded format in the absence of correction for inconsistency. We conclude that the commonly cited benefits of the double-bounded format hold only in the special case of nearly perfect consistency between initial and follow-up response distributions. Our method provides a simple tool researchers can use to determine the similarity in response distributions between the initial and follow-up responses and whether incorporating collected follow-up responses are likely to actually increase efficiency without introducing bias.



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http://dx.doi.org/10.1016/j.reseneeco.2013.04.005

## 1. Introduction

Twenty years have passed since the paradigm-shifting paper "Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation" by Hanemann et al. (1991) proposed asking respondents initial and follow-up dichotomous choice questions in a contingent valuation study.[1] Many empirical investigations of the approach, however, have found a lack of consistency between the distributions of the initial and follow-up responses (*e.g.* Alberini et al., 1997; Bateman et al., 2001; Cameron and Quiggin, 1994; DeShazo, 2002; Herriges and Shogren, 1996). Interestingly, each of these studies has proposed psychological explanations for this inconsistency, specifying how subjects react to the sequential elicitation mechanism. However, these explanations have been *ad hoc* and no single explanation can account for all observed inconsistency patterns.

Failure to correct for inconsistency can lead to false conclusions and inaccurate value estimates (*e.g.* Alberini et al., 1997; Chien et al., 2005). Because the double-bounded format is still being used (*e.g.* Brouwer and Martín-Ortega, 2012; Claudy et al., 2011; Holmquist et al., 2012; Schwarzinger et al., 2009; Watson and Ryan, 2007) and analyzed (*e.g.* Flachaire and Hollard, 2007; Veronesi et al., 2011; Watanabe, 2010), it is therefore important to understand the behavioral foundation for any inconsistency in order to make the most from the guidance in the literature regarding how to correct for inconsistency *ex post*. However, these models controlling for inconsistency have focused primarily on inconsistency due to a shift in the mean of the second response. They have largely ignored a different kind of inconsistency: less-than-perfect correlation between the first and second response distributions. As Carson and Groves (2007) point out, "...the appearance of a second price must signal that something is going on. All of the plausible assumptions lead to the key prediction that the correlation between the WTP distributions implied by the two questions is less than unity" (p. 196). For example, DeShazo (2002) proposes a 'framing effect' model which, although not explicitly stated, is based on the assumption that the first and the second responses are highly (almost perfectly) correlated. Yet the correlations between responses from his data sets are far from perfect.

In the current paper, we argue that ignoring imperfect correlation causes significant problems for analyzing behavioral inconsistency patterns in iterative question contingent valuation studies. We propose a more general inconsistency-diagnosing model which allows for imperfect correlation between the initial and follow-up responses. We show that predictions of previous behavioral models should be corrected in the presence of imperfect correlation. Furthermore, we can identify inconsistency in iterative responses for each bid interval. We find that inconsistency patterns generally vary for different data sets and different bid intervals within data sets. This implies that a particular behavioral model cannot explain all latent inconsistency patterns of responses in the double referendum format. We apply our method to five real data sets with a fairly wide range of inconsistency patterns and find that our model predictions are generally consistent with parametric results. Lastly we examine the impact of inconsistency in responses on the bias and efficiency of the double-bounded dichotomous choice format. We find that when inconsistency is not controlled for, the oft championed benefits of the double-bounded dichotomous choice format occur only in the special case of nearly perfect consistency between initial and follow-up responses. This emphasizes the need to correctly diagnose inconsistency so that the most appropriate controls can be applied.

## 2. Behavioral explanations of observed inconsistency

To begin, we discuss the common explanations of behavioral inconsistency. Alberini et al. (1997) and Carson et al. (1994) propose a "government wastage model" (also called a "cost expectations model" in DeShazo, 2002) arguing that respondents who initially say 'yes' may refuse to pay the increased second amount because they feel that the government would attempt to acquire more money than is needed to cover the cost of provision. In contrast, respondents who reject the first offered bid may consider the lowered second bid a sign of decreased quality of the good provided.

[1] Here, respondents are asked whether they are willing to pay some initial bid, then asked the same about a follow-up bid which is higher (lower) if the response to the first bid is yes (no).