Scope effects of respondent uncertainty in contingent valuation: Evidence from motorized emission reductions in the city of Nairobi, Kenya

Hilary Ndambiri[1] * Eric Mungatana[1] * Roy Brouwer[2]

[1]Centre for Environmental Economics and Policy in Africa, University of Pretoria, South Africa

[2]Department of Environmental Economics, Vrije Universiteit, Amsterdam, The Netherlands.

Abstract

This study analyzed the scope effects of respondent uncertainty in contingent valuation (CV) by evaluating whether willingness to pay (WTP) estimates were sensitive to changes in the magnitudes of motorized emission reductions in the city of Nairobi, Kenya. The WTP estimates were elicited through the conventional payment card (PC), stochastic payment card (SPC) and the polychotomous payment card (PPC) formats. While SPC and PPC formats were used to capture respondent uncertainty, the PC format captured respondent certainty regarding the amounts individuals were WTP for emission reductions. Based on parametric and nonparametric analysis, the results show that certain (PC) respondents stated significantly larger WTP amounts for larger emission reductions than for smaller reductions. Conversely, uncertain (SPC and PPC) respondents stated smaller amounts for larger emission reductions than certain (PC) respondents. The implication is that though respondents were sensitive to the scope of motorized emission reductions, respondent uncertainty lowered their sensitivity to scope.

Key words: Contingent valuation, respondent uncertainty, scope sensitivity, valuation formats, motorized emission reductions.

1. Introduction

Contingent valuation (CV) is a survey-based non market valuation approach used to elicit the policy values of providing environmental goods and services (Mitchell and Carson, 1989; Freeman, 1993; Smith, 1993). On a specific hypothetical scenario and detailed description of the good, people are asked directly to state how much they would be willing to pay for its provision or how much they would be willing to accept as compensation for its withdrawal (Carson, 2000; Mendelsohn and Olmstead, 2009). Therefore, CV approach can circumvent the absence of markets by inferring policy values of providing environmental goods and services from the choices of individuals found in the real market (Mitchell and Carson, 1989; Freeman, 1993; Smith, 1993).

The fact that CV approach is based on asking individuals how much they would be willing to pay or willing to accept based on hypothetical markets, as opposed to observing their behavior in the real market, has been a source of enormous controversy among researchers (Gregory *et al.,* 1993; Polasky *et al.,* 1996; Champ *et al.,* 1997; Johannesson *et al.,* 1998; van Kooten *et al.,* 2001; Alberini *et al.,* 2003). One of the controversies focuses on whether estimates of economic value are sensitive to goods' scope. That is, whether willingness to pay (WTP) or accept (WTA) estimates increase or decrease satisfactorily with changes in the composition, quantity or quality of the environmental goods being valued (Kahneman, 1986; Hausman, 1993; Carson, 1997; Svedsater, 2000). While some studies have shown significant evidence of respondents' insensitivity to goods' scope (Kahneman and Knetsch, 1992; Beattie *et al.,* 1998; Hammitt and Graham, 1999; Svedsater, 2000), others have shown significant sensitivity to scope (Smith and Osborne, 1996; Carson, 1997; Smith, 1999) while still others have pointed to the possibility of having scope sensitivity and insensitivity within the same study (Bateman *et al.,* 2004; Heberlein *et al.,* 2005).

There are several reasons why scope insensitivity is observed in practice and they include: amenity misspecification (Carson and Mitchell, 1993), framing or embedding effects (Randall and Hoehn, 1996), warm glow effects (Heberlein *et al.,* 2005) and the declining marginal existence values (Rollins and Lyke, 1998). Insensitivity to scope has also been linked to respondents' lack of familiarity with payments for environmental goods in hypothetical markets often leading to constructed preferences (Brouwer, 2009). Such lack of familiarity with environmental payments has, as well, been shown to be an important determinant of the underlying respondent uncertainty in CV (Loomis and Ekstrand, 1998; van Kooten *et al.,* 2001; Veisten *et al.,* 2004; Brouwer, 2009).

Respondent uncertainty is defined as respondents' state of indecisiveness about the amounts they are willing to pay for the provision of environmental goods and services (Polasky *et al.,* 1996; van Kooten *et al.,* 2001; Shaikh *et al.,* 2007; Brouwer, 2009; Logar and van den Bergh, 2012). Like scope sensitivity, it has also remained a contested issue in the CV literature for about two and a half decades. Researchers have not only studied the sources and welfare effects of respondent uncertainty but also the procedures for analyzing response uncertainty (Ready *et al.,* 2001; Alberini *et al.,* 2003; Samnaliev *et al.,* 2006; Shaikh *et al.,* 2007; Blomquist *et al.,* 2009; Brouwer, 2009; Moore *et al.,* 2010; Martinez-Espineira and Lyssenko, 2012). These procedures have, nonetheless, yielded inconsistent findings about the real welfare effects of respondent uncertainty (Akter and Bennett, 2008; Petrolia and Kim, 2011; Martinez-Espineira and Lyssenko, 2012). In most, but not all cases, respondent uncertainty has resulted in more conservative estimates of the WTP although at the expense of statistical efficiency. Even so, the scope effects of respondent uncertainty remain largely unknown as there is no known study that has analyzed respondent uncertainty in relation to sensitivity to goods' scope. The purpose of this paper was therefore to analyze the link between respondent uncertainty and scope sensitivity and thereby make a novel contribution

to the current CV literature. The analysis was merited by the fact that it would provide essential methodological inferences for welfare analysis since policy formulation and implementation may involve some aspects of public uncertainty and/or insensitivity to changes in either composition, quality or quantity of goods or services being provided to the public (Gyldmark and Morrison, 2001; Veisten *et al.,* 2004).

For this reason, WTP responses in the study were elicited from 'within' and 'between' respondents using payment card (PC), stochastic payment card (SPC) and the polychotomous payment card (PPC) formats with a case application to the valuation of motorized emission reductions in the City of Nairobi, Kenya. The PC format conventionally elicits preferences on the assumption that respondents know their WTP with certainty (Mitchell and Carson, 1989; Hanley *et al.,* 2003; Ryan *et al.,* 2004) while SPC (Wang, 1997; Wang and Whittington, 2005) and PPC (Welsh and Poe, 1998; Wang and He, 2011) formats do the same though with the assumption that respondents are uncertain about their WTP. Moreover, each of the these formats can be used ascertain whether or not WTP estimates are sensitive to goods' scope but, in this case, estimates from SPC and PPC formats were used to provide comparative information that would capture the effects of respondent uncertainty on individuals' sensitivity to scope as the PC estimates act as the yardstick.

The rest of the paper is organized as follows. Section 2 provides a brief review of literature on respondent uncertainty and scope sensitivity in CV. Section 3 discusses the motorized emission situation in the city of Nairobi. Section 4 describes the survey design. Section 5 presents the study findings and discussion and section 6 concludes.

2. Respondent uncertainty and scope sensitivity in contingent valuation

Contingent valuation studies have traditionally been based on the assumption that respondents know their preferences with certainty. Thus, responses to welfare analyses have mostly been elicited through payment card (PC), bidding games (BG), open-ended questions (OE), single bounded (SB) and double bounded (DB) formats among other variants (Li and Mattson, 1995; Ready *et al.,* 1995; Loomis and Ekstrand, 1998). Some empirical studies have however shown that respondents may not after all know their preferences with full certainty (Champ *et al.,* 1997; Johannesson *et al.,* 1998; Ready *et al.,* 2001; van Kooten *et al.,* 2001; Shaikh *et al.,* 2007). This is because preferences tend to be ambiguous (Wang, 1997) and are more generally affected by the policy environment of the good being provided (Dominguez-Torreiro and Solino, 2011). In addition, preferences are elicited within hypothetical markets and from respondents probably with insufficient cognitive ability to make trade-offs between their money and the good being valued (Ready *et al.,* 1995; Champ *et al.,* 1997; Wang, 1997; Alberini *et al.,* 2003; Shaikh *et al.,* 2007; Sund, 2009).

As a result, it has become important to model WTP estimates using value elicitation formats that account for respondent uncertainty such as SPC and PPC formats among others (Champ *et al.,* 1997; Wang, 1997; Welsh and Poe, 1998; van Kooten *et al.,* 2001; Wang and Whittington, 2005). These formats account for respondent uncertainty by allowing respondents to express their degree of uncertainty against bid values that are presented on a numerical or ordinal certainty scale. What has not been clear, though, has been the link between respondent uncertainty and sensitivity to changes in the magnitude of the good under valuation, otherwise known as scope sensitivity. It involves testing whether respondents are willing to pay significantly more for larger provisions and/or less for smaller provisions in terms of composition, quality or quantity of the environmental public good in question (Carson, 1997; Czajkowski and Hanley, 2009).

Scope sensitivity analysis may be internal ('within' respondent) or external ('between' respondent). In the internal version, the same respondent is asked to state his/her WTP for different magnitudes of the environmental good being valued while in the external version, two different magnitudes are valued by different respondents using split samples (Bateman *et al.,* 2004; Czajkowski and Hanley, 2009; Loomis *et al.,* 2009). With appropriate regression models, scope analysis may also be conducted by testing whether parameters of interest in the model are significantly different from zero (Hanley *et al.,* 2003; Loomis *et al.,* 2009). Unlike the external test of scope, the internal version of scope is easily passed by respondents' because of their urge to uphold the 'internal consistency' of their WTP answers (Heberlein *et al.,* 2005; Czajkowski and Hanley, 2009). Nonetheless, it is still important to conduct the internal test of scope since it allows pairwise comparison of WTP estimates for each respondent within the sample and therefore, control for heterogeneity among respondents (Adamowicz *et al.,* 1999; Czajkowski and Hanley, 2009).

Bateman *et al.* (2004) also notes that study designs in scope analysis can either use stepwise or advance disclosure of the valuation questions. In stepwise disclosure, the full sequence of valuation questions is revealed to respondents only as the survey proceeds. Therefore, the approach comes with an element of surprise that can strategically affect responses to the valuation questions. However, whether or not valuation questions are a surprise is immaterial from economic theory because it says nothing about it. For the advance disclosure, the full sequence of valuation questions is revealed to respondents before they are asked to state what they would be willing to pay. In this case, there are no surprises although strategic incentives, which are constant throughout the valuation process, may still be found. In addition, study designs in scope analysis may be constructed in a way in which changes in the magnitude of goods being valued are presented to respondents in a bottom-up or top-down manner. In the bottom-up approach, the less inclusive good is valued first followed by

the more inclusive good. In contrast, top-down approach involves the valuation of the more inclusive good first followed by the less inclusive good.

Following Bateman *et al.* (2004), the study used the advance disclosure design to elicit WTP for the different magnitudes of motorized emission reductions, which were presented to respondents in a bottom-up and top-down manner. For instance, in the bottom-up advance disclosure, the valuation questions were first revealed to respondents before they were asked to state what they would pay for "25%" and "50%" magnitudes of motorized emission reduction. The reverse case applied for the top-down advance disclosure. The use of the percentage approach to proxy different magnitudes of emission reductions follows similar applications by Shechter and Kim (1991), Carlson and Johansson-stenman (2000), Wang *et al.* (2006), Loomis *et al.* (2009) and Firoozzarea and Ghorbani (2011).

3. Motorized emissions in the City of Nairobi

The city of Nairobi is located at the south-eastern end of Kenya's agricultural heartland, at about 1° 9'S, 1° 28'S and 36° 4'E, 37° 10'E. It covers an area of about 696 Km^2 with an altitude varying between 1,600 and 1,850 metres above sea level (CBS, 2009). It is divided into eight administrative divisions, namely, Central, Dagoreti, Embakasi, Kasarani, Kibera, Makadara, Pumwani and Westlands. The city's population is about 8 per cent of the country's total population and 25 per cent of Kenya's urban population (CBS, 2009). The population is estimated to have grown from 343,500 people in 1962 to about 3.1 million in 2009 and by 2015, it is expected to hit the 3.8 million mark (CBS, 2009). There are several reasons that have motivated population growth in Nairobi, which include better economic prospects, opportunities for higher education, higher wage employment and the attraction of Nairobi as a market for goods and services (NEMA, 2010).

Rapid increase in population has led to unprecedented sprawl of informal settlements, increased poverty levels, increased motorization and attendant air pollution within the city. With the growth of motor vehicle population in the city, motorized emissions are considered a major source of air pollution accounting for about 90% of total emissions (Odhiambo *et al.,* 2010). For instance, the population of vehicles on the city's roads was 207,340 vehicles in 2004 and by 2008 over 300,000 vehicles were operating on city's roads. Out of the 300,000 vehicles, 36% were private cars, 27% were public transport vehicles and a whole 37% constituted city residents walking to different destinations because of the expensive public transport that could also not meet the rising demand for transport in the city (MORPW, 2009). With increased emission of toxic gases such as carbon monoxide, hydrocarbons, oxides of sulphur and nitrogen, and inhalable and respirable particulate matter (Kinney *et al.* (2011), many Nairobi residents are exposed to air quality problems (Odhiambo *et al.,* 2010; Kinney *et al.,* 2011), which potentially pose serious long-term implications for health and to the environment (Vliet and Kinney, 2007; Odhiambo *et al.,* 2010; Kinney *et al.,* 2011).

Even though problems posed by motorized emissions have been a cause of concern among local authorities (NEMA, 2010), the city lacks a comprehensive management policy for motorized emissions. It would therefore be desirable for the city authorities to draft such a policy given the huge number of resident and daytime populations within the city, approximately 3.1 and 4.2 million people, respectively. The drafting of such a policy can only be attained if peoples' preferences for a policy proposal to reduce motorized emissions are known. Nonetheless, not much is known about peoples' preferences because studies available so far on air quality in Nairobi (Mulaku and Kariuki, 2001; Odhiambo *et al.,* 2010; Vliet and Kinney, 2007; Kinney *et al.,* 2011) deal only with the technical aspects of measuring concentrations of pollutants in the air and their possible effects on human health and the environment. As a result, policy information on the socioeconomic aspects of the

population that is pertinent towards the formulation of emission management policy is lacking. Therefore, this case application was useful on the premise that the missing policy information would be provided and thereby set precedence for improving air quality management in the city.

4. Survey design

4.1 Environmental public good considered in the study

Motorized emission reduction constituted the environmental good of interest in the study upon which internal and external scope sensitivity tests were conducted. The internal test of scope analyzed the 'within respondent' bottom-up and top-down mean WTP for emission reductions while external scope test only analyzed the 'between respondent' bottom-up mean WTP estimates. The reason behind the latter case is that the top-down estimates would potentially be biased as they are asked second (Bateman *et al.,* 2004; Nielsen and Kjaer, 2011). For instance, in the internal test of scope, half of the respondents surveyed under PC, SPC and PPC formats were, on one hand, requested to value 25% emission reduction first followed by a question on what they would pay for a 50% emission reduction (the bottom-up approach). The remaining half was, on the other hand, asked to value 50% emission reduction first followed by a question on how much they would pay for a 25% emission reduction (the top-down approach). As such, the following hypotheses were formulated to capture the internal test of scope scenario described above for the three formats:

<table>
<tr><td align="center">**Bottom-up approach (BU)**</td><td align="center">**Top-down approach (TD)**</td></tr>
<tr>
<td>(a) $H_0: wtp_{BU(25\%)}^{pc} = wtp_{BU(50\%)}^{pc}$</td>
<td>$H_0: wtp_{TD(50\%)}^{pc} = wtp_{TD(25\%)}^{pc}$</td>
</tr>
<tr>
<td>$H_1: wtp_{BU(25\%)}^{pc} < wtp_{BU(50\%)}^{pc}$</td>
<td>$H_1: wtp_{TD(50\%)}^{pc} > wtp_{TD(25\%)}^{pc}$</td>
</tr>
<tr>
<td>(b) $H_0: wtp_{BU(25\%)}^{spc} = wtp_{BU(50\%)}^{spc}$</td>
<td>$H_0: wtp_{TD(50\%)}^{spc} = wtp_{TD(25\%)}^{spc}$</td>
</tr>
<tr>
<td>$H_1: wtp_{BU(25\%)}^{spc} < wtp_{BU(50\%)}^{spc}$</td>
<td>$H_1: wtp_{TD(50\%)}^{spc} > wtp_{25\%}^{spc}$</td>
</tr>
<tr>
<td>(c) $H_0: wtp_{BU(25\%)}^{PPC} = wtp_{BU(50\%)}^{PPC}$</td>
<td>$H_0: wtp_{TD(50\%)}^{PPC} = wtp_{TD(25\%)}^{PPC}$</td>
</tr>
<tr>
<td>$H_1: wtp_{BU(25\%)}^{PPC} < wtp_{BU(50\%)}^{PPC}$</td>
<td>$H_1: wtp_{TD(50\%)}^{PPC} > wtp_{TD(25\%)}^{PPC}$</td>
</tr>
</table>

That is, the mean WTP for 25% (50%) motorized emission reductions is significantly lower (higher) than the mean WTP for 50% (25%) emission reductions 'within' respondents surveyed under PC, SPC and PPC formats, respectively.

As for the external tests of scope, the mean WTP from half the sample that was asked to value 50% emission reduction first and another half of the sample that was asked to value 25% emission reduction first were estimated and compared. The following hypotheses were formulated to capture the external test of scope scenario for the three formats:

Bottom-up approach (BU)

$$(d) \quad H_0: wtp^{pc}_{BU(25\%)} = wtp^{pc}_{BU(50\%)}$$
$$H_1: wtp^{pc}_{BU(25\%)} < wtp^{pc}_{BU(50\%)}$$
$$(e) \quad H_0: wtp^{spc}_{BU(25\%)} = wtp^{spc}_{BU(50\%)}$$
$$H_1: wtp^{spc}_{BU(25\%)} < wtp^{spc}_{BU(50\%)}$$
$$(f) \quad H_0: wtp^{PPC}_{BU(25\%)} = wtp^{PPC}_{BU(50\%)}$$
$$H_1: wtp^{PPC}_{BU(25\%)} < wtp^{PPC}_{BU(50\%)}$$

That is, the mean WTP for 25% (50%) motorized emission reduction is significantly lower (higher) than the mean WTP for 50% (25%) emission reductions 'between' respondents under PC, SPC and PPC formats. In order to test these hypotheses, boostrapped means of the WTP estimates from PC, SPC and PPC formats were obtained and compared based on the t-test analysis. It was expected that individuals would adjust their payments upward for a larger (50%) emission reduction and downward for a smaller (25%) reduction in emission.

4.2 Payment vehicle for the environmental good

Suitable selection of payment vehicles is, by and large, regarded as important in CV studies because it minimizes the induction of strategic behavior among respondents resulting to inaccurate WTP responses (Morrison *et al.,* 2000; Carson and Groves, 2007). Popular payment vehicles used in CV studies consist of prices, fees, taxes, trust funds and amenity

bills. The use of these payment vehicles can, however, lead to negative reaction and protests among respondents suppose they have an objection against the mode of payment and, therefore bias the survey results (Morrison *et al.,* 2000). Following Fonta *et al.* (2009), this study employed a neutral-type of payment vehicle known as the special trust fund in which respondents were asked to make a onetime payment towards the exclusive purpose of air quality management through motorized emission reductions. Although this payment vehicle is subject to free riding problem among respondents, it was preferred to prices, fees, taxes and amenity bills as people in Nairobi are habitually opposed to increases in prices, fees, taxes and other similar payment vehicles. Notably, the city has a history of litigations, negative reactions and comments against increases in prices, fees, taxes or amenity bills.

4.3 Value elicitation formats

The study used the conventional payment card (PC), stochastic payment card (SPC) and the polychotomous payment card (PPC) formats to elicit WTP from individuals. In the PC format, respondents were presented with an ordered range of threshold values where they were asked to peruse through the values and circle the highest amount that they would be willing to pay (Mitchell and Carson, 1989). The information gathered was, then, taken to mean that respondents' WTP was equal to or greater than the circled value but less than the next higher value (Cameron and Huppert, 1989). Respondents were asked the following valuation question:

"*Suppose the presented policy to reduce emissions from motorized vehicles and improve air quality in the city of Nairobi will actually be implemented and reduce the current amount of emissions by X%, what is the maximum amount of money you would be willing to pay one-off to the special trust fund to achieve this? (circle or tick a single amount on the card).*"

Although PC valuation questions are theoretically vulnerable to forms of range and midpoint bias, empirical evidence is scarce about the existence of range bias or midpoint bias (Klose, 1999; Ryan *et al.,* 2004). Since PC format conventionally assumes that respondents know their WTP with certainty (it does not account for respondent uncertainty), it was in this case used as a yardstick against which estimates from SPC and PPC formats were compared.

For the SPC format, respondents were offered an array of bids with probabilistic values under ordinal certainty scales labeled as ''definitely yes'' ''probably yes'' ''not sure'' ''probably no'' and ''definitely no'' (Wang, 1997). For every bid amount presented on the card, individuals were asked to select a number as a probability response value that they would accept to pay the selected amount. Essentially, the method explicitly embeds uncertainty into the analysis by letting respondents to state their own degree of certainty about their answers to each of the bid amounts offered. Subsequently, it becomes possible to perform statistical analysis of the responses taking into account the different levels of certainty (Wang and Whittington, 2000; 2005). Respondents were thus presented with the following valuation question:

"*Suppose the presented policy to reduce emissions from motorized vehicles and improve air quality in the city of Nairobi will actually be implemented and reduce the current amount of emissions by X%, how certain are you that you would actually one-off pay the amounts of money shown on this card to the special trust fund to achieve this? (circle or tick your level of certainty to pay each of the amounts on the card).*"

The main limitation of this format is the likelihood of raising the same type of range bias found in the PC application. As for the PPC format, respondents were also presented with a broad range of bids as in the PC format, but this time, only the ordinal levels labeled as

''definitely yes'' ''probably yes'' ''not sure'' ''probably no'' and ''definitely no'' were presented to allow them to express their level of uncertainty for every amount offered (Welsh and Poe, 1998). Notably, no probabilistic values were provided to respondents as is the case with SPC. As such, the following valuation question was offered to the respondents:

"Suppose the presented policy to reduce emissions from motorized vehicles and improve air quality in the city of Nairobi will actually be implemented and reduce the current amount of emissions by X%, how certain are you that you would actually one-off pay the amounts of money shown on this card to the special trust fund to achieve this? (mark x against your level of certainty to pay each of the amounts shown on the card)"

Like the SPC, the PPC format also introduces respondents' uncertainty into the analysis and circumvents the incentives for starting point bias and other difficulties inherent in the process of bid selection. This, in turn, increases the precision of the estimated parameters and central tendency estimates (Welsh and Poe, 1998; Wang and He, 2011). However, the PPC format has the possibility of inducing the same type of range bias that is found in PC and SPC applications.

4.4 Study area and population

Nairobi is Kenya's capital and the largest city with eight administrative divisions that together form Nairobi County. It occupies an area of about 696 Km^2 that lies adjacent to the eastern edge of the Rift Valley with an average elevation of 1724 metres above sea level (CBS, 2009). It has a moderate climate characterized by relatively sunny summers, cool winters and a modest rainfall. Besides trade, agriculture and industrial manufacturing, the city also acts as the headquarters of most government, private and international organizations. The population of Nairobi constitutes the main driver of environmental

change. It stands at 3.1 million people, which is about 8 per cent of the country's total population and about 25 per cent of Kenya's urban population (CBS, 2009). Factors influencing population change include better economic prospects, opportunities for higher education, higher wage employment and the attraction of Nairobi as a market for goods and services (NEMA, 2010). These factors have led to rapid population change in the city resulting into unprecedented sprawl of informal settlements, increased poverty levels, increased motorization and the attendant air pollution in the city.

4.5 Study sample and the survey instrument

In the survey, a three-way randomized split sample approach based on PC, SPC and PPC formats was used to select a representative sample of 1464 respondents from the eight administrative divisions that form city of Nairobi. In the first split sample, respondents were subjected to the PC valuation format while in the second and third split samples, respondents were subjected to SPC and PPC valuation formats, respectively. Each split sample had about 488 different respondents earmarked for the survey and drawn from the eight administrative divisions to ensure representativeness of the sample to the population of interest. The survey adopted personal interviews based on interviewer administered questionnaires to collect information from respondents. The questionnaire, which had been translated into the local language, had five sections, namely: a) a background section that sought respondents' general knowledge of air pollution in Nairobi; b) a section describing the motorized emissions reduction plan; c) a section describing both positive and negative effects of motorized emissions reduction plan; d) a section having valuation and the debriefing questions and; e) a section that sought respondents' information on socio-demographic and economic characteristics.

4.6 Piloting and survey implementation

Before the implementation of the survey, a thorough pilot test of the survey instrument was conducted on thirty respondents where respondents were asked to comment on the suitability of the questions in the survey. Bid amounts were also generated from the pilot survey out of which the mean, median, minimum and the maximum WTP values were determined. Based on the responses and comments provided by the respondents, a final questionnaire for the survey was prepared. Enumerators were also trained on what the study entailed, the contents in the questionnaire and how to administer the questionnaire through role-play. The implementation of the survey took place in three phases according to the different value elicitation formats used in the study.

4.7 Valuation scenario

The valuation section of the survey presented respondents with the following information to ensure that they understood the status quo of the city: *"The City of Nairobi is one of the most polluted urban areas in Kenya. It is characterized by high concentrations of toxic gases such as carbon monoxide (CO), sulphur oxides (SO$_x$), nitrogen oxides (NO$_x$), hydrocarbons (CH$_4$), lead (Lb) and particulate matter (PM$_x$) among others. These gases are emitted mainly from public and private vehicles, which account for over 90% of total emissions. High concentration of these gases in the atmosphere has affected the natural and built environment and most importantly human health leading to respiratory and heart diseases among others."*

Respondents were then presented with the following hypothetical improvement scenario to ensure that they understood what they were paying for: *"Suppose stakeholders comprising government and private sector agencies are planning to introduce a policy that will restore air quality to standards prescribed by World Health Organization (WHO). Therefore, they*

come up with a "special motorized emission control trust fund" into which individuals contribute money to ensure problems to the natural and built environment and human health associated with motorized emissions are eliminated. Suppose also the contribution into the trust fund is a onetime payment for the exclusive purpose of policy formulation and implementation to reduce motorized emissions..."

Respondents were then asked the valuation questions earlier mentioned so as to state the amounts they were willing to pay to reduce two different magnitudes (25% and 50%) of motorized emissions through bottom-up and top-down advance disclosure of valuation questions. The bid amounts took on fifteen different values, namely: Kenya shillings (Kshs). 0, 25, 50, 70, 100, 150, 200, 250, 300, 400, 500, 800, 1000, 1500 and Kshs. 2,000, which were obtained from a thorough pre-test survey based on the open-ended value elicitation format as recommended by Haab and McConnell (2002).

4.8 Statistical model

With interval data being generated in the study, scope sensitivity analysis was conducted using the interval regression model. This model was used to estimate both bottom-up and top-down mean WTP for emission reductions as well as factors explaining individuals' sensitivity to scope. The underlying assumption of the model holds that the true WTP of an individual is greater than or equal to the amount circled, but strictly less than the next highest amount shown on the card (Cameron and Huppert, 1989). In the PC format, the amounts circled were thus, used to form intervals and situate each response in a unique interval. For the SPC and PPC formats, the highest amounts individuals were definitely sure they would pay were used to form intervals into which individual responses were situated. Thus, WTP responses from each of the valuation formats were treated as intervals rather than point valuations for ease of comparison across formats (Cameron and Huppert, 1989; Welsh and

Poe, 1998; Whitehead *et al.,* 2000; Bigerna and Paolo, 2011). More specifically, suppose we let R_L be the maximum amount that respondent would pay and R_U be the lowest amount that respondent would switch to a 'No' rather than a 'Yes' response. The true WTP, WTP^*, would then lie somewhere in the switching interval $[R_L, R_U]$, that is, $R_L \leq WTP < R_U$. Since the distribution of WTP values is often skewed, the log normal distribution is taken as the first approximation for WTP distribution (Cameron and Huppert, 1989). Therefore:

$$Log\ WTP_i = x_i'\omega + \mu_i \tag{1}$$

where x' are the characteristics of the respondent, μ is the random variable that is normally distributed with zero mean and standard variance σ, and ω are regression coefficients. The probability that a respondent would be willing to pay a given monetary amount is:

$$Prob(yes) = prob(WTP \geq R_L) = 1 - M_{WTP}(R_L) \tag{2}$$

where $M_{WTP}(R_L)$ is the cumulative distribution function of the random WTP variable. The probability that the WTP would fall between any two monetary thresholds is:

$$Prob(R_U > WTP \geq R_L) = M_{WTP}(R_U) - M_{WTP}(R_L) \tag{3}$$

which results in a corresponding log-likelihood function for *n* number of respondents, algebraically represented as:

$$Log(L) = \sum_{i=1}^{n} Log \left\{ M_{WTP}\left(\frac{R_U - \omega x_i}{\sigma}\right) - M_{WTP}\left(\frac{R_L - \omega x_i}{\sigma}\right) \right\} \tag{4}$$

Following the assumption that the stochastic term is normally distributed, both ω and σ can be estimated and then used to calculate the mean and median WTP. As such, the mean WTP is given by $exp(x_i'\omega + \sigma^2/2)$ while the median WTP by $exp(x_i'\omega)$. Here, x' is taken as the vector of mean values of appropriate explanatory variables, ω as the vector of estimated

Table 1: Socio-demographic and economic variables of the respondents and the average of Nairobi's population

Variable	Variable description, type and measurement	Mean	Min	Max	Nairobi
Age	Number of years respondent has lived (continuous variable).	32.0	21	66	30.0
Gender	Share of gender of the respondents (dummy variable: 1=male; 0=otherwise).	0.64	0	1	0.70
Education	Level of education of respondent (categorical: 1= no education; 2=standard; 3=secondary ; 4= tertiary; 5=university).	3.47	1	5	3.00
Household income (Kshs.)	Average annual earnings (continuous variable).	18,566.67	4,500	69,000	25,500.00
Household size	Number of members in the household (continuous variable).	3.63	1	6	3.00
Distance	Length from nearby road in meters (continuous variable).	192.65	20	300	150.00
Vehicle ownership	Share of respondents owning a motor vehicle (dummy variable: 1=own; 0=otherwise).	0.17	0	1	0.20
Future income certainty	Share of respondents certain about future incomes (dummy variable: 1=certain; 0=otherwise).	0.63	0	1	-
Area of residence	Share of respondents residing in the urban area (dummy variable: 1=urban; 0=otherwise).	0.57	0	1	0.60
Scope	Share of emission reduction (dummy variable: 1=50%; 0=25%).	0.50	0	1	-
Format	Share of valuation formats capturing respondent uncertainty (dummy variable: 1=captures; 0=otherwise).	0.67	0	1	-

Nairobi's population information on future income certainty, scope and format was unavailable.

coefficients and σ as the estimated standard variance. Notably, explanatory variables initially considered for the computation of mean WTP estimates are described in Table 1. However, stepwise regression was used to identify significant predictors of the stated WTP following Wang *et al.* (2006). Consequently, insignificant variables were dropped and the final set of variables used in the computation of the mean WTP estimates are shown in Table 6.

5. Findings and discussion

5.1 Descriptive results across the valuation formats

Descriptive results of the socio-demographic and economic characteristics of the respondents across the valuation formats are presented in Table 2. As shown, the mean age of the respondents was 32 years with men accounting for the largest share (64%) of the respondents. Most respondents had secondary level of education and an average household size of 3 people. The average annual income of respondents was Kshs. 18,566.67 ($218.43) with a large share of respondents (63%) saying they were certain about their future incomes. On average, respondents resided 192.65 metres from nearby roads with a majority (57%) living in the urban areas as opposed to peri-urban areas (43%). Only a minority (17%) of respondents said they owned a motor vehicle.

To assess whether or not there were significant differences among respondents' socio-demographic and economic characteristics across PC, SPC and PPC formats, the non parametric Kruskal-Wallis test was performed. As shown in the last columns of Table 2, most respondent characteristics differed significantly across the formats except for age, gender and ownership of motor vehicles. This implied that respondents' characteristics had to be controlled for in the computation of mean WTP that would be used for scope sensitivity analysis.

Table 2: Descriptive results on respondents' socio-economic and demographic characteristics across formats in the city

Variable	PC		SPC		PPC		Whole Sample		Kruskal-Wallis test	
	Mean	Std. error	Mean	Std. error	Mean	Std. error	Mean	Std. error	Chi-square	p-value
Age	31.50	0.37	32.00	0.38	32.50	0.38	32.00	0.35	3.60	0.166
Gender	0.62	0.02	0.64	0.02	0.65	0.02	0.64	0.01	1.12	0.571
Education	3.61	0.05	3.34	0.04	3.47	0.04	3.47	0.03	16.98***	0.000
Household income (Kshs.)	19,400	215.27	17,500	194.18	18,800	208.60	18,566.67	205.28	9.28***	0.010
Household size	3.49	0.06	3.79	0.05	3.60	0.05	3.63	0.03	21.84***	0.000
Distance to nearby road	212.00	2.36	169.90	1.89	196.05	2.18	192.65	2.13	25.92***	0.000
Vehicle ownership	0.18	0.02	0.16	0.02	0.19	0.02	0.17	0.01	1.83	0.401
Future income certainty	0.83	0.02	0.52	0.02	0.54	0.02	0.63	0.01	31.48***	0.000
Area of residence	0.69	0.02	0.52	0.02	0.51	0.02	0.57	0.01	34.05***	0.000

Notes: *, ** and *** denote $p < 0.1$, $p < 0.05$ and $p < 0.01$.
PC (payment card); SPC (stochastic payment card); PPC (polychotomous payment card).
Age (continuous variable); Gender (dummy: 1=male, 0=otherwise); Education (categorical: 1=no education; 2=primary school; 3=secondary school; 4=tertiary education; 5=university degree); Household income (continuous); Household size (continuous); Distance (continuous); Vehicle ownership (dummy: 1=own, 0=otherwise); Future income certainty (dummy: 1=certain, 0=otherwise); Area of residence (dummy: 1=urban, 0=otherwise).

5.2 Scope sensitivity analysis

Notably, the survey had a target of 1464 respondents but, only 1460 respondents completed the questionnaires. While 1219 (83%) respondents indicated a positive WTP, 241 (17%) respondents stated a zero WTP. For respondents who stated a zero WTP, a closed-ended debriefing question was presented them so as to separate protest responses from true zeroes. Hence, four possible alternatives were presented to respondents, namely: i) because air quality improvement has no value to me. ii) because it is the responsibility of the Government; iii) because I have many other basic financial commitments and; iv) because it is the responsibility of motor vehicle owners.

Following Strazzera *et al.* (2003), the first and the third responses were categorized as true zeroes while the other two as protest responses since they did not address the value of the good in question but rather some objection as to who should actually pay for motorized emission reductions. Based on the above classification, 96 (7%) respondents had true zero WTP responses while 145 (10%) had protest responses. Following Mitchell and Carson (1989), Whitehead *et al.* (1998), Strazzera *et al.* (2003), Wang and Whittington (2000; 2005), Dziegielewska and Mendelsohn (2007) and Brouwer (2009), the protest responses were dropped off from the analysis. Therefore, only 1315 responses, about 90% of the sample size, were subjected to further analysis. Preliminary analysis showed clear response patterns of the bid amounts and levels of certainty. The survey found that majority of respondents (90% for the SPC and 76% for PPC) were definitely certain about paying the lowest bid amount (Kshs 25 ($0.29)) for motorized emission reductions. Likewise, majority of them (95% for the SPC and 100% for PPC) were also definitely certain that they would not pay the highest bid amount (Kshs. 2,000 ($23.5)) to reduce emissions. As for the ability to pay, the study found that majority of the respondents (26% for the PC, 27% for SPC and 22% for PPC) were in the annual income range of Kshs. 20,000-30,000 ($235-$352). The

rest of the results on internal ('within' respondent) and external ('between' respondent) tests of scope, which are robust in all the three formats, are presented in Tables 3 and 4 and Table 5, respectively. Table 3 presents the results about half of the respondents presented with the bottom-up valuation questions while Table 4 presents the results about half of the respondents presented with the top-down valuation questions. The results are also presented as per the CV formats used to elicit WTP responses.

In regard to PC format, the valuation results presented in Table 3 indicate that respondents were on average willing to pay Kshs. 127.09 ($1.52) for reducing motorized emissions by 25% and Kshs. 206.67 ($2.43) for emission reduction by 50%. The results imply that respondents had a larger WTP for larger emission reductions than for smaller reductions. Subsequently, the null hypothesis of no significant differences in the mean WTP for the bottom-up approach to emission reduction was rejected at the 1% level of significance. For the SPC format, the study found that respondents were on average willing to pay Kshs. 68.77 ($0.81) for 25% emission reduction and Kshs. 110.77 ($1.30) for 50% reduction. In this case, respondents were also willing to pay larger amounts for larger emission reductions as opposed to smaller reductions. Conversely, these amounts are smaller compared to those under the PC format where respondents were assumed to be certain about their preferences. On the whole, the null hypothesis on the equality of mean WTP estimates for the bottom-up emission reductions was also rejected at the 1% level of significance. As for the PPC format, the mean WTP for 25% emission reduction was Kshs. 81.60 ($0.96) and Kshs. 123.02 ($1.45) for 50% reduction. Thus, respondents were also willing to pay larger amounts for larger emission reductions as opposed to smaller reductions. Like in the SPC case, the mean WTP under the PPC format was also smaller than the one for PC format where respondents were assumed to be certain about their preferences. The null hypothesis of the equality of mean WTP for the bottom-up emission reduction was rejected at the 1% level of

Table 3: Interval regression results on internal tests of scope sensitivity for the bottom-up motorized emission reductions in the city

Description	PC		SPC		PPC	
Hypotheses	$H_0: \text{wtp}_{BU(25\%)}^{pc} = \text{wtp}_{BU(50\%)}^{pc}$		$H_0: \text{wtp}_{BU(25\%)}^{spc} = \text{wtp}_{BU(50\%)}^{spc}$		$H_0: \text{wtp}_{BU(25\%)}^{ppc} = \text{wtp}_{BU(50\%)}^{ppc}$	
Percentage of emission reduction.	25%	50%	25%	50%	25%	50%
Mean WTP	127.09	206.67	68.77	110.77	81.60	123.02
Standard error.	7.28	13.14	4.62	9.70	5.51	11.43
Sub-sample size	218	218	228	228	211	211
Bootstrapped 95% confidence intervals.	110.47 – 143.70	175.01 – 238.33	61.63 – 75.90	99.26 – 122.27	69.99 – 93.20	105.68 – 140.36
T-test value	5.511***		4.148***		3.458***	
P-value	0.000		0.000		0.001	

Notes: *, ** and *** denote $p < 0.1$, $p < 0.05$ and $p < 0.01$.

PC (payment card); SPC (stochastic payment card); PPC (polychotomous payment card).

BU (bottom-up approach).

significance. These results imply that the mean WTP for the bottom-up internal test of scope (the 'within respondent' mean WTP for 25% emission reduction first followed by 50% reduction) were scope sensitive and that respondents passed the bottom-up internal test of scope. However, uncertain (SPC and PPC) respondents stated significantly lower amounts for larger emission reductions than certain (PC) respondents.

In Table 4, the survey found that the mean WTP for 50% motorized emission reduction under the PC format was Kshs. 310.05 ($3.65) and Kshs. 238.76 ($2.81) for 25% reduction. Similarly, respondents were willing to pay higher amounts for larger emission reductions as opposed to smaller reductions. Accordingly, the null hypothesis of no significant differences in the mean WTP for the top-down approach to emission reductions was rejected at the 1% level of significance. For the SPC format, respondents' mean WTP for 50% emission reduction was Kshs. 130.10 ($1.53) while that for 25% reduction was Kshs. 70.10 ($0.82). The null hypothesis on the equality of mean WTP for the top-down emission reduction was also rejected at the 1% level of significance. Notably, respondents were willing to pay higher amounts for larger emission reductions as opposed to smaller reductions. Results from the PPC format were not different from those presented above since respondents were also willing to pay more (Kshs. 85.34 ($1.00)) for larger emission reductions (50%) and less (Kshs. 49.86 ($0.56)) for smaller reductions (25%). The null hypothesis that the mean WTP estimates were equal for top-down emission reduction was rejected at the 1% level of significance. Correspondingly, the results imply that the 'within respondent' mean WTP for 50% emission reduction first followed by 25% reduction (the top-down internal test of scope) were scope sensitive and that respondents passed the top-down internal test of scope. Similar finding are reported by Loomis and Ekstrand (1997), Poe *et al.* (2000), Foster and Mouranto (2003), Bateman *et al.* (2004) and Czajkowski and Hanley (2009) among others where respondents pass the internal test of scope. However, as noted by Bateman *et al.*

Table 4: Interval regression results on internal tests of scope sensitivity for the top-down motorized emission reductions in the city

Description	PC		SPC		PPC	
Hypotheses	$H_0: wtp^{pc}_{TD(50\%)} = wtp^{pc}_{TD(25\%)}$		$H_0: wtp^{spc}_{TD(50\%)} = wtp^{spc}_{TD(25\%)}$		$H_0: wtp^{ppc}_{TD(50\%)} = wtp^{ppc}_{TD(25\%)}$	
Percentage of emission reduction.	50%	25%	50%	25%	50%	25%
Mean WTP	310.05	238.76	130.10	70.10	85.34	49.86
Standard error.	16.40	13.70	12.17	4.4	5.97	3.37
Sub-sample size	217	217	217	217	224	224
Bootstrapped 95% confidence intervals.	276.78 – 343.33	206.70 – 270.81	108.66 – 151.53	59.82 – 80.39	74.21 – 96.48	43.57 – 56.15
T-test value	3.349***		5.120***		5.400***	
P-value	0.001		0.000		0.000	

Notes: *, ** and *** denote $p < 0.1$, $p < 0.05$ and $p < 0.01$.

PC (payment card); SPC (stochastic payment card); PPC (polychotomous payment card).

TD (top-down approach).

(2004), respondent in this survey may as well have passed the internal test of scope owing to the urge to remain consistent with their responses.

Table 5 presents the results of the external ('between' respondents) tests of scope. Under the PC format, the results show that respondents were on average willing to pay Kshs. 127.09 ($1.52) for 25% emission reduction and Kshs. 310.05 ($3.65) for 50% reduction. The null hypothesis of no significant differences in the 'between respondents' mean WTP was rejected at the 1% level of significance. Under the SPC format, the survey found that respondents were willing to pay Kshs. 68.77 ($0.81) for reducing emissions by 25% and Kshs. 130.10 ($1.53) for 50% emission reduction. The null hypothesis of equality of the 'between respondents' mean WTP for emission reductions was rejected at the 1% level of significance. As for the PPC format, the survey established that the mean WTP for 25% emission reduction was Kshs. 81.60 ($0.96) and that for 50% reduction was Kshs. 85.34 ($1.00). The null hypothesis of no significant differences of the 'between respondents' mean WTP for emission reductions was, however, not rejected even at the 10% level of significance. This is because the marginal value of change in the mean WTP was quite small that it was masked by the statistical error. All in all, the results imply that the 'between respondent' mean WTP estimates for the emission reduction were scope sensitive and that respondents passed the external test of scope. Like in the earlier case, uncertain (SPC and PPC) respondents stated significantly lower amounts for larger emission reductions than certain (PC) respondents.

Except for the non significant results from the PPC format, all the other significant results imply that the 'between respondent' estimates of the mean WTP for emission reductions were scope sensitive and that respondents passed the external test of scope. Similar findings have been reported by Carson and Mitchell (1993), Whitehead *et al.* (1998), Foster and

Table 5: Interval regression results on external tests of scope sensitivity for motorized emission reductions in the city

Description	PC		SPC		PPC	
Hypotheses	$H_0: wtp^{pc}_{BU(25\%)} = wtp^{pc}_{BU(50\%)}$		$H_0: wtp^{spc}_{BU(25\%)} = wtp^{spc}_{BU(50\%)}$		$H_0: wtp^{ppc}_{BU(25\%)} = wtp^{ppc}_{BU(50\%)}$	
Percentage of emission reduction.	25%	50%	25%	50%	25%	50%
Mean WTP	127.09	310.05	68.77	130.10	81.60	85.34
Standard error.	7.28	16.40	4.62	12.17	5.51	5.97
Sub-sample size	218	217	228	217	211	224
Bootstrapped 95% confidence intervals.	110.47 – 143.70	276.78 - 343.33	61.63 – 75.90	108.66 – 151.53	69.99 – 93.20	74.21 – 96.48
T-test value	15.246***		5.488***		0.329	
P-value	0.000		0.000		0.742	

Notes: *, ** and *** denote $p < 0.1$, $p < 0.05$ and $p < 0.01$.

PC (payment card); SPC (stochastic payment card); PPC (polychotomous payment card).

BU (bottom-up approach).

Mouranto (2003) and Loomis *et al.* (2009). Notably, PC format, which operates on the assumption that respondents know their WTP with certainty, consistently yielded larger mean WTP values than SPC and PPC formats. For instance, the format yielded Kshs. 161.88 as opposed to Kshs. 89.77 for SPC and Kshs. 102.31 for PPC formats. Following this revelation, it can be said that allowing respondents to express their level of uncertainty (as is the case with SPC and PPC formats) had a downward effect on their stated WTP and hence, their sensitivity to scope.

5.3 Explaining individuals sensitivity to scope

In this case, interval observations were used to explain individuals' sensitivity to scope. Prior to interval regressions, a spearman's correlation test was conducted to assess the existence of multicollinearity among the regressors shown in Table 6. Notably, the presence of large bivariate correlations with rho coefficient of 0.9 are generally used to show strong linear associations, which implies that collinearity may be a problem (Strazzera *et al.,* 2003). The results of this test, however, ruled out the presence of multicollinearity in the models as the rho coefficients of correlation were below the established rule ($\rho < 0.9$) for the variables. Besides, the calculation of the Variance Inflation Factor (VIF) also justified the absence of multicollinearity among the variables since the calculations yielded a mean VIF of 1.15 against a benchmark of 10.0.

For the interval regressions, the dependent variable measured the sensitivity of individuals' WTP towards the scope of motorized emission reductions in the city of Nairobi. It was captured through interval data on the amounts respondents were willing to pay for 25% and 50% magnitudes of motorized emission reductions. This variable was regressed on the age and gender of the respondent, respondents' income, distance respondents reside from nearby roads, motor vehicle ownership, respondents' area of residence and two dummy variables,

Table 6: Interval regression results on factors explaining individuals' sensitivity to scope for motorized emission reductions in the city

Explanatory factor	PC model Coefficient	Std. error	SPC model Coefficient	Std. error	PPC model Coefficient	Std. error	PC-SPC-PPC model Coefficient	Std. error
Age	-0.061***	0.006	-0.080***	0.005	-0.047***	0.006	-0.063***	0.004
Gender	0.228	0.146	0.258**	0.116	0.176	0.131	0.269***	0.081
Household income	1.97e-05***	5.51e-06	3.12e-05***	6.05e-06	3.80e-05***	6.51e-06	2.59e-05***	3.43e-06
Distance to nearby road	-0.006***	7.19e-04	-1.99e-04	6.82e-04	-0.004***	8.43e-04	-0.004***	4.38e-04
Vehicle ownership	-0.045	0.183	-0.111	0.174	-0.885***	0.198	-0.139	0.106
Area of residence	0.600***	0.149	0.461***	0.102	1.029***	0.112	0.857***	0.072
Scope (50%=1; 25%=0)	0.599***	0.135	0.241**	0.104	0.322***	0.118	0.042	0.074
Format (uncertain=1; certain=0).	-	-	-	-	-	-	-0.354***	0.077
lnsigma (σ)	0.350***	0.036	0.097***	0.036	0.191***	0.036	0.296***	0.021
Sigma (σ)	1.419	0.051	1.101	0.039	1.211	0.044	1.344	0.028
Log likelihood	-1204.42		-973.05		-970.15		-3249.10	
Interval observations	435		445		435		1315	
Wald chi2 (7)	4952.03		5587.42		4163.22		-	
Wald chi2 (8)	-		-		-		12494.30	
Probability > chi2	0.000		0.000		0.000		0.000	

Notes: *, ** and *** denote $p < 0.1$, $p < 0.05$ and $p < 0.01$.

PC (payment card); SPC (stochastic payment card); PPC (polychotomous payment card).

Age (continuous variable); Gender (dummy: 1=male, 0=otherwise); Household income (continuous); Distance (continuous); Vehicle ownership (dummy: 1=own, 0=otherwise); Area of residence (dummy: 1=urban, 0=otherwise); Scope (dummy: 1=50% emission reduction, 0=25% emission reduction); Format (dummy: 1=format capturing respondent uncertainty, 0=format capturing respondent certainty).

that is, *'scope'* to capture respondents sensitivity to 25% and 50% magnitudes of emission reduction that was done by testing whether its sign is positive and statistically significant (Czajkowski and Hanley, 2009; Loomis *et al.,* 2009); and '*format*' to capture the effect of allowing respondents to express their level of uncertainty (as in SPC and PPC formats) on scope sensitivity as proxied by the amounts respondents were willing to pay for the different magnitudes of emission reduction. The effect of this variable was evaluated by analyzing its sign and statistical significance, following a procedure by Loomis *et al.* (2009). All the results are presented in Table 6.

As shown in the table, the likelihood functions of all the four models (PC, SPC, PPC and the PC-SPC-PPC) are all significant at 1% level of significance, which implies that the models had strong explanatory power. On the relationships among variables, the study found the existence of an inverse relationship between respondents' age and the sensitivity of respondents WTP to the scope of motorized emission reductions. This means that older persons were less likely to be scope sensitive than younger persons. A positive relationship was, on the other hand, found between respondents' gender and sensitivity to scope, which means that males were more likely to be scope sensitive than females. As for the income variable, a positive relationship with individuals' sensitivity to scope was established implying that high income individuals were more likely to be scope sensitive than low income individuals. For the distance variable, a negative relationship with individuals' sensitivity to scope was unveiled. This means that individuals living closer to nearby roads were more likely to be scope sensitive than individuals living further away from nearby roads. This finding is the result of what Brouwer *et al.* (2006) termed as distance-decay effects. On the car ownership variable, an inverse relationship was established with regard to individuals' sensitivity to scope. It means that non car owners were more likely to be scope sensitive than car owners. This is probably because, unlike car owners, non car owners may

have limited incentives for strategic behaviour suppose that the motorized emission reduction plan was to be implemented.

On the relationship between the area of residence (urban or peri-urban) and individuals' sensitivity to scope, study findings show that respondents residing in the urban areas where motorized emissions are high were more likely to be scope sensitive than respondents residing in the peri-urban areas where emissions are minimal. The *'scope'* variable emerged positive and statistically significant, which means that the survey respondents were scope sensitive and that they would pay larger amounts for larger emission reductions (50%) than for smaller reductions (25%). Hence, responses in the survey passed the scope sensitivity test. This finding compares well with findings by Loomis and Ekstrand (1997), Poe *et al.* (2000), Foster and Mouranto (2003), Bateman *et al.* (2004), Czajkowski and Hanley (2009) and Loomis *et al.* (2009) among others. As for the '*format*' variable, an inverse relationship was unveiled. It means that uncertain respondents were less likely to be scope sensitive than certain respondents. The negative sign and the statistical significance of this variable suggests that indeed, respondent uncertainty had a downward effect on individuals' sensitivity to scope. In other words, allowing respondents to express their level of uncertainty (as in SPC and PPC formats) was likely to result in lower payments for larger emission reductions than the case when respondents are assumed to be certain (as in PC format).

6. Conclusions and recommendations

The aim of the survey was to ascertain whether respondent uncertainty had any effect on respondents' sensitivity to goods' scope. This was done in the context of the willingness of individuals to pay for a policy proposal to reduce motorized emissions in the city of Nairobi Kenya. The study applied contingent valuation method through PC, SPC and the PPC

31

formats to elicit WTP values for the bottom-up (25% then 50%) and top-down (50% then 25%) emission reductions based on advance disclosure approach. This enabled testing of various hypotheses on 'within' and 'between' respondents WTP in order to ascertain whether respondents were internally and externally sensitive to scope. While the PC format conventionally assumes that respondents are certain about their WTP, SPC and the PPC formats assume that respondents are uncertain and therefore, allow them to express their level of uncertainty. Hence, the use of SPC and PPC formats, based on the findings of the PC format, enabled the testing of whether or not respondent uncertainty had influence on individuals' sensitivity to scope.

The study findings show that individual responses for motorized emission reductions in the city were both internally and externally scope sensitive except for the findings under the PPC format in the latter case. These findings are generally consistent with economic theory, which supposes that welfare estimates should be sensitive to changes in the magnitudes of the good under valuation. The results also make a novel contribution to CV literature regarding scope tests under conditions of respondent uncertainty. It was established that when individuals are given the opportunity to express their level of uncertainty, as in SPC and PPC formats, it is likely that they will be less sensitive to scope than in the case where they are assumed to be certain, as in PC format. Therefore, accounting for respondent uncertainty has the potential to lower the scope sensitivity of individuals in CV. In regard to the determinants of individuals' sensitivity to scope, the study findings show that age and gender of the respondent, respondents' income, distance respondents dwell from nearby roads, motor vehicle ownership and the area of residence have statistically significant influence on the sensitivity of individuals' WTP for emission reductions. The *'scope'* variable is positive and significant implying that respondents in the survey were willing to pay larger amounts for larger emission reductions than for smaller reductions hence, scope

sensitive. The '*format*' variable is negative and significant, meaning that allowing respondents to express their uncertainty significantly yields lower payments for larger emission reductions than when respondents are assumed to be certain about their preferences.

On the whole, the study has initiated a better understanding of the relationship between respondent uncertainty and scope sensitivity in CV. Going by the results, it is necessary for planners and policy makers in Nairobi, Kenya, Africa and beyond to account for respondent uncertainty when valuing air quality management programmes so as to come up with precise estimates of welfare change. However, this study is one of its kind in analyzing the relationship between respondent uncertainty and sensitivity to goods' scope in CV. While the results still appear to support the use of the CV method in studying the incremental benefits and costs of air quality management policies, they may only be unique to the study area and the subject under study. Therefore, more research is recommended on the subject of this study using other statistical models, other environmental goods or other countries.

References

Adamowicz, W.L., P.C. Boxall, J.J. Louviere, and Swait, J.D. (1999). Stated preference methods for valuing environmental amenities. In Bateman, I.J. and K.G. Willis (eds) Valuing environmental preferences: theory and practice of the contingent valuation method in the USA, EC, and developing countries. Oxford University Press, New York.

Akter, S. and J. Bennett (2008). Preference uncertainty in contingent valuation, *Ecological Economics* 67(3): 345 – 351.

Alberini, A., K. Boyle, and M. Welsh (2003). Analysis of contingent valuation data with multiple bids and response options allowing respondents to express uncertainty, *Environmental Economics and Management* 45(1):40-62.

Beattie, J., J. Covey, P. Dolan, L. Hopkins, M. Jones-Lee, N. Pidgeon, A. Robinson, and A. Spencer (1998). On the Contingent Valuation of Safety and the Safety of Contingent Valuation: Part I - Caveat Investigator, *Risk and Uncertainty* 17(3): 5-25.

Bateman, I.J., M. Cole, P. Cooper, S. Georgiou, D. Hadley, and G.L. Poe (2004). On Visible Choice Sets and Scope Sensitivity, *Environmental Economics and Management* 47(1): 71-93.

Blomquist G.C., K. Blumenschein, and M. Johannesson (2009). Eliciting willingness to pay without bias using follow-up certainty statements: comparisons between probably/definitely and a 10-point certainty scale, *Environmental and Resource Economics* 43(4):473-502.

Brouwer, R. (2009). Stated preference uncertainty: signal or noise? Institute for Environmental Studies, VU University Amsterdam, The Netherlands.

Brouwer, R., S. Aftab, L. Brander, and E. Haque (2006). Economic valuation of flood risk exposure and flood control in a severely flood prone developing country. Poverty Reduction and Environmental Management (PREM) Working Paper, 06/02.

Cameron, T. A. and D. D. Huppert (1989). OLS versus ML estimation of non market resource values with payment card interval data, *Environmental Economics and Management* 17(3): 230-246.

Carlsson, F. and O. Johansson-Stenman (2000). Willingness to pay for improved air quality in Sweden, *Applied Economics* 32(6): 661-669.

Carson, R.T. (1997). Contingent Valuation Surveys and Tests of Insensitivity to Scope. In R.J. Kopp, W. Pommerhene, and N. Schwartz, eds., Determining the Value of Non marketed Goods: Economic, Psychological, and Policy Relevant Aspects of Contingent Valuation Methods. Boston, Kluwer, pp. 127-163.

Carson, R., T. (2000). Contingent valuation: a user's guide, *Environmental Science and Technology* 34(8): 1413–1418.

Carson, R and R. Mitchell (1993). Using surveys to value public goods: the contingent valuation method. Washington, DC, Resources for the Future.

Carson, R.T. and T. Groves (2007). Incentive and informational properties of preference questions, *Environmental and Resource Economics* 37(1):181–210.

Central Bureau of Statistics (CBS) (2009). Economic Survey (2009). *Central Bureau of Statistics*, Nairobi, Kenya.

Champ, P.A. and T.C. Brown (1997). A comparison of contingent and actual voting behaviour. Proceedings from W-133 Benefits and Cost Transfer in Natural Resource Planning, Portland, USA.

Czajkowski, M. and N. Hanley (2009). Using labels to investigate scope effects in stated preference methods, *Environmental Resource Economics* 44(4):521–535.

Dominguez-Torreiro, M. and M. Solino (2011). Uncertainty in Individuals' Preferences for Non-commodity Outputs Provided by Rural Development Programs (RDPs): A Contingent Valuation Approach. European Association of Agricultural Economists, Zurich, Switzerland.

Dziegielewska, D.A. and R. Mendelsohn (2007). Does "No" mean "No"? A protest methodology, *Environmental and Resource Economics* 38(1): 71-87.

Firoozzarea, A. and M. Ghorbani, (2011). Investigation of citizens' WTP for Mashhad air pollution reduction: applying Heckit model. Khavaran Higher-education Institute, Mashhad, Iran.

Fonta, M.W. and E.H. Ichoku, (2009). The value of managing urban solid waste: a case study of Enugu State, Nigeria, *Canadian Journal of Development Studies* 28(3): 3–14.

Foster, V. and S. Mouranto (2003). Elicitation format and sensitivity to scope do contingent valuation and choice experiments give the same results? *Environmental and Resource Economics* 24(2): 141–160.

Freeman, A., M. (1993). The measurement of environmental and resource values: theory and methods. Resources for the Future, Washington.

Gregory, R., S. Lichtenstein, and P. Slovic (1993). Valuing environmental resources: a constructive approach, *Risk and Uncertainty* 7(2): 177–197.

Gyldmark, M. and G.C. Morrison (2001) Demand for health care in Denmark: results of a national sample survey using contingent valuation, *Social Science and Medicine* 53(8):1023–1036.

Haab, T.C. and K.E. McConnell (2002). Valuing Environmental and Natural Resources: the Econometrics of Non market Valuation. Edward Elgar, Cheltenham.

Hammit, J. K. and J.D. Graham (1999). Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability? *Risk and Uncertainty* 18(1): 33–62.

Hanley, N., D. MacMillan, I. Patterson, and R.E. Wright (2003). Economics and the design of nature conservation policy: a case study of wild goose conservation in Scotland using choice experiments, *Animal Conservation* 6(2):123–129.

Hausman, J.A. (1993) Contingent Valuation: A Critical Assessment. Contributions to Economic Analysis (Ed). Amsterdam: North Holland Publishers.

Heberlein, T.A., M.A. Wilson, R.C. Bishop, and N. Cate (2005). Rethinking the scope test as a criterion for validity in contingent valuation, *Environmental Economics and Management* 50(1): 1-22.

Johannesson, M., B. Liljas, and P.O. Johansson (1998). An experimental comparison of dichotomous choice contingent valuation questions and real purchase decisions, *Applied Economics* 30(5): 643-47.

Kahneman, D. and J. Knetsch, (1992). Valuing public goods: the purchase of moral satisfaction, *Environmental Economics and Management* 22(1): 57–70.

Kahneman, D. (1986) "Comments." In Valuing Environmental Goods: An Assessment of the Contingent Valuation Method, edited by Ronald G. Cummings, David S. Brookshire and William D. Schulze. Totowa, NJ: Rowman and Allanheld.

Kinney, P.L., M. Gatari, N. Volavka-close, N. Ngo, P.K. Ndiba, A. Law, A. Gachanja, M.S. Gaita, S.N. Chilrud, and E. Sclar (2011). Traffic impacts on PM 2.5 air quality in Nairobi, Kenya, *Environmental Science and Policy* 14(4): 369-378.

Klose, T. (1999). The contingent valuation method in health care, *Health Policy* 47(2): 97-123.

Li, C. and L. Mattsson (1995). Discrete choice under preference uncertainty: an improved structural model for contingent valuation, *Environmental Economics and Management* 28(2): 256-269.

Logar, I. and J.C.J.M. van den Bergh (2012). Respondent uncertainty in contingent valuation of preventing beach erosion: An analysis with a polychotomous choice question. *Environmental Management* 113: 184-193

Loomis, J. and E. Ekstrand (1997). Economic benefits of critical habitat for the Mexican spotted owl: a scope test using a multiple-bounded contingent valuation survey, *Agricultural and Resource Economics* 22(2):356-366.

Loomis, J. and E. Ekstrand (1998). Alternative approaches for incorporating respondent uncertainty when estimating willingness to pay: The case of the Mexican spotted owl, *Ecological Economics* 27(1): 29–41.

Loomis, J.B., L. Trong, and A. González-cabán (2009). Willingness to pay function for two fuel treatments to reduce wildfire acreage burned: a scope test and comparison of white and Hispanic households, *Forest policy and economics* 11(3):155-160.

Martínez-Espiñeira, R. and N. Lyssenko (2012). Alternative approaches to dealing with respondent uncertainty in contingent valuation: A comparative analysis, *Environmental Management* 93(1): 130-139.

Mendelsohn, R., and Olmstead, S. (2009). The Economic valuation of environmental amenities and disamenities: methods and applications, *Annual Review of Environment and Resources* 34:325–347.

Ministry of Roads and Public Works (MORPW) (2009). Traffic Situation in Nairobi. Ministry of Roads and Public Works, Government of Kenya, Nairobi, Kenya.

Mitchell, R.C. and R.T. Carson (1989). Using surveys to value public goods: the contingent valuation method, Johns Hopkins University Press, Baltimore.

Moore, R., R.C. Bishop, B. Provencher, and P. A. Champ (2010). Accounting for respondent uncertainty to improve willingness-to-pay estimates, *Canadian Journal of Agricultural Economics* 58(3):381-401.

Morrison, M.D., R.K. Blamey, and J.W. Bennett, (2000). Minimizing payment vehicle bias in contingent valuation studies, *Environmental and Resource Economies* 16(4): 407-422.

Mulaku, G.C. and L.W. Kariuki (2001). Mapping and analysis of air pollution in Nairobi, Kenya. International Conference on Spatial Information for Sustainable Development. Nairobi, Kenya.

NEMA (2010). State of the environment report for Kenya. National Environment Management Authority, Nairobi.

Nielsen, J.S. and T. Kjær (2011). Does question order influence sensitivity to scope? Empirical findings from a web-based contingent valuation study, *Environmental Planning and Management* 54(3): 369-381.

Odhiambo, G.O., A.M. Kinyua, C.K. Gatebe, and J. Awange (2010). Motor vehicles air pollution in Nairobi, Kenya, *Research Journal of Environmental and Earth Sciences* 2(4): 178–187.

Petrolia, D.R. and T.G. Kim, (2011). Contingent valuation with heterogeneous reasons for uncertainty, *Resource and Energy Economics* 33(3): 515-526.

Poe, G.L., K.J. Boyle, and J.C. Bergrsom (2000). A Meta Analysis of Contingent Values for Groundwater Contamination in the United States. Paper presented at the European Association of Environmental and Resource Economists, Rythymnon, Greece.

Polasky, S., O. Gainutdinova, and J. Kerkvliet (1996). Comparing CV Responses with Voting Behaviour: Open Space Survey and Referendum in Corvallis Oregon, paper presented at annual U.S.D.A. W-133 meeting, Jekyll Island, GA.

Ready, R., J. Whitehead, and G.C. Blomquist (1995). Contingent valuation when respondents are ambivalent, *Environmental Economics and Management* 29(2):181-197.

Ready, R., S. Navrud, and W.R. Dubourg, (2001). How do respondents with uncertain willingness to pay answer contingent valuation questions? *Land Economics* 77(3): 315–26.

Randall, A. and J.P. Hoehn, (1996). Embedding in Market Demand Systems, *Environmental Economics and Management* 30(3):369-380.

Rollins, K. and A. Lyke (1998). The Case for Diminishing Marginal Existence Values, *Environmental Economics and Management* 36(3): 324-344.

Ryan, M., D.A. Scott, and C. Donaldson (2004). Valuing health care using willingness to pay: a comparison of the payment card and dichotomous choice methods, *Health Economics* 23(2): 237–258.

Samnaliev, M., T.H. Stevens, and T. More (2006). A comparison of alternative certainty calibration techniques in contingent valuation, *Ecological Economics* 57(3):507-519.

Shaikh, S., L. Sun, and G.C. van Kooten (2007). Treating respondent uncertainty in contingent valuation: a comparison of empirical treatments, *Ecological Economics* 62(1): 115–25.

Shechter, M. and M. Kim, (1991). Valuation of pollution abatement benefits: direct and indirect measurement, *Urban Economics* 30(2): 133-151.

Bergamo, S. and P. Paolo (2011). Italian consumers' willingness to pay for renewable energy sources. Department of Economics, Finance and Statistics, University of Perugia, Rome, Italy.

Smith, K.V. (1993). Non market valuation of environmental resources: an interpretive appraisal, *Land Economics* 69(1): 1-26.

Smith, V.K. (1999). Of birds and books: more on hypothetical referenda, *Political Economy* 10(7): 197–200.

Smith, V.K., and L. Osborne (1996). Do Contingent Valuation Estimates Pass a Scope Test? A Meta Analysis, *Environmental Economics and Management* 31(3): 287-301.

Strazzera, E., M. Genius, R. Scarpa, and G. Hutchinson (2003). The effect of protest votes on the estimates of WTP for use values of recreational sites, *Environmental and Resource Economics* 25(4): 461–476.

Sund, B. (2009). Certainty calibration in contingent valuation - exploring the within-difference between dichotomous choice and open-ended answers as a certainty measure. Swedish Business School, Örebro University, Sweden.

Svedsater, H. (2000). Contingent valuation of global environmental resources: test of perfect and regular embedding, *Economic Psychology* 21(6): 605-623.

van Kooten, G.C., E. Krcmar, and E.H. Bulte, (2001). Preference uncertainty in non- market valuation: a fuzzy approach, *American Journal of Agricultural Economics* 83(3): 487-500.

Veisten K.H., S. Navrud, and J. Strand (2004). Scope insensitivity in contingent valuation of complex environmental amenities, *Environmental Management* 73(4):314–331.

Vliet, E.D.S., and P.L. Kinney, (2007). Impacts of roadway emissions on urban particulate matter concentrations in sub-Saharan Africa: new evidence from Nairobi, Kenya, *Environmental Research Letters* 2(4): 1-5.

Wang, H. (1997). Treatment of "Don't-Know. Responses in contingent valuation surveys: a random valuation model, *Environmental Economics and Management* 32: 219-232.

Wang, H. and J. He (2011). Estimating individual valuation distributions with multiple bounded discrete choice data, Applied Economics 43(21): 2641-2656.

Wang, H. and D. Whittington (2000). Willingness to pay for air quality improvement in Sofia, Bulgaria. World Bank Policy Research Working Paper No 2280, Washington, DC: World Bank.

Wang, H. and D. Whittington (2005). Measuring individuals' valuation distributions using a stochastic payment card approach, *Ecological Economics* 55(2): 143–54.

Wang, X.J., W. Zhang, Y. Li, K.Z. Yang, and M. Bai (2006). Air quality improvement estimation and assessment using contingent valuation method: a case study in Beijing, *Environmental Monitoring and Assessment* 120(1): 153–168

Welsh, M.P. and G.L. Poe, (1998). Elicitation effects in contingent valuation: comparisons to a multiple bounded discrete choice approach, *Environmental Economics and Management* 36(2):170-85.

Whitehead, J., G. Blomquist, R. Ready, and J. Huang (1998). Construct validity of dichotomous choice contingent valuation questions, *Environmental and Resource Economics* 11(1): 107–116.

Whitehead, J.C., W.B. Clifford, and T.J. Hoban (2000). WTP for research and extension programs: divergent validity of contingent valuation with single and multiple bound valuation questions. Department of Economics, East Carolina University, Greenville, USA.