



On the construct validity of measures of willingness to pay for green electricity: Evidence from a South African case



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HIGHLIGHTS

- We test the convergent and theoretical validity of two willingness-to-pay measures.
- Double-bounded dichotomous choice (DC) and open-ended (OE) measures were tested.
- Convergent validity was low due to low correlation coefficients among measures.
- Theory of planned behaviour was used to build regression models.
- Different factors emerge in the DC and OE models indicating low theoretical validity.

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ABSTRACT

The price consumers are willing to pay (WTP) extra for green electricity (GE) is one of the uncertainties possibly impacting on the overall feasibility of its market introduction. In the literature, several measurements of WTP are used. However, the number of studies comparing WTP measures is limited. This study investigates the construct validity (convergent and theoretical) of two widely used WTP measures (double-bounded dichotomous choice (DC) and open-ended (OE)). A model informed by the well-known theory of planned behaviour was applied to survey data from 890 South African domestic energy users. It was found that convergent validity among the WTP measures was fairly low. Moreover, results from Tobit regressions showed that a grounded theoretical model yields statistically significant results. However, different independent variables emerge in the DC and OE models. Therefore, the theoretical validity of one of the WTP measures seems to be low. The paper proposes a number of explanations for the low construct validity observed.

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1. Introduction

Renewable energy (RE), such as energy generated from wind, sunlight, the tides and subterranean heat (geothermal), are considered to be “green” because it is less damaging and polluting to the environment than coal [1]. Yet, the introduction of RE products, like green electricity (GE), as a public good on the consumer market is confronted with a number of uncertainties. The price that consumers are willing to pay (WTP) extra for such products is one of them, as its level influences the overall feasibility of market introduction. Past studies on WTP for GE within this framework showed that WTP is measured in several ways. Yet, the number

of studies systematically comparing WTP elicitation techniques is limited [2]. The following question was asked in this study: To what extent are dichotomous choice (DC) and open-ended (OE) measures of WTP substitutes? This paper uses two types of construct validity to answer this: convergent and theoretical validity.

The contributions of this paper are twofold. First, it adds to our knowledge on the extent of validity of WTP measures. By showing that the convergent and theoretical validity of two often-used elicitation methods are low, this paper raises the awareness of academic scholars and policy makers to make distinctions between the two measures. Second, the majority of studies on WTP for GE were performed in developed economies. Very few have been performed in emerging economies. This study was conducted in South Africa and contributes to the field of WTP for GE from an emerging economy perspective. This context is relevant as consumers in low (er) income countries tend to be more sensitive to price changes [3]. The results are believed to be relevant to developed countries.

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2. Theoretical backgrounds and hypotheses

2.1. Contingent valuation and its elicitation effect

From an economic theoretical point of view, GE is an interesting case because it is a so-called impure public good [4] as it is characterised by the joint production of a private good and an environmental public good, the latter being a good that is non-rival and non-excludable. In the case of GE, the private good is the individual consumption of electricity. The public good is the reduction of greenhouse gas emissions from which other consumers cannot be excluded and for which the utility for one person does not decrease the utilities for others. GE customers voluntarily pay an additional premium that covers the additional production expenses of generating consumers' electricity from RE sources. This additional premium is an expression of the consumer's WTP and an expression of (choice) behaviour.

Methods to economically value the size of this premium can be broadly classified into two groups [5]: approaches that value a good via a demand curve, and methods that do not. Demand curve approaches can be divided into revealed and stated or expressed preference methods. The consumers' demand for a (public) good can be *revealed* by examining the purchase of related goods in the private marketplace. Alternatively, the demand for public goods, and thus the WTP level, can be measured by investigating consumers' *stated* preferences for these goods relative to their demand for other goods (asking actors explicitly how much they value environmental goods). Two types of stated preference methods can be distinguished [5]: choice experiments and contingent valuation (CV). We focus on the latter because it is an often-used approach to let individuals state their valuation.

CV is applied to estimate non-use values and/or non-market use values. According to Carson et al. [6], "its flexibility facilitates valuation of a wide variety of non-market goods, including those not currently provided". It first defines the good to be valued in detail, listing its attributes and using different elicitation methods. The consumer is then asked about her WTP.

A source of error of any CV method [7] is the elicitation technique (the format in which the WTP question is stated). There are four WTP elicitation formats [8]:

- Bidding or bargaining format: A researcher proposes WTP values that a respondent accepts or rejects and continues to make higher or lower bids depending on the decision of the respondent.
- Payment scale format: Respondents choose (different) values from a predefined and ordered list, and all individuals use the same list.
- Open-ended (OE) format: Each respondent is asked to choose her or his own WTP value, unbounded and unprompted.
- Dichotomous choice (DC) format: Each respondent receives a randomly assigned bid and is invited to accept or reject this bid (single-bounded version). In the so-called double-bounded version, the respondent is given a second bid based on the response to the first bid.

To obtain an overview of the main characteristics of and methods used in recent CV studies on WTP for GE, a systematic literature survey was conducted.

Google Scholar, Science Direct, Swetwise and Proquest were used to search for the following keywords: "willingness to pay", "green electricity", "renewable energy", "sustainable energy". Studies had to be published in academic journals, and had to focus on WTP for GE from a consumer perspective.

A sample of 51 studies relating to WTP for GE was found. Our systematic analyses resulted in the following findings. Forty-four studies were conducted in developed countries, with the majority being conducted in the USA (14 studies; e.g. [9] and in Europe (24 studies; e.g. [10]). Only two studies were conducted in Africa: one in South Africa [11] and one in Kenya [12]. From these findings, there seems to be a lack of studies from emerging economies. This may be due to GE for domestic purposes not yet being widespread in these countries.

In 19 studies, researchers used the DC option. Examples of studies applying single DC questions are Hansla et al. [13], Yoo and Kwak [14], Kostakis and Sardianou [15] and Guo et al. [16]. Although it is custom to combine DC with randomised bids, this is not necessarily the case. Some scholars use ordinal scales [9,17] or interval scales [13] to indicate the extent to which consumers are WTP (extra). Some studies (e.g. [18,19]) use a double-bounded version of the DC model. In eight studies, OE questions were used to measure WTP (e.g. [10,20,21]). A limited number of papers (14) applied choice experiments (e.g. [22,23]). This review shows that predominantly two types of questions are used in consumer studies on WTP: DC and OE questions.

The OE format has some obvious advantages ([2]: pp. 106–107). It is easy and convenient to answer, does not require an interviewer, and does not result in any starting-point bias. Some disadvantages have also been identified. The approach tends to generate a larger number of non-responses or protest (zero) bids because subjects find it too difficult to answer or do not feel inclined to provide a true answer. They would rather indicate cost than true value.

The main advantage of the single-bounded DC approach is that it supports the respondent to go through a complete valuation process. Due to the fact that the approach is regarded as incentive-compatible, it runs a low risk of strategic bias. Disadvantages are that the approach derives the maximum WTP, but not the actual WTP amount, it is prone to starting-point bias, sensitive to the extent to which individuals are already familiar with the (public) good, and a large number of observations are needed to establish the distribution of WTP values.

Several studies compared results generated by these two elicitation methods (the so-called elicitation effect) (see [8]). With a few exceptions (e.g. [24]), comparative studies reveal that WTP values elicited by the DC technique are systematically higher compared to the OE technique. Venkatachalam [2] in his review, therefore, stated that one of the main issues related to the CV method is construct validity. So far we have not yet come across any empirical study that test construct validity of DC and OE techniques.

Literature suggests four possible explanations for this so-called elicitation effect. A first explanation is that the probability of strategic response bias is low in the DC option. Consequently, an individual is less inclined to over- or understate her true WTP value. A second explanation relates to the cognitive complexity of OE WTP questions. Respondents just find it too difficult "to put a number on it" and often submit a zero value, lowering the average value. Preference uncertainty is a third explanation. Especially for complex and unfamiliar goods, individuals seem to miss the ability to submit a precise estimate of their WTP. "Yea-saying" is a reflection of this. In a DC format, respondents accept the proposed bid as a cue for a reasonable WTP amount. In an OE format, this cue is absent. A related phenomenon is anchoring or starting-point bias, which implies that different starting points produce different estimates, which are biased towards the initial value. A fourth explanation argues that individuals may have two aims when responding to WTP questions. They want to truthfully

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